International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Termigradation : Effective Use of Termites (Cryptotermes Domesticus) (Termitidae) (Isoptera : Blattodea) in Degradation of Solid Waste Product

Tashqeen Fatima[1], Dr Barish E. James[2], Ayushi Bajpai[3]

[1,2]Department of Zoology, Isabella Thoburn College, University of Lucknow
[3]Department of Zoology, University of Lucknow

ABSTRACT

Termites, often viewed as pests, are vital in decomposition and waste management, acting as nature recyclers by breaking down complex organic substances. . The term "termigradation" refers to the degradation process facilitated by termites. Unlike vermicomposting and traditional composting, which cannot break down lignin or tough waste products like plastics, termites can tackle these materials. Utilizing termites for plastic degradation is environmentally friendly and does not emit toxins, reducing environmental pollution and threats to human health and plants and animals.

Termites are significant soil insects capable of breaking down plastics through their gut microbiota, as numerous microbes in their digestive system can degrade plastics. The experiment focused on Termigradation by termites, where they were fed six different types of solid waste materials. To study the termigradation of solid waste, six types of waste products were used: sawdust, coconut husk, low-density polyethylene, high-density polyethylene, a mixture of paint and cement, and disposable plates. This study demonstrated that termites have a symbiotic relationship with the microbes and fungi in their gut, aiding in the degradation of solid waste products, and they preferred low-density polyethylene over high-density polyethylene. This process can help reduce pollution and helps to minimize the plastic pollution. The data was analyzed with a test significance level is 0.001.

Keywords: Termites, Termigradation , solid waste management , plastic degradation, gut microbes.

INTRODUCTION

Termites are very similar to ants they have pale brown body and they are considered as pest due to the damage that they cause to wood but they have different abilities and unique role in degrading solid waste. (Wheeler W.M. , 1923) A typical ant colony consist of workers , soldiers , and reproductive individuals of males and females. (Synder T.E. , 1925) [15, 12]

Muncipal dependable waste administration is very fundamental part of urban foundation that guarantees the protection of environment and human health (World Bank 1995). Termites are conducted as decomposers and known as environment engineers (Dangerfield and others). (1998), (Nabegu,(2010).[6] [10]

It is documented that termites may be second-hand for the degradation of soild or hard waste materials,ie

named Termigradation. (Abbasi S.A., 2007) [1] This process is principally approved place composting withstand. Termites maybe used as a bioagent for hard waste management and named as Soil Engineers. Termites are voracious feeders they can consume waste products of our daily household and digest them. (Warnecke F. et.al, 2007)[14] They can rapidly grind down hard substances and plastics such as coconut shells, saw dust, disposal plates , low and high density polythene .Termites grow very fast, they have high rate of reproduction**.** (Alfiya Fathima and Reena Abraham 2020) [8]

Most of developing countries generates large amount of waste products which results in dumping grounds or incineration but disposal by biological means using cellulolytic organism have become popular by termites as they are wood feeders and they can digest the cellulose by microbes which are present in their gut.(Asomani -Boateng and Haight, 2007)(B.S. Fagbohunka and E.N.Ezima, 2021),[7]

Plastics are mainly utilized due to their material and synthetic properties as they are made by process of polymerization . Termites have potential to degrade plastic (Ali et.al., 2021a ,2021b , 2022a)[10] . Various microbes state harbour in gut of termites and attack on plastics and degrade them. [3]

LOW DENSITY POLYETHYLENE (LDPE)

It is the main reason behind environmental contamination as it is mainly used. It has various properties, including an opacity, tensile strength, hardness, chemical resistance, and ductility at low temperatures.

HIGH DENSITY POLYETHYLENE (HDPE)

High-density polyethylene is sturdy, inconsequential, not of high cost, smooth procedural effectiveness. It is a type of artificial flexible material, commonly utilized in the fabric industry, good and laboratory equipment. (Amit kumar and others.2022).[9]

Every year, about 500 billion to 1 trillion plastic bags are produced and only 1 % of these are reused every year. The increasing use of plastic occurring every day poses a threat to the environment. For reducing the threat of increasing usage their degradation is very important. (Yakowitz H , 1990 and Curlee T R and Das S 1991).[5]

MATERIALS AND METHOD

For the experimental setup Termites were taken with a colony and cleaned them and insects were kept in a box and solid waste products such as saw dust, coconut husk , low density polyethylene, high density polyethylene, mixture of paint and cement , disposable plates were used .

The experiment was done for three consecutive weeks (from 25 Nov 2024 to 15 Dec 2024). Plastic container boxes measuring 18cm length , 12 cm breadth , 6cm height . Boxes were holed for aeration . Each box contains different diets total no of five termites were kept along with replicas of each diet.

FORMATION OF DIET

- Coconut husk :- were cut into small pieces
- Saw dust :- fine powdered form used
- Low density polyethylene :- were cut into very small pieces
- High Density Polyethylene- were cut into very small pieces
- Mix. Of Paint & Cement- crushed into small pieces
- Disposal Plates- were cutted into small pieces

  Each experimental boxes contains 10 gms of product.

FIG 1.& 2. Colony of Termites

FIG .3. Distribution of different diets

RESULT

After conducting the experiment for three consecutive weeks we analyzed that Termites were able to degrade solid waste products , they preffered low density polyethylene over high density one and they least preffered coconut husk

The result of their gut microbiota shows that Termites possesses symbiotic relationship with bacteria and fungi they are as *Cryptomerus* and *Bacillus* are plastic degrading bacteria are seen in gut microbiota of termites . *Lysinibacilluset* shows symbiotic relationship with the gut of termites , where as some fungi are also present they are *Xylaria* and *Aspergillus* species .

These microbes and fungi are present in gut of termites which helps in degradation of solid waste materials.

Among the diets given to the termites they mostly preffered the low density polyethylene as it is light weight and easily gets digested secondly they mostly degrade mixture of paint and cement , and third choice was disposal plates . and saw dust .

The difference observed between these diets was highly significant with a *p*-value of less than

0.001(p<0.001). Therefore based on the observational study we reject null hypothesis.
The ANOVA test perform for the statistical analysis and Graph were made with the help of GRAPH PRISM 10.2.0. software.

Table : 1- Consumption % and Consumption rate of Termites on different solid waste

	WEEK-1		WEEK-2		WEEK-3	
DIET	CONSUMPTION %	CONSUMPTION IN GM	CONSUMPTION %	CONSUMPTION IN GMS	CONSUMPTION %	CONSUMPTION IN GM
SAW DUST	21±4.44	2.07±0.44	22±4.83	1.45±0.51	24±5.40	2.42±0.28
COCONUT HUSK	3±4.44	0.32±0.44	5±4.83	0.53±0.51	6±5.40	0.57±0.28
LOW DENSITY POLYETHYLENE	15±4.4	1.45±0.44	18±4.83	0.95±0.51	21±5.40	1.62±0.28
HIGH DENSITY POLYETHYLENE	13±4.44	1.3±0.44	16±4.83	1.05±0.51	18±5.40	1.05±0.28
MIX. OF PAINT AND CEMENT	35±4.44	3.45±0.44	40±4.83	4±0.51	45±5.40	2.18±0.28
DISPOSAL PLATES	24±4.44	2.42±0.44	28±4.83	1.8±0.51	32±5.40	1.8±0.28
MEAN	18.5	1.835	21.5	1.63	24.33	1.61

(The data was analyzed using analysis of Two-way Anova with four replica and significance was tested at 5% level (P = 0.05) and 1% level (P = 0.01%)

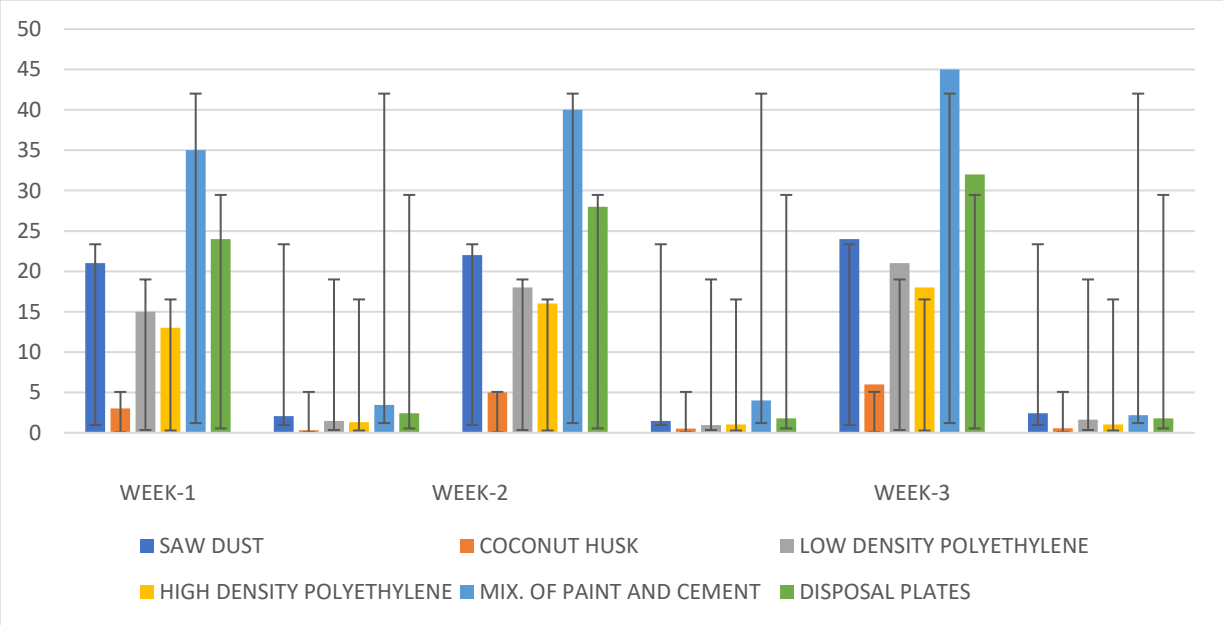

FIG. 4. Graph showing mean consumption rate and consumption percentage of Termites on different solid waste products

Table : 2- Survival % of Termites on Different Solid wastes

DIET	SURVIVAL %
SAW DUST	75
COCONUT HUSK	82
LOW DENSITY POLYETHYLENE	88
HIGH DENSITY POLYETHYLENE	73
MIX. OF PAINT AND CEMENT	80
DISPOSAL PLATES	70
MEAN	78
SD	6.60
SE	2.70

The data was analyzed using analysis of Two-way Anova with four replica and significance was tested at 5% level (P = 0.05) and 1% level (P = 0.01%)

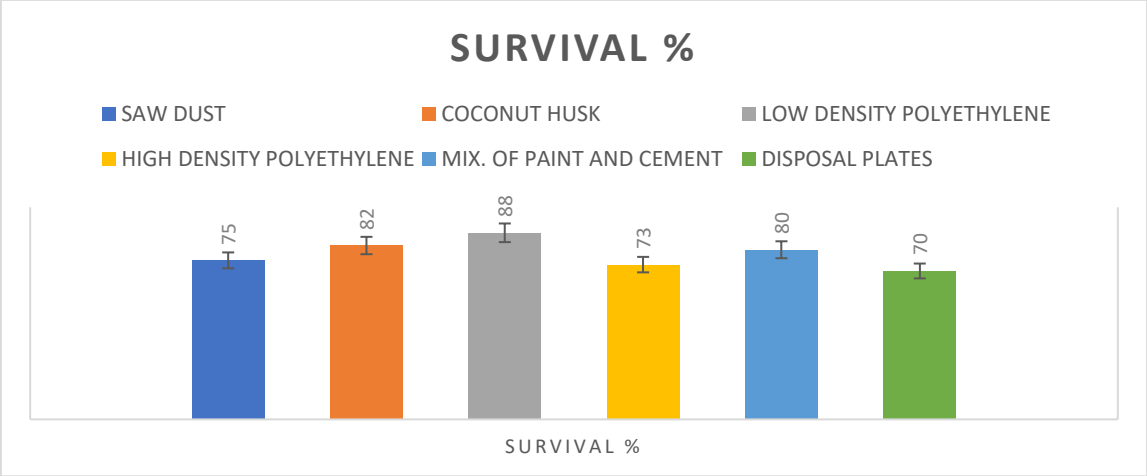

FIG: 5 – Graph showing survival percentage of Termites on different solid waste products

DISCUSSION

Termites are mostly regarded as pest and damages the wood products , but we have found their use in an effective way , gut microbes and fungi of termites are able to degrade solid waste materials. Hence in this way they can be used in an good helps to maintain the pollution. During the pandemic in 2019 , the usage of plastic was increased due to excess usage of PPE kits , at that termites were seen degrading them(Sameh S. Ali and Rania Al−Tohamy, 2023) [4] . This research gives that termites are able to degrade lignocellulose by their gut symbionts (microbes and fungi). (Ali S.S. et al. 2021).[1]

Results of the experiment shows that they are able to degrade plastic and different types of solid waste materials.

Previous studies has done on same topic have reported similar results where termites were used in degradation of PPE kits and their gut microbiota shows presence of different microbes and fungi which helps in degradation of solid waste materials. [4]]

Intestine of termites maybe seen as a environment accompanying complex microbial communities. Termites are immediately thinking expected a bioreactor capable of favorably debasing lignocellulose. [9]

CONCLUSION

The use of Termites in the degradation of solid waste products is an effective way. Termite gut has symbiotic relationship with microbes and fungi, which can degrade these solid waste materials such as Low and High-density polythene disposal plates etc are degraded by them. This phenomenon of degradation of solid waste by Termites is called Termigradation.

We use plastics in our routine life, but excessive usage of plastic poses health risk to pollution to our atmosphere. Biodegradation procedures for degradation plastics are considered as eco-friendly. This research indicates that termites possess the potential to degrade plastics and other solid waste materials. This work demonstrates that plastic polymers maybe decompose by microbial group of termites. Currently, it is essential to explore eco-friendly technologies capable of fully degrading plastic materials

REFRENCES

1. Abbasi, S. A., & Gajalakshmi, S. (2015). Disposal of municipal solid waste with in situ termireactors: proof-of-concept. *Bioresources and Bioprocessing*, *2*, 1-5.
2. Ali, S. S., Elsamahy, T., Al-Tohamy, R., Zhu, D., Mahmoud, Y. A. G., Koutra, E., ... & Sun, J. (2021). Plastic wastes biodegradation: Mechanisms, challenges and future prospects. *Science of The Total Environment*, *780*, 146590.
3. Ali, S. S., Mustafa, A. M., & Sun, J. (2021). Wood-feeding termites as an obscure yet promising source of bacteria for biodegradation and detoxification of creosote-treated wood along with methane production enhancement. *Bioresource Technology*, *338*, 125521.
4. Al-Tohamy, R., Ali, S. S., Zhang, M., Sameh, M., Mahmoud, Y. A. G., Waleed, N., ... & Sun, J. (2023). Can wood-feeding termites solve the environmental bottleneck caused by plastics? A critical state-of-the-art review. *Journal of Environmental Management*, *326*, 116606.
5. Curlee, T. R., & Das, S. (1991). Identifying and assessing targets of opportunity for plastics recycling. *Resources, conservation and recycling*, *5*(4), 343-363.
6. Dangerfield, J. M., McCarthy, T. S., & Ellery, W. N. (1998). The mound-building termite Macrotermes michaelseni as an ecosystem engineer. *Journal of tropical Ecology*, *14*(4), 507-520.
7. Fagbohunka, B. S., Ezima, E. N., Okonji, R. E., Adegbesan, B. O., & Itakorode, B. O. (2021). Biodegradation of wastes using cellulase from termite, Amitermes eveuncifer (Silverstri) Soldier: A clue to the application of termites cellulase in waste management. *FUOYE Journal of Pure and Applied Sciences (FJPAS)*, *6*(2), 10-19.
8. Fathima, A., & Abraham, R. (2020). Term gradation: use of termites in solid waste management. *Int. Res. J. Eng. Technol*, *7*(04), 1878-1881.
9. Kumar, A., Kalleshwaraswamy, C. M., Sharma, R., Sharma, P., & Poonia, A. (2022, August). Biodegradation of plastic using termites and their gut microbiota: a mini review. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1057, No. 1, p. 012016). IOP Publishing.
10. Nabegu, A. B. (2010). An analysis of municipal solid waste in Kano metropolis, Nigeria. *Journal of Human Ecology*, *31*(2), 111-119.
11. Sharma, R., Kaur, R., Rana, N., Poonia, A., Rana, D. C., & Attri, S. (2021). Termite's potential in solid waste management in Himachal Pradesh: A mini review. *Waste Management & Research*, *39*(4), 546-554.
12. Snyder, T. E. (1925). The origin of the castes in termites. *Proceedings of the Biological Society of Washington*.

13. Sunil, G., Yang, Y., Jae-Hyung, A., & Hor-Gil, H. (2020). Biodegradation of polyethylene: a brief review. *Applied Biological Chemistry*, *63*(1).
14. Warnecke, F., Luginbühl, P., Ivanova, N., Ghassemian, M., Richardson, T. H., Stege, J. T., ... & Leadbetter, J. R. (2007). Metagenomic and functional analysis of hindgut microbiota of a wood-feeding higher termite. *Nature*, *450*(7169), 560-565.
15. Wheeler, W. M. (1923). Social life among the insects. *The Scientific Monthly*, *16*(1), 5-33.