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A COMPARATIVE STUDY ON WASTE DECOMPOSED USING DIFFERENT SPECIES OF EARTHWORMS

Shivakumar B. P. and Sanjana M. S.*

Department of Environmental Engineering, JSS Science and Technology University, Mysore, Karnataka, India.

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***Corresponding Author**

Sanjana M. S.

Department of Environmental Engineering, JSS Science and Technology University, Mysore,Karnataka, India.

ABSTRACT

Green waste is an important fraction of urban greening and recently composting of which is challenging due to presence of lignin, which is highly resistant to decomposition. Green waste is either burnt or disposed with other waste which ends up in landfills which makes it again complex to treat. Vermicomposting has received attention as it is environmental friendly even if it takes longer time to degrade organic matter. The objective of the present study was to evaluate the major nutrient status of vermicompost of different green waste processed by two species of earthworms namely *Eisenia fetida* and *Eudrilus eugeniae* and to compare the efficacy of these earthworms regarding the decomposition of green waste. The physical parameters like Moisture content, pH and EC were recorded along with macronutrients of soil, the amount of organic materials like nitrogen, pH, EC, Phosphorus, potassium, TOC were analysed at the beginning and end of the experiment. The inoculation period, development and cocoon production of the species were also investigated. Result showed that degradation rate was faster in *Eisenia fetida* whereas higher multiplication rate was found in *Eudrilus euginae* in fruit and vegetable waste.

KEYWORDS: Greenwaste, Earthworms, Soil, Compost.

1. INTRODUCTION

Green waste is evident during all seasons and specific disposal of which is never taken into consideration. The challenge involved in composting of green waste is majorly the presence of lignin that typically protects cellulose preventing and slowing aerobic decomposition. Green waste consists of tree wood and bark, pruning from young trees and shrubs dead and green leaves grass clippings and soil. Likewise green waste composition is highly variable and depends on the predominant source vegetation the season of the year and the local collection policies among other. Thusvariability in the composition of green waste can affect its decomposition. Recent trends involve burning of green waste, this results in greenhouse gases and aesthetically very unpleasant, it also ends up in a landfill making it complex. In this context reduction ofthe time required for composting and the increase in the quality of the product have become important goals in the use of composting of green waste. Several physical chemical and biologicaltechnologies have been developed to manage green waste. In recent years, emphasis has been given to biological approaches such as composting and vermicomposting which can be used as a source menu to increase soil fertility for nutrient content or as an alternative to solve cultivation. Therefore, this study sought to evaluate the majornutrient status of vermicompost of different green waste by *Eisenia fetida* and *Eudrilus euginae* species of earthworms and comparing the potential of these earthworms regarding the decomposition of green waste.

2. MATERIALS AND METHODS

2.1 Organic Waste Collection

In order to carry out vermicomposting studies, Green waste of same quantity (2kg) from five different location of Mysore, Karnataka are collected using bin bags namely waste from Kitchen, SJCE campus, Kukkrahally lake, Netaji Park, Fruit & Vegetable shop. Green waste sample along with soil(4kg) in the ratio 1:2was introduced into the drums.

2.2 Earthworm Collection

The earthworms species used in the present study are *Eisenia fetida* and *Eudrilus eugeniae* which were obtained from Organic Farming Research Station Naganahalli, Mysuru. Earthworms are cultivated here for vermicomposting. Two hundred earthworms are added to each of the sample along with cow dung slurry after the pre- decomposition period.

2.3 Design of Composting Drums

Five drums were brought from Gujri, Lashkar Mohalla Mysore. Each drum is of 120 litre capacity. They were vertically cutinto two equal halves using a Bosch cutting machine. The caps are then struck tight with the help of fevi bond and M- seal. The obtained 10 boat shaped drums are used for the study in which five drums were used for *Eisenia fetida* and the other five for *Eudrilus euginae* species of earthworms. The curved part of the drumis considered as the bottom part. 10-13 holes of 0.7mm diameter are drilled for theexcess water to drain off and for good aeration. Before introducing the waste, a layer of gunny cloth is placed so that earthworms do not escape through the drilled hole.

2.4 Composting process

The composting process was carried out in open space to allow the natural aeration. The drums were supported on the bricks and the plastic trays were kept below the drums for the collection of leachate. For the study, around 2kg of wastes were added to 2 sets of drums. The green waste was composed for 160 days by sprinkling water for once in two days and turning the waste. After 30 days of Pre composting, the green waste was treated with earthworms. 200 earthworms were added to all the tracers along with cow dung slurry except control(soil). Samples were collected and analysed for determining pH,nitrogen, phosphorus, potassium, EC, TOC. The total number of earthworms were counted at end of the experiment.

2.5 Physico-chemical analysis of compost

The analysis of the compost samples were performed in “The Organization for the Development of People (ODP)", Bannimantap Mysuru”. The samples were analysed three times: Just after the collection of the sample, After the pre- decomposition period i.e., before introducing the earthworms and at the end of the project period. The pH was determined using a digital pH meter, EC using a conductivity meter, TOC by walky and black’s rapid titration method, TKN by ultraviolet spectrophotometric screening method, phosphorous by ascorbic acid method and potassium by flame emission technique.

Figure 1: Image of modified composting drums.

2.6 Effect on growth rate andreproduction rate of earthworm species

Growth rate of earthworm, clitellumdevelopment, cocoon production andpopulation buildup of earthworm dependupon the physico-chemical composition ofthe feeding materials, types of feed mixture and environmental conditions like temperature, moisture and pH which determine the sexual maturation inearthworms.

3. RESULTS AND DISCUSSION

In the present study, an attempt has been made to enhance the degradation of green waste using 2 different species of earthworms. Bench-scale was conducted for various tracers of green waste and effect of vermicomposting was analysed. The effect was studied through analysing variation in pH, EC, TOC, Nitrogen, Phosphorous and Potassium**.** All the soil parameters have been increased at the end of the experiment.

pH

The pH in the vermin composts was increased in the tracers and are representedin the table1. A plot of variation of pH against different tracers is shown in Figure2. From Table 1 it is observed that, the pH in all the tracers gradually increased due to the increased rate of aeration in the drum by daily turning tend to decrease CO_2 levels in the compost, which in turn tend to increase pH.

TKN

In the present study the variation in TKNduring composting process was studied.Plots of variation of TKN for various tracers has made shown in Figure 5. From the plot it is observed that, TKN content increased gradually in all the tracers due to digestion of substrate in earthworms' gut and simultaneous addition of nitrogenous excretory products, mucous, body fluid,enzymes, the net loss of dry mass in termsof CO_2 as well as water loss byevaporation due to heat evolution duringoxidisation of organic matter

Phosphorous

In the present study the variation in phosphorous in composting process of green waste have been studied. Plots ofvariation of Phosphorus for various tracers has made shown in Figure 6. From the plotit is observed that, Phosphorus content increased gradually in all the tracers due to physical breakdown of the plant material by worms or by the native micro flora that produces various organic acids or phosphatases and is responsible for solubilization of insoluble phosphate.When organic matter passed through the earthworm gut, some amount of phosphorus is converted into more available form due to enzyme phosphatase and further release might be attributed to the phosphorus solubilizingmicroorganisms present in the cast.

EC

In the present study the variation in EC in composting process of green waste have been studied. Plots of variation of EC for various tracers has made shown in Figure3. From the plot it is observed that, EC content increased gradually in all the tracers due to addition of substrate (cow dung)

Potassium

In the present study the variation in K incomposting process of green waste have been studied. Plots of variation of K for various tracers has made shown in Figure 7. From the plot it is observed that, K content increased gradually in all the tracers due to physical decomposition of organic matter of waste. When organic matter passes through the gut of earthworm, unavailable potassium is transformed to more soluble forms withenhanced rate of mineralization.

Table 1: Variation in pH of different tracers.

Tracers	Immediately after collection of waste		Before adding earthworms		After adding earthworms	
	Eisenia fetida	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*
T1	6.69	6.69	6.76	6.75	6.9	6.82
T2	6.69	6.69	6.75	6.77	6.9	6.79
T3	6.69	6.69	6.77	6.78	6.92	6.8
T4	6.69	6.69	7.1	6.8	7.3	7.1
T5	6.69	6.69	7	6.6	7.24	7
Soil	6.69	6.9	6.82	6.82	6.82	6.82

Table 2: Variation in TOC of different tracers.

Tracers	Immediately after Collection of waste		Before adding earthworms		After adding earthworms	
	Eisenia fetida	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*
T1	0.56	0.56	0.6	0.59	0.64	0.6
T2	0.56	0.56	0.58	0.57	0.63	0.61
T3	0.56	0.56	0.61	0.59	0.65	0.6
T4	0.56	0.56	0.67	0.65	0.72	0.69
T5	0.56	0.56	0.65	0.64	0.7	0.68
Soil	0.56	0.56	0.59	0.59	0.59	0.59

Table 3: Variation in TKN of different tracers.

Tracers	Immediately after collection of waste		Before adding earthworms		After adding earthworms	
	Eisenia fetida	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*
T1	0.09	0.09	0.11	0.11	0.16	0.15
T2	0.09	0.09	0.15	0.12	0.19	0.18
T3	0.09	0.09	0.12	0.12	0.19	0.2
T4	0.09	0.09	0.24	0.22	0.35	0.3
T5	0.09	0.09	0.22	0.2	0.32	0.27
Soil	0.09	0.09	0.13	0.13	0.13	0.13

Table 4: Variation in phosphorous of different tracers.

Tracers	Immediately after collection of waste		Before adding earthworms		After adding earthworms	
	Eisenia fetida	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*
T1	0.5	0.5	0.9	0.8	1.2	1.2
T2	0.5	0.5	0.7	0.7	1	0.9
T3	0.5	0.5	0.8	0.7	1.4	1
T4	0.5	0.5	1.5	1.6	2	1.9
T5	0.5	0.5	1.3	1.4	1.9	1.7
Soil	0.5	0.5	0.82	0.82	0.82	0.82

Table 5: Variation in potassium of different tracers.

Tracers	Immediately after Collection of waste		Before adding earthworms		After adding earthworms	
	Eisenia fetida	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*
T1	0.03	0.03	0.09	0.08	0.11	0.1
T2	0.03	0.03	0.08	0.09	0.1	0.12
T3	0.03	0.03	0.09	0.08	0.12	0.15
T4	0.03	0.03	0.18	0.16	0.2	0.18
T5	0.03	0.03	0.16	0.15	0.19	0.17
Soil	0.03	0.03	0.1	0.1	0.1	0.1

Table 6. Variation in EC of different tracers.

Tracers	Immediately after Collection of waste		Before adding earthworms		After adding earthworms	
	Eisenia fetida	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*	*Eisenia fetida*	*Eudrilus euginae*
T1	0.32	0.32	0.5	0.49	0.8	0.7
T2	0.32	0.32	0.42	0.4	0.7	0.5
T3	0.32	0.32	0.4	0.41	0.74	0.73
T4	0.32	0.32	0.7	0.68	1.2	1.1
T5	0.32	0.32	0.69	0.66	1	0.9
Soil	0.32	0.32	0.39	0.39	0.39	0.39

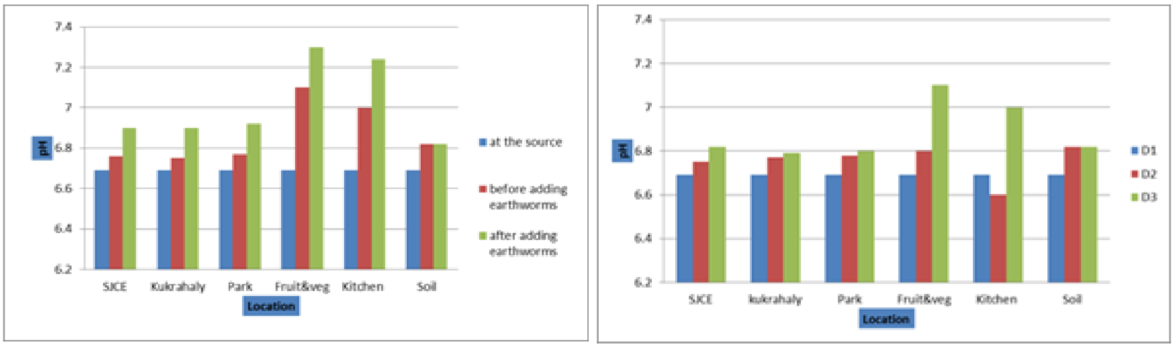

Figure 2: Variation in pH of different tracers: a) Eisenia fetida b) Eudrilus euginae.

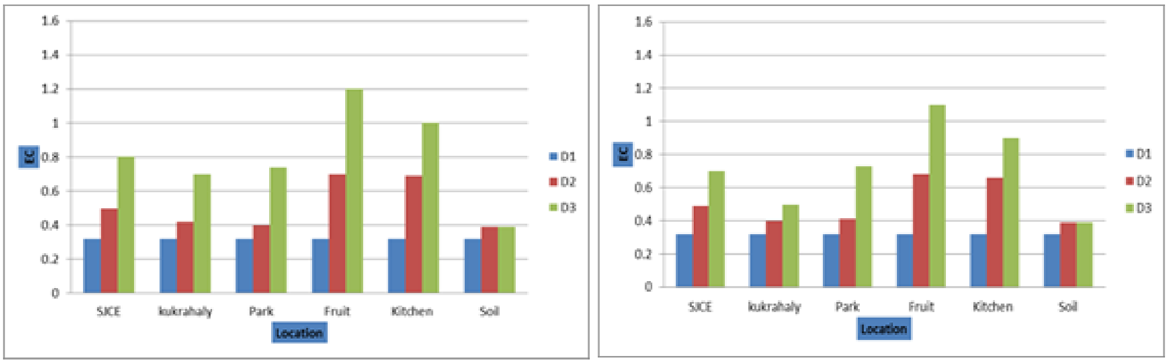

Figure 3: Variation in EC of different tracers: a) Eisenia fetida b) Eudrilus euginae

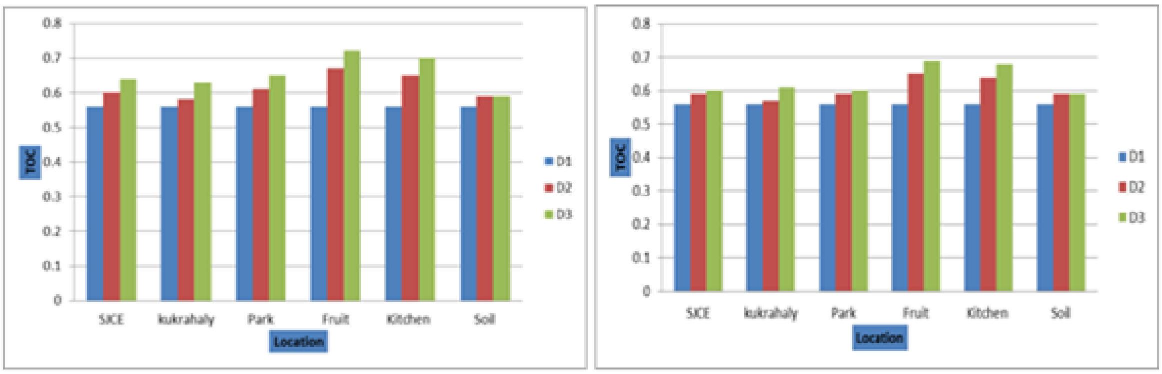

Figure 4: Variation in TOC of different tracers: a) Eisenia fetida b) Eudrilus euginae.

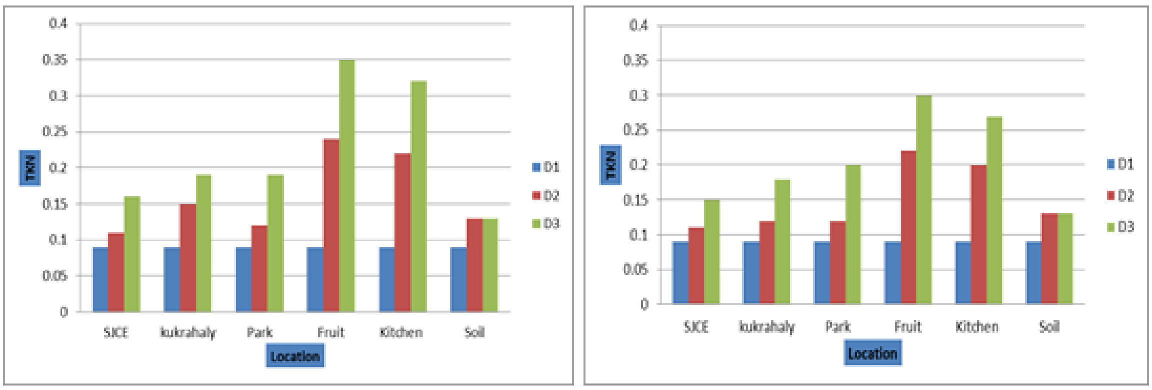

Figure 5: Variation in TKN of different tracers: a) Eisenia fetida b) Eudrilus euginae.

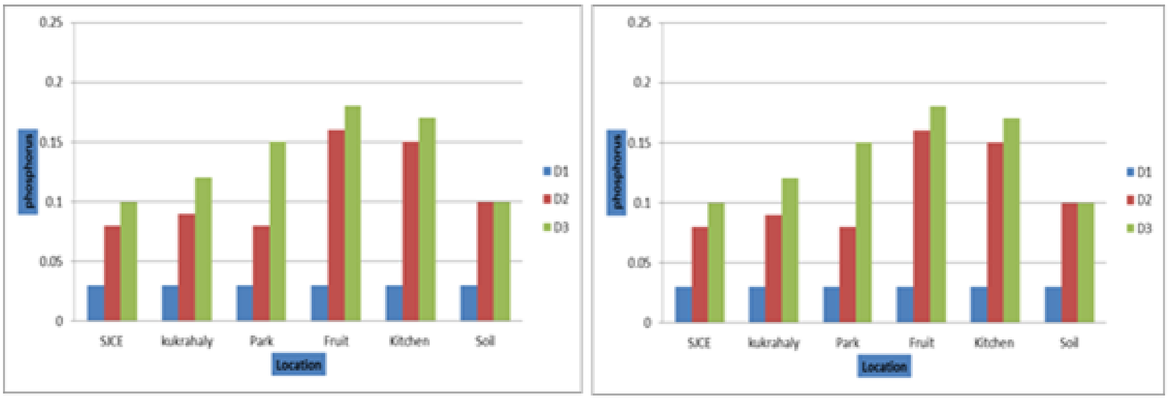

Figure 6: Variation in Phosphorous of different tracers: a) Eisenia fetida b) Eudrilus euginae.

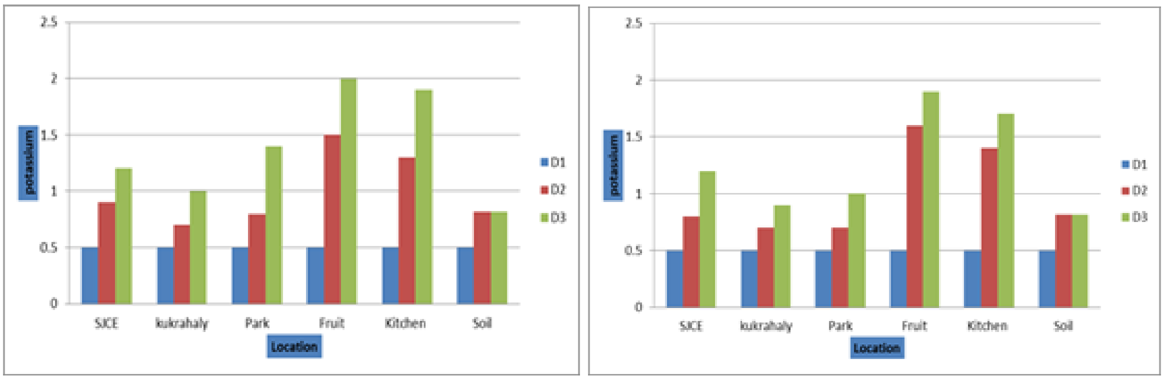

Figure 7: Variation in Potassium of different tracers: a) Eisenia fetida b) Eudrilus euginae.

3.1 Effect on growth rate and reproduction of earthworm species

The total biomass and number of worms recovered at the end of experiment were high. The biomass of earthworm species showed progressive raise up to 7th week in *E. fetida* and 6th week in *E. eugeniae*. In *E. euginae* where maximum growth attained, 9.2 cm in the 6th week. In *E. fetida* growth attained was 7.9 cm in the 7th week. Regarding the clitellum development, *E. euginae* was pre clitelated on the second week and mature individual with clitellum totally developed started to emerge on the 3rd week and *E.fetida* was developed in 4th week.

3.2 Rate of Cocoon Production by Earthworm Species

E. fetida started to release cocoon on the 5th week and *E eugeniae* started to release cocoon on the 4th week. The highest total number of cocoons was attained *in Eudrilus eugeniae*. Clitellum development started earlier in 4th week of *Eisenia fetida* and in 3rd week for *Eudrilus eugeniae*.

CONCLUSIONS

The composted green waste at the end of the experiment showed increase in all the soil parameters when compared with initial values. It can be seen that the soil nutrients have gradually increased from first to thirdanalysis and highest peak can be seen in T4 i.e., Fruit and vegetable waste by the activity of *Eisenia fetida* species of Earthworm. The compost produced from *Eisenia fetida* was black in colour, powdered form and good texture, whereas in *Eudrilus euginae* the compost wasbrown and was compacted. Mixing of bulking agents like cowdung in composting green waste enhanced the nutrient profile of vermicompost thereby accelerating the degradation of lignin and also supported the earthworm growth. Greater number of *Eudrilus euginae* species of earthworms can be seen in fruit and vegetable waste. *Eisenia fetida* was more efficient in bioconversion of green waste into nutrient rich vermicompost whereas *Eudrilus euginae* exhibited better growth and reproductive ability whencompared to *Eisenia Fetida*.

REFERENCES

1. Abhilash.P.C, Akankshajain, Akanshasingh, Harikesh.B.singh, Sharma.K, “Solid waste management of temple floral offerings by vermicomposting using Eisenia fetida”.Waste management, 2015; (33): 1113-1118.
2. Ahamada Ziwa and Henry Kayonda “Nutrient recovery from pineapple waste through controlled batch and continuous vermicomposting systems”. Journal of Environmental Management, 2019; (279): 1117-1184.
3. Ajay.S.Kalamdhad, Kazmi.A.A, MeenaKhwairkpam, Muntjeer Ali, Yatish. K.Singh, “Rotary drum composting of vegetable waste and tree leaves”. Bioresource technology, 2018; (100): (6442-6450).
4. Anilnath, Linee Goswami, Satya Sundar Battacharya, Sweety Sutradhar “Application of drum compost & vermicompost to improve soil health, growth and yield parameters for tomato and cabbage plants”. Journal of Environmental Management, 2017; (200): 243-252.
5. An’qi zhou, Jia Wang, Rong Hao, Shaaban Muhammad, Yanbing Jiang, Yupeng Wu, “How do earthworms affect decomposition of residues with different quality apart from fragmentation andincorporation?’’. Geoderma, 2018; (326): 68-75.
6. Ashis Chakraborti, Biswanath Kundu, Chandra Khatua, Somoshree Sengupta, Sudipta Tripathi, Vamsi Krishna balla, “Dynamics of organic matter decomposition during vermicomposting of banana stem waste using eisenia fetida”. Waste management, 2018;

(79): 287-295.
7. Chaichi Devi and Meena Khwairakpam "Management of lignocellulosic green waste saccharam spontaenum through vermicomposting with cow dung". Waste management, 2020; (113): (88-95).
8. Deepthi Madathil peedika, kulananel Saminathan, Ramasamy, Rini Joseph "Nutrient recovery and vermicompost production from livestock solid wastes with epigeic earthworms". Bioresource technology, 2019; (20): (609-920).
9. Divya Balamani P, Gomathy B, Kalpana N, Nandha Kumar P, Sharmila K J, "Nitrogen, phosphorous, and potassium range of vermicompost using eisenia fetida and perionyx excavates". Innovare journal of agricultural scienes, 2019; (7): (2321-6832).
10. Elvin Thomas, Shanthi Prabha Viswanathan, Vijo Thomas Kurien "The potential of earthworms in soil carbon storage: a review". Environmental and Experimental biology, 2020; (18): 61-75.
11. Fernanda Cipriano Rocha "Production of organic compost from different plant waste generated in the management of green urban space".Soilsciences, 2018; (79): 287-295.
12. Garg.A, Kumar.R, Manu M.K, "Drum composting of food waste: A kinetic study". Environmental sciences, 2016**;** (35): 456-463.
13. Garg V K and Kavita sharma "Conversion of a toxic weed into vermicompost by eisenia fetida: Nutreint content and earthworm fecundity".Bioresource technology, 2020; (11): 100-530.
14. Garg V K and Renuka Gupta "Optimization of cow dung spiked pre- consumer processing vegetable waste for vermicomposting using Eisenia fetida". Ecotoxicology and environmental safety, 2016; (74): 19- 24.
15. Hui Xia and Kui Huang "Role of earthworms mucus in vermicomposting system: Biodegradation tests based on humification and microbial activity. Science of the total environment, 2018; (60): 703-708.
16. Joseph Antony, Sandeep Bukke, Victor Joseph "Biodegradation of waste materials using organic fertilizers preparation, comparison and effects of vermicomposting on loamy and red soil". Bioresource technology, 2016; (55): 1026-2056.
17. Kanchan shahi, Kapil kumar, Naval Kishore singh, Surindra suthar "Enhanced vermicomposting of leaf litter by white-rot fungi pre-treatment and subsequent feeding by Eisenia fetida under a two-stage process". Bioresource Technology, 2020; (13): 100-609.
18. Kaviraj and Satyawati sharma "Municipal solid waste management through vermicomposting employing exotic and local species of earthworms". Bioresource

technology, 2015; (90): 169-173.

19. Kulandaivelu Velmourougane and Kurian Raphael “Chemical and microbiological changes during vermicomposting of coffee pulp using exotic and native earthworm species”.Biodegradation, 2010; (22): 497-507.
20. Linlin cai, Qian Wu, Scott X.Chang, Suyan Li, Xiaoqiang Gong, Xiangyang Sun, “Alkyl polyglycoside and Earthworm(E.fetida) enhance biodegradation of green waste and its use for growing vegetables”. Ecotoxicology and Environmental Safety, 2019; (167): 459-466.
21. Muddasir Basheer and Om prakash agarwal “Management of paper waste by vermicomposting using epigeic earthworm, eudrilus eugeniae”. Waste management, 2015; (4): 42-47.
22. Nadiri.S and Omrani.G, “Determination of biochemical changes in cow manure during the process ofvermicompost with the usage of earthworms (eisenia fetida)”. Advances in environmental biology, 2011; (11): 3624-3628.
23. Nuhaa Soobhany, Romeela Mohee, Vinod kumar garg“Experimental process monitoring and potential of eudrilus euginae in the vermicomposting of organic solid waste in Mauritius”. Ecologicalengineering, 2015; (84): 149-158.
24. Prasanta Raul, Sarmistha paul, Satya sundar bhattacharya, Subhasish Das “Vermi-sanitization of toxic silk industry waste employing eisenia fetida and eudrilus euginae: Substrate compatibility, nutrient enrichment and metal accumulation dynamics”. Bioresource technology, 2018; (266): 267-274.
25. Rajendran M, and Thivyatharsan R. “Performance of different species of earthworms on vermicomposting”. International journal of research in agriculture and food sciences, 2015; (2): (2311-2476).
26. Reineck.A.J, Saayman.R.J, Viljoen A. “The suitability of Eudrilus euginae, periyonix excavates and eisenia fetida for vermicomposting in southern Africa in terms of their temperature requirements” Soilbiochemistry, 2018; (24): 1295-1307.
27. Sahjahan Ali “Life cycle of vermicomposting earthworms eisenia fetida and eudrilus euginae under laboratory-controlled condition”. Sciences of techniques, 2018; (20): 610-921.
28. Scott X Chang, Suyan Li, Xiaoqiang Gong, Xiangyang Sun, Zhengfeng An “Bamboo biochar amendment improves the growth and reproduction of E.fetida and the quality of green waste vermicompost”. Ecotoxicologyand Environmental Safety, 2018; (156): 197-204.

29. Surindra suthar "Vermicomposting of vegetable market solid waste using eisenia fetida: Impact of bulking material on earthworm growth and decomposition rate". Ecological engineering, 2019; (35): (914-920).
30. Vikram Reddy M and Swati Pattnaik "Nutrient status of vermicompost of urban green waste processed by three earthworm species- Eisenia fetida, eudrilus euginae and perionyx excavates". Environmentalsoil sciences, 2015; (100): 5444-5453.
31. Wen Gao, Xiuhong Wang, Yali Wang, Yinsheng li, Yizhao Wu, "Toxicity of arsenite to earthworms and subsequent effects on soil properties". Soil biology abd biochemistry, 2018; (117): 36-47.