

# The Impact of *Eudrilus eugeniae* and *Eisenia fetida* Fed with different Feeds on the Quality of Soil

Medonguno Thami\*<sup>1</sup>, Lilongchem Thyug<sup>2</sup>, Rusokhrienuo Theunuo<sup>3</sup> and Pelesano Kin<sup>4</sup>

<sup>1-4</sup> Department of Zoology, Kohima Science College Jotsoma, Kohima - 797 001, Nagaland, India

Received: 16 May 2026; Revised accepted: 20 June 2026

## Abstract

The present study was undertaken for 80 days, to evaluate the quality of vermicompost soil using *Eudrilus eugeniae* and *Eisenia fetida* fed with two different feeds- Castor Leaves and Sweet Potato Leaves. The room temperature along with other key parameters were closely monitored and regulated during the experiment period. The growth performance of the earthworms and the physico-chemical properties of the vermicompost soils were observed, tabulated and a comparative study was done, wherein *Eisenia fetida* fed with Sweet Potato Leaves had the highest weight gain (171.4%), length increment (39.8%), number of adult earthworms (36%) and increased population (1373.3%). The results indicated that *Eisenia fetida* produced better soil quality and also exhibited better growth rate. Interestingly, the two feeds used in the study was found to have no significant impact on the soil quality. Physico-chemical analysis showed that pH was more acidic in the vermicompost samples along with higher concentrations of N, P and K. EC and OC was also found to be higher in these samples indicating the positive impact of earthworms on soil quality.

**Key words:** *Eudrilus eugeniae*, *Eisenia fetida*, Earthworms, Vermicompost, Nutrients, Feeds

Earthworms are terrestrial oligochaetes that belong to the phylum Annelida and constitute one of the largest animal biomasses in temperate ecosystem. They are considered ecosystem engineers [1-2], and are seen as prospective partner for man in ecosystem management [3], because of their ability to deplete diverse range of organic matter. Earthworms are found in damp, compost rich soil and typically absent or scarce in soil that has high clay content, a very coarse texture and acidic (pH < 4) [4] and are broadly classified into three groups viz: Epigeic, Endogeic, and Anecic [5]. The various soil physico-chemical properties like moisture, pH, Nitrogen (N), Phosphorus (P), Potassium (K), Organic Carbon (OC) etc. are influenced by earthworms due to participation in the association of soil particles as well as the transfer of biomass. Earthworms facilitate the putrefaction of organic matter by increasing the microbial activity and their numbers in the soil [6] and serves as ecological mediators [7].

Vermicomposting is a composting technique that uses the collective action of micro-organisms and earthworms to speed up the breakdown of biodegradable materials into nutrient rich soil. While microbes are primarily responsible for the metabolic degradation of organic materials, earthworms play a critical role in the process of aerating, acclimating and disintegrating the substrate, which significantly changes the activity of the microbes [8]. Vermicompost is a blend of organic matter, humus, live earthworms, cocoons, worm casts and other living things [9]. This non-thermophilic process can convert various organic materials such as kitchen wastes, agricultural wastes, industrial wastes, etc. into valuable fertilizers.

A small percentage of over 4,400 species of earthworms are suitable for vermicomposting. Vermicomposting requires earthworm species with high rates of assimilation, digestion and consumption of food, high growth rates, wide adaptability to external factors with varying temperature conditions, tolerance to diseases and have high reproduction rate [9]. While epigeic earthworms are utilized for vermicomposting, some anecic earthworms such as *Lampito mauritii* and *Lumbricus terrestris* have also been found to decompose organic matters and the combination of both the epigeic and anecic may be an advantage for the rapid production of vermicompost [10]. It has been found that during the initial phases of vermicomposting, epigeic earthworms like *Eisenia fetida* and *Eudrilus eugeniae* enriched their bacterial diversity [11-12] and are the most favored for composting showing optimal growth at 25°C, and the tolerance level ranging between 0-35°C for *Eisenia fetida* and 9-35°C for *Eudrilus eugeniae* [13], indicating that *Eisenia fetida* have wider temperature tolerance than *Eudrilus eugeniae*. The decomposition rate relies on the type of feeds or waste substances and the quality of vermicompost produced depend on the substrates used, moisture, pH, temperature and the earthworm species selected for the process. Vermicompost is frequently used as a fertilizer addition because it gradually releases main and minor nutrients while significantly lowering the C/N ratio to meet plant needs. There is paucity of information on vermicomposting abilities of earthworms in Nagaland and therefore, the present study attempts to assess the impact of different feeds on the two species separate feeds on the quality of soil.

\*Correspondence to: Medonguno Thami, E-mail: thamimedo7@gmail.com; Tel: +91 9089654043

Citation: Thami M, Thyug L, Theunuo R, Kin P. 2026. The impact of *Eudrilus eugeniae* and *Eisenia fetida* fed with different feeds on the quality of soil. *Res. Jr. Agril. Sci.* 17(3): 389-396.

## MATERIALS AND METHODS

The present investigation was carried out in the Lower Midland agro-climatic zone of Kohima district, Nagaland, India, over a period of 80 days from 27 December 2024 to 17 March 2025. Kohima is situated at an elevation of approximately 1,444 m above mean sea level and is geographically located at 25°40'39" N latitude and 94°06'34" E longitude. The region experiences a moderate subtropical highland climate, which provides favorable environmental conditions for vermicomposting activities. The experiment was conducted to evaluate the influence of two organic substrates, namely castor leaves (*Ricinus communis* L.) and sweet potato leaves (*Ipomoea batatas* L.), on vermicompost quality and the performance of two earthworm species, *Eudrilus eugeniae* and *Eisenia fetida*. Freshly collected castor and sweet potato leaves were partially decomposed for 2–3 days to facilitate microbial colonization and accelerate the decomposition process. The leaves were subsequently chopped into fragments of approximately 4–5 cm length to enhance the surface area available for microbial and earthworm activity. Cow dung aged 5–6 days was utilized as a supplementary feed and inoculum source due to its rich microbial population and balanced nutrient composition.

Two epigeic earthworm species, *Eudrilus eugeniae* and *Eisenia fetida*, widely recognized for their high efficiency in organic waste conversion, were employed in the study. Prior to their introduction into the experimental units, the number, individual body weight, and body length of the earthworms were recorded to assess growth and biomass gain during the vermicomposting period. The experiment consisted of 14 plastic pots (27 cm diameter × 26 cm depth), arranged under controlled conditions. Six pots were assigned to each earthworm species, with three replicates receiving castor leaves and three replicates receiving sweet potato leaves as substrates. The remaining two pots, containing the respective substrates

but without earthworms, served as controls. Each pot was prepared with a basal layer of crushed stones and 25 g of twigs to ensure proper drainage and aeration, followed by 2 kg of soil to simulate a natural bedding environment and 1.5 kg of cow dung as a pre-feeding material. Five adult earthworms were introduced into each treatment pot. The pots were covered with gunny bags to maintain darkness and moisture while allowing adequate aeration. Throughout the experimental period, temperature was maintained between 16 and 24°C, and moisture levels were sustained through watering on alternate days. To ensure continuous feed availability, an additional 200 g of the respective substrate was added whenever the initial material was substantially decomposed. Irrigation was discontinued three days prior to harvesting to facilitate vermicompost collection and separation of earthworms.

Upon completion of the 80-day composting period, vermicompost samples from each replicate were collected, air-dried, gently crushed, sieved, labeled, and subjected to physicochemical analysis using standard laboratory procedures. Soil reaction (pH) and electrical conductivity (EC) were determined in a 1:2.5 vermicompost-to-water suspension using digital pH and conductivity meters, respectively. Total nitrogen content was estimated by the Kjeldahl digestion method as described by Jackson [14], available phosphorus was determined using Olsen's extractant method, and available potassium was quantified using a flame photometer. Organic carbon content was estimated following the Walkley and Black wet oxidation method [15]. The selected parameters were used as indicators of vermicompost maturity and nutrient enrichment resulting from the interaction of substrate type and earthworm species. Statistical analyses were performed using appropriate and updated statistical software packages to evaluate the effects of substrate type, earthworm species, and their interactions on the physicochemical characteristics of the vermicompost. Treatment means were compared using suitable tests of significance at the prescribed probability level to determine statistically meaningful differences among treatments.



Plate 1 Castor leaves



Plate 2 Sweet potato leaves



Plate 3 *Eudrilus eugeniae* and *Eisenia fetida*

## RESULTS AND DISCUSSION

The weight, length, number of earthworms and the adult earthworms were measured, counted and recorded into the (Table 1). The experiment revealed that *Eisenia fetida* fed with sweet potato leaves (SPL) had the highest weight gain (171.4%), length increment (39.8%), number of adult earthworms (36%) and increased population (1373.3%). *Eudrilus eugeniae* supplied with SPL had the lower weight gain

(52.2%) and lowest length increment (16.4%). Whereas *Eudrilus eugeniae* provided with castor leaves (CL) had lower population growth (6.67%) and lower number of adult earthworms (Fig 1-3). The number of adult earthworms of *E. eugeniae* fed with both the substrates decreased in number as compared to the initial number of earthworms introduced which may probably be due to the temperature variations. *E. eugeniae* is known to thrive well in warmer temperatures [16]. Both earthworms enhanced body weight growth may result in

varying ambient state and the substrate's nature [16]. The expansion rate between the two species may be due to species

unique growth or the feed quality and inclinations by the individual earthworm's species [10].

Table 1 Growth performance of *Eudrilus eugeniae* and *Eisenia fetida* feeding on castor leaves and sweet potato leaves during the process of vermicomposting

Growth parameters	<i>Eudrilus eugeniae</i>		<i>Eisenia fetida</i>	
	Castor	Sweet potato	Castor	Sweet potato
Individual body weight				
Initial (g)	1.779±0.11	1.94±0.08	0.385±0.02	0.315±0.01
Final (g)	2.773±0.2	2.953±0.2	0.746±0.36	0.855±0.07
Weight gain (%)	55.9%	52.2%	93.8%	171.4%
Individual body length Individual body weight				
Initial (cm)	14.346±0.49	15.84±0.51	5.24±0.18	5.24±0.19
Final(cm)	18.22±0.8	18.438±0.7	7.15±0.3	7.33±0.3
Length increment (%)	27%	16.4%	36.45%	39.8%
Initial average number of EWs	15	15	15	15
Final average number of EWs	16±0.67	21±0.56	179±4.25	221±6.38
Average number of adult EWs	10±0.33	12±0.58	33±1.15	36±2.51
Increased population (%)	6.67%	40%	1093.3%	1373.3%

Each value represents the mean (Mean ± S.E) of three replicates

Table 2 Physico-chemical properties of vermicompost produced by *Eudrilus eugeniae* and *Eisenia fetida*

Parameters	Control	<i>E. eugeniae</i>	<i>E. fetida</i>	Control	<i>E. eugeniae</i>	<i>E. fetida</i>
	(Castor)	(Castor)	(Castor)	(Sweet potato)	(Sweet potato)	(Sweet potato)
pH	7.86	7.26	6.91	7.92	7.89	7.7
EC	0.69	1	1.16	0.69	0.78	0.93
Nitrogen (Kg/ha)	351.12	476.52	520.41	351.12	382.47	445.17
Phosphorus (Kg/ha)	362.17	420.11	476.97	387.08	412.69	392.57
Potassium (Kg/ha)	528.3	654.65	629.85	619.4	833.2	982
Organic carbon (%)	2.25	2.63	2.64	2.31	2.06	2.46

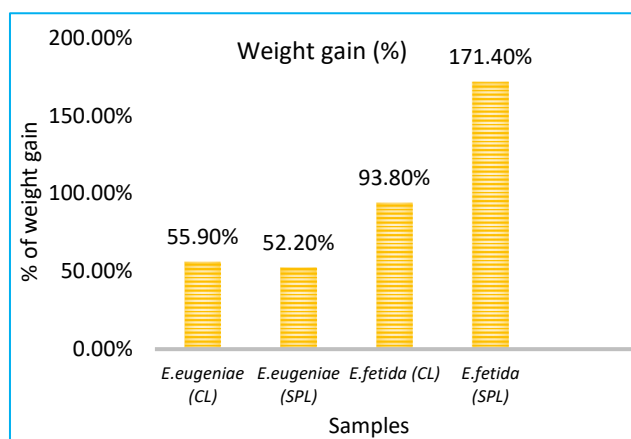


Fig 1 Weight gain (%) in the earthworms

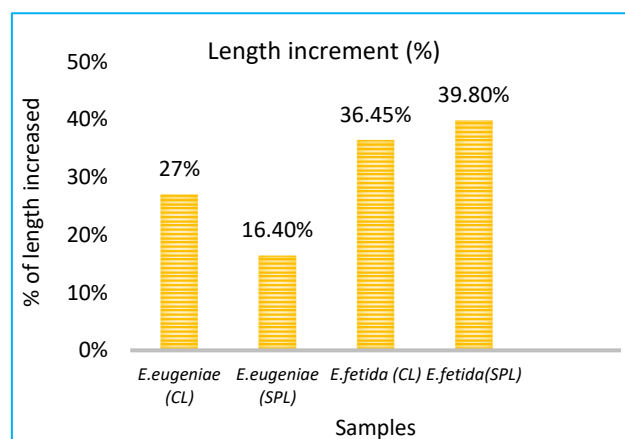


Fig 2 Body length increment (%) in the earthworms

Comparative values of the physico-chemical properties of soils (with and without worms) fed with castor leaves (CL) and sweet potato leaves (SPL) are shown in (Table 2). When provided with castor leaves, vermicompost with *Eisenia fetida* was more acidic than the soil with *Eudrilus eugeniae* (Fig 4) also the value of EC, N, P and OC present in the soil with *Eisenia fetida* was found to be higher than both the other two soil i.e. with *Eudrilus eugeniae* and Control sample (Fig 5-7, 9). However, the value of K in the soil sample with *Eudrilus eugeniae* was higher than the other two samples (Fig 8).

Similarly, with the substrate sweet potato leaves (SPL), soil with *Eisenia fetida* had lower pH value than *Eudrilus eugeniae* and the Control sample (Fig 10). The value of EC, N, K and OC present in the soil sample with *Eisenia fetida* is higher than the other two samples (Figure 11-12, 14-15). The soil sample with *Eudrilus eugeniae* had higher value of P than the soil containing *Eisenia fetida* and the Control sample (Fig 13) however it has less OC than the Control sample (Fig 15). The soil samples (with worms) fed with the CL shows higher value of EC, N, P and OC (Fig 17-19, 21) while it exhibited

lower pH (Fig 16) in comparison to the soil containing worms fed with sweet potato leaves (SPL). Interestingly, the value of K was found to be higher in the soil fed with SPL (Fig 20).

The pH of all the soil samples comprising the earthworms were lower than the pH of the initial control sample

i.e., without the earthworm and this is due to the development of carbon dioxide and accumulation of organic acids [17-18]. These findings aligned with those made by Garg *et al.* [19]; Suthar [20], Khwairakpam and Bhargava [21] and Yadav and Garg [22].

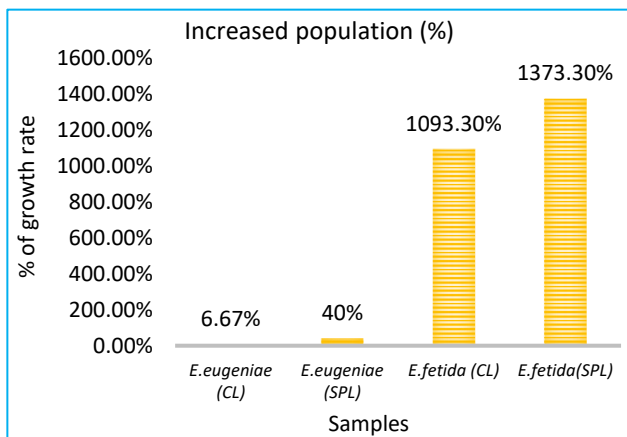


Fig 3 Population density increase (%) in the earthworms

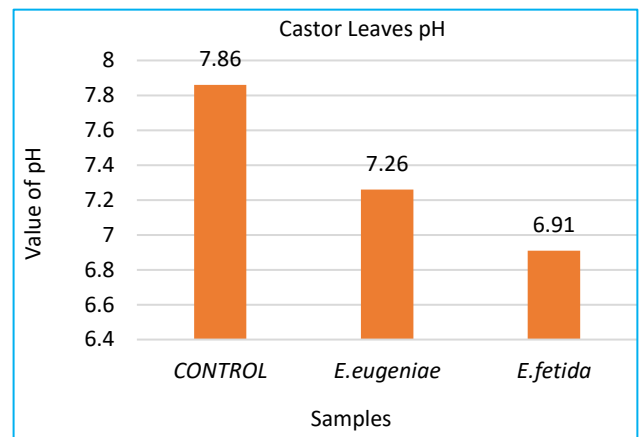


Fig 4 pH value of the soil fed with castor Leaves

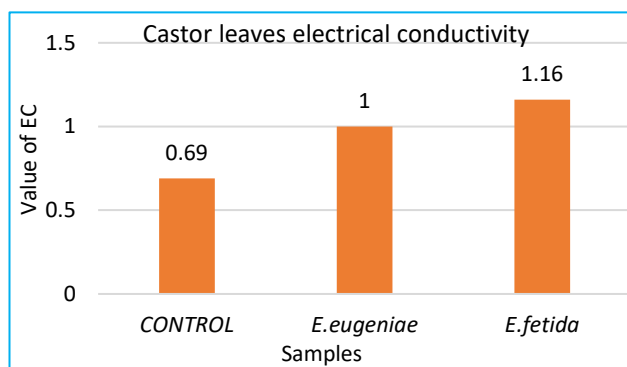


Fig 5 EC value of soil fed with castor leaves

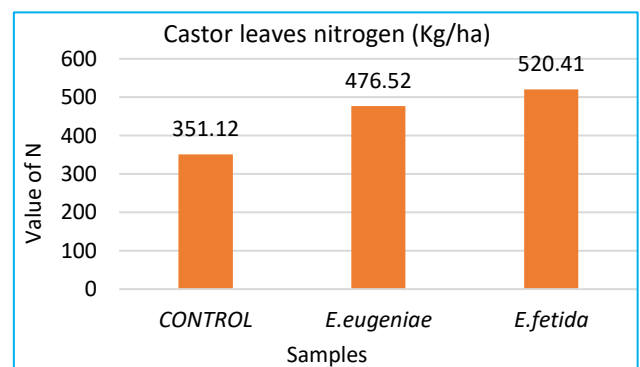


Fig 6 Nitrogen value of soil fed with castor leaves

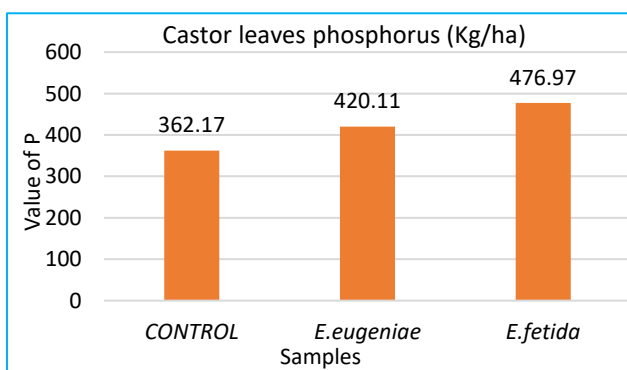


Fig 7 Phosphorus value of soil fed with castor leaves

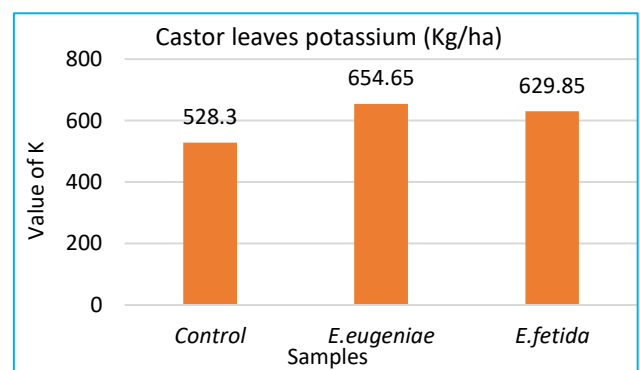


Fig 8 Potassium value of soil fed with castor leaves

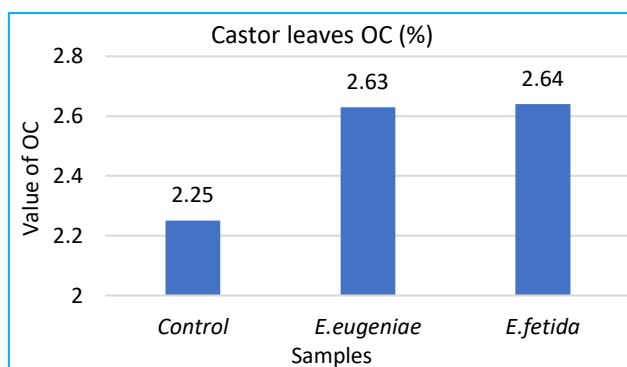


Fig 9 OC (%) value of soil fed with castor leaves

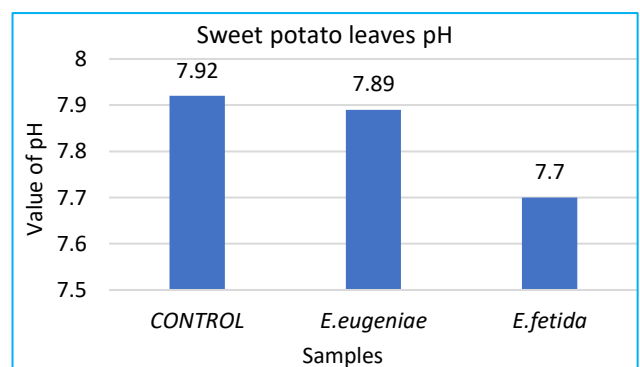


Fig 10 pH value of soil fed with sweet potato leaves

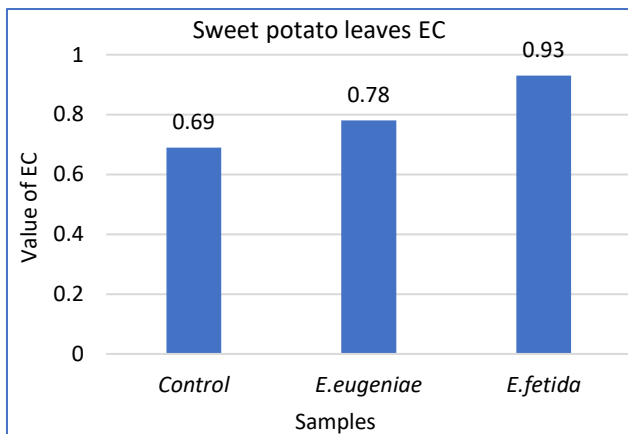


Fig 11 EC value of soil fed with sweet potato leaves

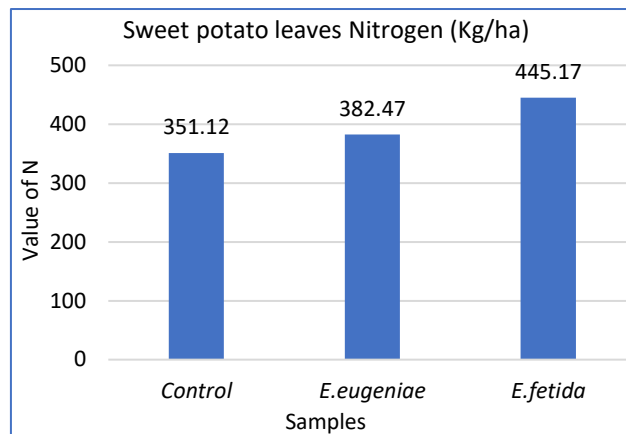


Fig 12 N value of soil fed with sweet potato leaves

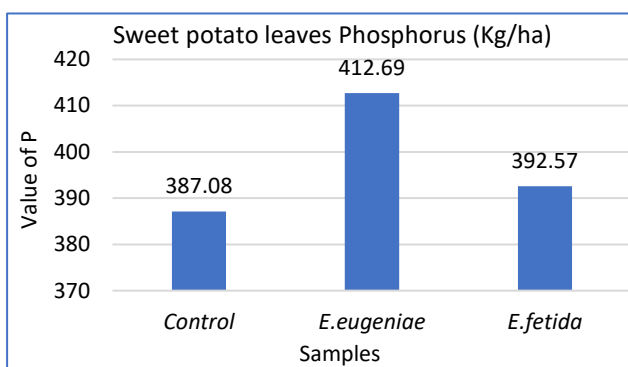


Fig 13 P value of soil fed with sweet potato leaves

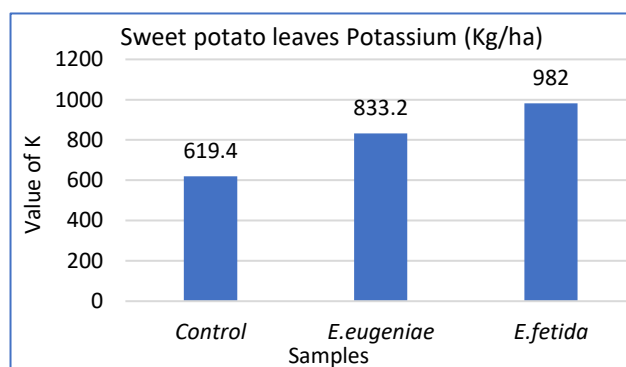


Fig 14 K value of soil fed with sweet potato leaves

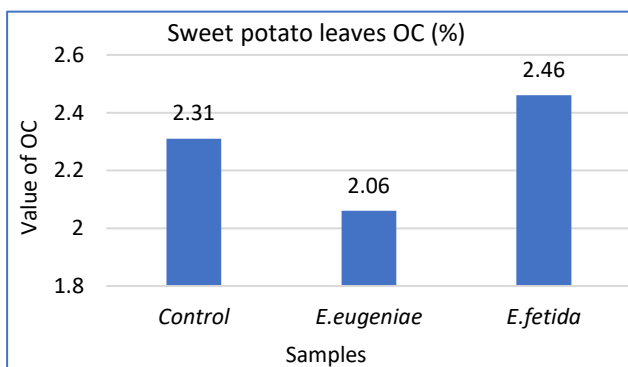


Fig 15 OC (%) value of soil fed with sweet potato leaves

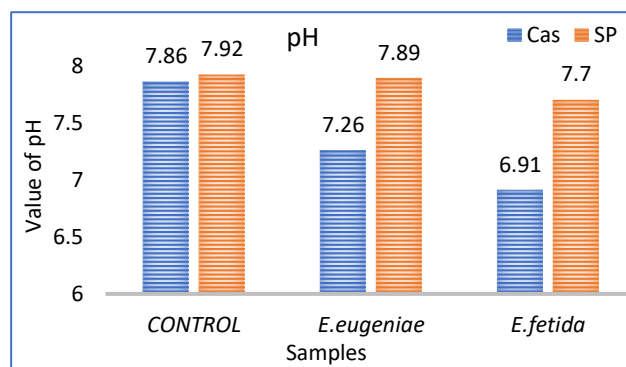


Fig 16 Comparison of pH values between castor and SP

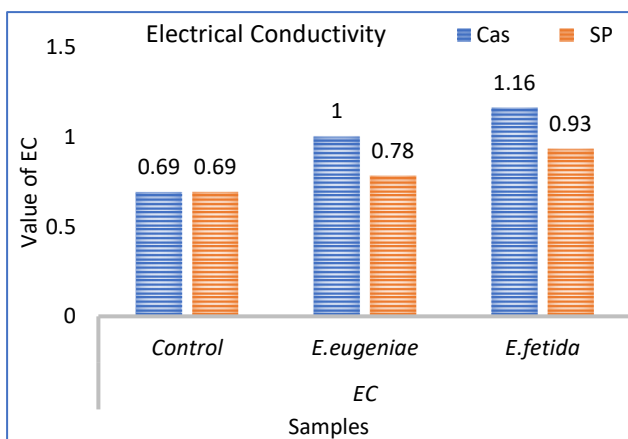


Fig 17 Comparison of EC values between castor and sweet potato leaves

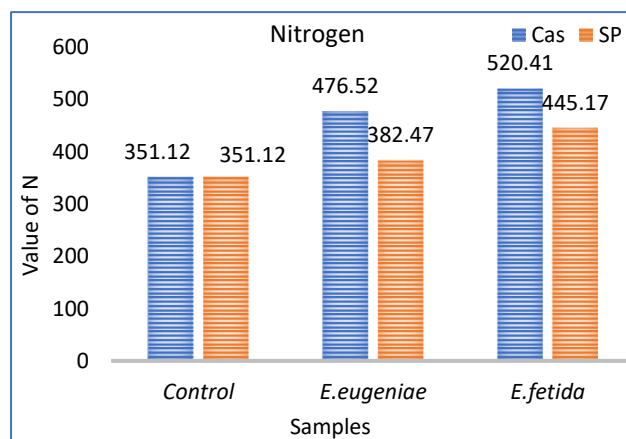


Fig 18 Comparison of Nitrogen values between castor and sweet potato leaves

Similarly, the EC values of the vermicompost were higher than the control sample and were in accordance with

those of Yadav and Garg [22] and Rajendran and Thivyatharsan [23]. The mineralization and augmentation of soluble salts

levels and the nutrients released by the plant substrate during vermicomposting increases the EC [24].

Also, the NPK value in the vermicompost soil is higher than the control sample and this finding is in consistent with Khwairakpam and Bhargava [21] and Kumar *et al.* [25]. The rise in nitrogen's concentration during vermicomposting is due to mineralization of organic matter [26] and the rapid conversion of ammonium ions into nitrates [27-28]. Because of the improved rate of mineralization by higher microbial metabolism, the value of P and K rises [29].

The OC in the soil containing *Eudrilus eugeniae* fed with SPL was lower than the control sample adhering to Campitelli and Cappi [30] and Suthar [20] on account of mineralization and microbial respiration leading to the loss of carbon [31]. Contrastingly, the soil with *Eudrilus eugeniae* fed with CL, *Eisenia fetida* with CL and *Eisenia fetida* with SPL have higher OC than the Control sample which is in contrary to the

prevailing literatures therefore, further analysis is required to determine the cause of anomaly.

Further, castor leaves (CL) and sweet potato leaves (SPL) had no effect on the nutrient quality of the vermicompost soil according to the ANOVA test; however, the rate of deterioration rate is higher in SPL than the CL due to the determinant of structural difference and higher water content, rendering them to decay faster.

Since there is no impact on soil chemistry from either feed, the epigenic earthworm *Eisenia fetida* shows impressive growth and optimal nutrient uptake from the substrate. Hence, it can be inferred that *Eisenia fetida* is a more competent earthworm for vermicomposting. The growth in *Eisenia fetida* is due to their remarkable temperature resilience [16] and have greater reproductive potential than *Eudrilus eugeniae* [32-33]. However, this finding is in contrast to the findings of Rajendra and Thivyatharsan [23], Shetty and Biradar [34].

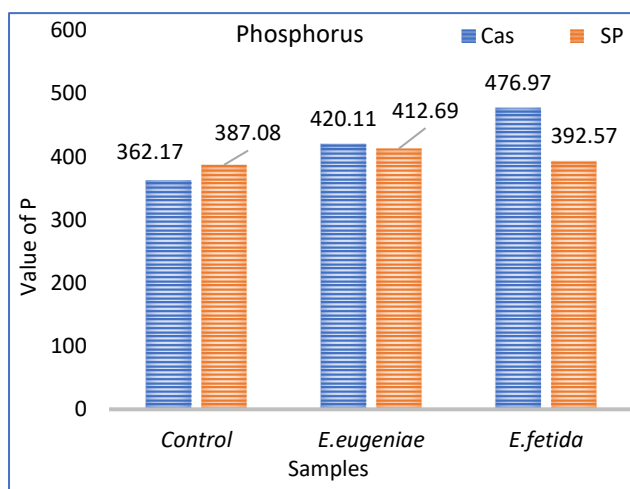


Fig 19 Comparison of Phosphorus values between castor and sweet potato leaves

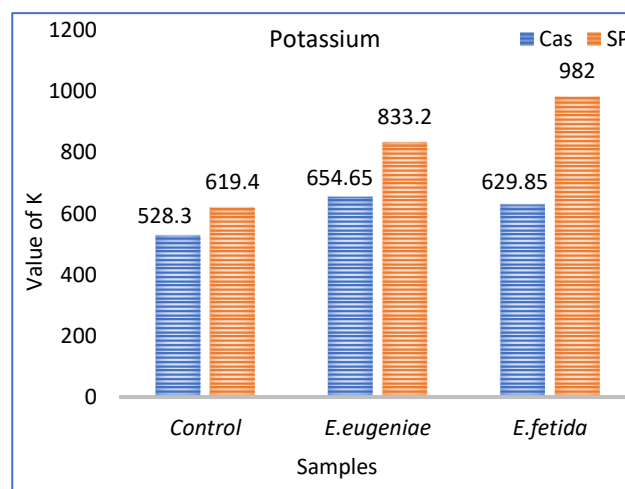


Fig 20 Comparison of Potassium values between castor and sweet potato leaves

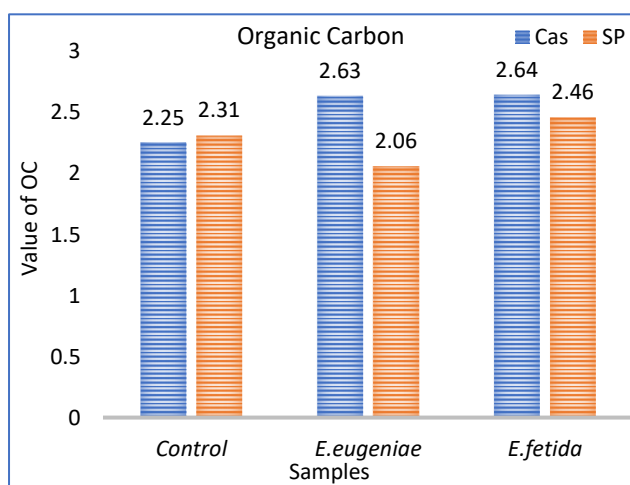


Fig 21 Comparison of OC values between castor and sweet potato leaf

## CONCLUSION

The present study demonstrated the effectiveness of castor leaves (*Ricinus communis*) and sweet potato leaves (*Ipomoea batatas*) as substrates for vermicomposting using the epigeic earthworm species *Eudrilus eugeniae* and *Eisenia fetida*. Among the two earthworm species evaluated, *E. fetida* exhibited superior growth and reproductive performance,

particularly when fed with sweet potato leaves, recording the highest increase in body weight, length, adult population, and overall earthworm multiplication. In contrast, *E. eugeniae* showed comparatively lower growth and reproduction, especially under castor leaf feeding, which may be attributed to its greater sensitivity to fluctuating temperatures. Vermicomposting significantly improved the physicochemical properties of the substrate, resulting in lower pH and higher electrical conductivity, nutrient availability (N, P, and K), and organic carbon content compared to the control. The reduction in pH and enhancement of nutrient status indicate active mineralization and microbial transformation processes during vermicomposting. Although both castor and sweet potato leaves produced nutrient-enriched vermicompost, statistical analysis revealed no significant effect of substrate type on the overall nutrient quality of the final product. Nevertheless, sweet potato leaves decomposed more rapidly than castor leaves, likely due to their softer structure and higher moisture content. The consistently superior performance of *E. fetida* in terms of growth, reproduction, and nutrient enrichment highlights its greater adaptability and efficiency in organic waste conversion under the prevailing environmental conditions. Therefore, *Eisenia fetida* can be recommended as a more suitable earthworm species for vermicomposting of castor and sweet potato leaf residues in the Lower Midland region of Nagaland. Further investigations under varying environmental conditions and with a wider range of organic substrates are recommended to validate and expand these findings.

## Acknowledgments

The authors are thankful to the Department of Zoology, Kohima Science College, Jotsoma for providing the necessary facilities and instruments required to carry out the research.

Special thanks to the Directorate of Soil and Water Conservation, AG Colony, Kohima, Nagaland and Indian Council of Agriculture Research, Jorhat, Assam for providing the required species i.e., *Eisenia fetida* and *Eudrilus eugeniae* respectively.

## LITERATURE CITED

1. Jones CG, Lawton JH, Shachak M. 1994. Organisms as ecosystem engineers. In: *Ecosystem Management: Selected Readings*. New York, NY: Springer New York. pp 130-147.
2. Lavelle P, Bignell D, Lepage M, Wolters V, Rogers P, Ineson P, Heal OW, Dhillion S. 1997. Soil functions in changing world: The role of invertebrate ecosystem engineers. *European Journal of Soil Biology* 33: 159-193.
3. Byers JE, Cuddington K, Jones CG, Talley TS, Hastings A, Lambrinos JG, Crooks JA, Wilson WG. 2006. Using ecosystem engineers to restore ecological systems. *Trends in Ecology and Evolution* 21(9): 493-500.
4. Gunathilagaraj K, Ravignanam T. 1996. Vermicomposting of sericultural wastes. *Madras Agricultural Journal* 1996: 455-457.
5. Bouché MB. 1977. Strategies lombriciennes. In: (Eds) Lohm U, Persson T. *Soil Organisms as Components of Ecosystems*. *Ecological Bulletins* 25: 122-132.
6. Eggleton P, Inward K, Smith J, Jones DT, Sherlock E. 2009. A six year study of earthworm (Lumbricidae) populations in pasture woodland in southern England shows their responses to soil temperature and soil moisture. *Soil Biology and Biochemistry* 41(9): 1857-1865.
7. Ahmed N, Al-Mutairi KA. 2022. Earthworms effect on microbial population and soil fertility as well as their interaction with agriculture practices. *Sustainability* 14(13): 7803.
8. Lazcano C, Gómez-Brandón M, Domínguez J. 2008. Comparison of the effectiveness of composting and vermicomposting for the biological stabilization of cattle manure. *Chemosphere* 72(7): 1013-1019.
9. Sharma S, Kumar A, Singh AP, Vasudevan P. 2009. Earthworms and vermitechology – A review. *Dynamic Soil, Dynamic Plant* 3(2): 1-12.
10. Suthar S. 2008. Microbial and decomposition efficiencies of monoculture and polyculture vermireactors, based on epigeic and anecic earthworms. *World Journal of Microbiology and Biotechnology* 24(8): 1471-1479.
11. Vivas A, Moreno B, García-Rodríguez S, Benitez E. 2009. Assessing the impact of composting and vermicomposting on bacterial community size and structure, and microbial functional diversity of an olive-mill waste. *Bioresource Technology* 100(3): 1319-1326.
12. Gopal M, Bhute SS, Gupta A, Prabhu SR, Thomas GV, Whitman WB, Jangid K. 2017. Changes in structure and function of bacterial communities during coconut leaf vermicomposting. *Antonie van Leeuwenhoek* 110(10): 1339-1355.
13. Edwards CA. 1988. Breakdown of animal, vegetable and industrial organic wastes by earthworms.
14. Jackson ML. 2005. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, India.
15. Walkley AJ, Black IA. 1934. Estimation of soil organic carbon by the chromic acid titration method. *Soil Science* 37: 29-38.
16. Reinecke AJ, Viljoen SA, Saayman RJ. 1992. The suitability of *Eudrilus eugeniae*, *Perionyx excavatus* and *Eisenia fetida* (Oligochaeta) for vermicomposting in southern Africa in terms of their temperature requirements. *Soil Biology and Biochemistry* 24(12): 1295-1307.
17. Elvira C, Sampedro L, Benitez E, Nogales R. 1998. Vermicomposting of sludges from paper mill and dairy industries with *Eisenia andrei*: a pilot-scale study. *Bioresource Technology* 63(3): 205-211.
18. Premuzic Z, Brichta JP, Rendina AE, Iorio AF. 2002. Fertility and toxicity parameters for the commercialization of soil additive using muds from the Matanza River in Argentina. *Información Tecnológica* 13(5): 25-30.
19. Garg P, Gupta A, Satya S. 2006. Vermicomposting of different types of waste using *Eisenia foetida*: a comparative study. *Bioresource Technology* 97(3): 391-395.
20. Suthar S. 2009. Vermistabilization of municipal sewage sludge amended with sugarcane trash using epigeic *Eisenia fetida* (Oligochaeta). *Journal of Hazardous Materials* 163(1): 199-206.
21. Khwairakpam M, Bhargava R. 2009. Vermitechology for sewage sludge recycling. *Journal of Hazardous Materials* 161(2-3): 948-954.
22. Yadav A, Garg VK. 2011. Recycling of organic wastes by employing *Eisenia fetida*. *Bioresource Technology* 102(3): 2874-2880.
23. Rajendran M, Thivyatharsan R. 2014. Performance of different species of earthworm on vermicomposting. *International Journal of Research in Agriculture and Food Sciences* 2: 2311-2476.
24. Gong X, Li S, Chang SX, Wu Q, Cai L, Sun X. 2019. Alkyl polyglycoside and earthworm (*Eisenia fetida*) enhance biodegradation of green waste and its use for growing vegetables. *Ecotoxicology and Environmental Safety* 167: 459-466.
25. Kumar S, Tripathi G, Mishra GV. 2021. A comparative study on agrowaste conversion into biofertilizer employing two earthworm species. *Applied Ecology and Environmental Sciences* 9(2): 280-285.
26. Kaushik P, Garg VK. 2003. Vermicomposting of mixed solid textile mill sludge and cow dung with the epigeic earthworm *Eisenia foetida*. *Bioresource Technology* 90(3): 311-316.
27. Domínguez J. 2004. State-of-the-art and new perspectives on vermicomposting research. In: Edwards CA (Ed). *Earthworm Ecology*. CRC Press, Boca Raton, Florida, USA. pp 401-424.
28. Suthar S, Singh S. 2008. Vermicomposting of domestic waste by using two epigeic earthworms (*Perionyx excavatus* and *Perionyx sansibaricus*). *International Journal of Environmental Science and Technology* 5(1): 99-106.
29. Suthar S. 2007. Vermicomposting potential of *Perionyx sansibaricus* (Perrier) in different waste materials. *Bioresource Technology* 98(6): 1231-1237.

30. Campitelli P, Ceppi S. 2008. Chemical, physical and biological compost and vermicompost characterization: A chemometric study. *Chemometrics and Intelligent Laboratory Systems* 90(1): 64-71.
31. Karmegam N, Vijayan P, Prakash M, Paul JAJ. 2019. Vermicomposting of paper industry sludge with cowdung and green manure plants using *Eisenia fetida*: A viable option for cleaner and enriched vermicompost production. *Journal of Cleaner Production* 228: 718-728.
32. Ali S, Kashem MA. 2018. Life cycle of vermicomposting earthworms *Eisenia fetida* and *Eudrilus eugeniae* under laboratory-controlled condition. *Biomedical Journal of Scientific and Technical Research* 10(5): 8110-8113.
33. Begum KS, Kashem MA, Sarker MMH. 2025. Seasonal effects on growth and reproduction of *Eisenia fetida* and *Eudrilus eugeniae*. *Eurasian Journal of Soil Science* 14(2): 178-188.
34. Shetty A, Biradar PM. 2023. Biology of the epigeic earthworm, *Eisenia fetida* in different organic wastes. *Journal of Environmental Biology* 44: 736-743.