International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

REMOVAL OF HEAVY METALS FROM INDUSTRIAL SEWAGE SLUDGE BY APPLICATION OF VERMICOMPOSTING.

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Abstract -India faces a significant challenge with the escalating production of industrial sewage sludge, which contains hazardous heavy metals and toxins, posing a serious environmental threat. Managing the disposal of such waste is increasingly difficult due to its resistance to degradation. This research explores the potential of vermicomposting as a sustainable solution for mitigating heavy metal contamination in sewage sludge. Vermicomposting harnesses earthworms to accelerate organic matter decomposition and immobilize heavy metals. The study investigates various vermicomposting parameters, such as worm species, moisture levels, pH, and NPK to optimize heavy metal removal. Furthermore, it assesses the quality of the resulting vermicompost, focusing on heavy metal concentrations and potential agricultural applications. The findings indicate that vermicomposting holds promise as an eco-friendly method for addressing heavy metal pollution in sewage sludge, offering opportunities for sustainable waste management and soil enhancement.

***Key Words*:** *Industrial waste, Heavy Metals, Land applications, Vermicomposting Method, Chemical speciation, Characterization and speciations.*

1.INTRODUCTION

Sewage sludge, a residual product of wastewater treatment, has presented a persistent challenge regarding its safe disposal due to its elevated heavy metal content. Notably, heavy metals like lead, cadmium, and copper pose significant environmental risks, particularly when applied to agricultural land, where they can endure and pollute soil and water. Consequently, there is an urgent demand for innovative and sustainable methods to decrease heavy metal levels in sewage sludge. Vermicomposting, an ecologically sound process utilizing earthworms, emerges as a promising remedy. This method, renowned for converting organic waste into nutrient-rich vermicompost while concurrently lowering heavy metal concentrations, has garnered attention. Earthworm activity enhances organic matter decomposition, thereby diminishing heavy metal bioavailability through mechanisms like adsorption, complication, and microbial activity. This study probes the potential of vermicomposting in remediating heavy metalcontaminated sewage sludge. It scrutinizes various factors influencing vermicomposting efficiency in heavy metal removal, such as earthworm species selection, moisture regulation, and carbon-to-nitrogen ratio adjustment. Furthermore, it assesses resulting vermicompost quality and its agricultural suitability, addressing waste management and soil enhancement needs simultaneously. By 2 examining heavy metal removal from sewage sludge via vermicomposting, this research contributes to sustainable and environmentally friendly solutions, mitigating sewage sludge's environmental impact while harnessing its agricultural potential.

2. MATERIALS AND METHODS

Vermicomposting involves the decomposition of organic matter with the assistance of worms and microorganisms. In the natural environment, these organisms play a crucial role in breaking down organic material. When it comes to vermicomposting sewage sludge, red worms are employed to facilitate decomposition, with cow dung and plant leaves serving as activators in specific proportions alongside the sludge.

2.1 Collection Of Raw Material

The Industrial sewage sludge was gathered from a Water Treatment Plant (WTP) situated in CETP, Kurkumbh, Pune. The activators cow dung and plant leaves were collected from the nearest farm. The species of Earthworm were collected from the Gandul Project Division, Aaundh, Pune.

2.2 Vermicomposting Preparation Process

1.Line the bottom of the triplicates or box with a thin coating of cow dung.

2.The second layer should consist of spread plant leaves and grass, promoting the growth of earthworms, with adequate water sprayed on top.

3.Follow up with a thick layer of cow dung in the third layer, which greatly aids in earthworm growth.

4.Distribute the layer of industrial sludge evenly among the triplicates, assessing the nutritional quality of the compost on the waste sludge, and then sprinkle water to maintain moisture levels.

5.Allow the material to undergo decomposition for 15 to 20 days.

6.Once composting is complete, directly apply the earthworms to the triplicates.

2.3 Input of Additive Materials

The raw materials were combined within the triplicate to ensure uniform distribution of nutrient levels, promoting consistent vermicomposting activity. In a trial phase, sewage sludge and activators such as cow dung were mixed in a 50:50 mass ratio and introduced into the triplicates. The quantities of each raw material added to Triplicate are as follows: Sewage Sludge (15kg) and Cow Dung (15kg).

2.4 Input of Earthworm

The earthworms utilized in our experiment, Eisenia fetida, were observed to begin processing the raw materials starting from the uppermost bed layers. As they consume the topmost layer, they gradually migrate downward, facilitating the vermicomposting process from the upper levels downward. As nutrients are depleted, the earthworms move down through the layers, preparing the upper levels for further decomposition.

2.5 Lab Analysis

- pH
- Moisture content
- Temperature
- Total nitrogen
- Total phosphate
- Total potassium
- Heavy metals (Fe, Zn and Cu)

3. RESULT AND DISCUSSION

3.1. Effect of vermicomposting on physical chemical characters of sludge

The physico chemical parameters shown significant changes when industrial sewage sludge was composted with earthworm Eisenia Fetida. Results of all the measured parameters such as organic carbon, Nitrogen, Potassium, Phosphorous on final day were significantly 3 changed from initial sample. Organic carbon values significantly decreased in the metal treated culture beds from 240.5 to 15.915. Earthworms have the ability to oxidize the organic carbon into carbon dioxide and also it increase the nitrogen content by the gut microorganism. The amount of total nitrogen present in the final compost was dependent upon the initial nitrogen present in the feed mixture and the degree of decomposition. TKN increased significantly from initial amount of 1.26 g/kg. The maximum increase in TKN was observed as 8.5 g/kg . Earthworms also add nitrogen in the form of enzymes during the fragmentation. The increase in TAP content was observed as 2.35 g/kg in final feed mixtures and was significantly increased to the range 0.44 g/kg. The total available Phosphorus (TAP) was significantly higher in the vermicompost than the initial feed mixture, due to action of worm gut enzymes. The same results also showed for K as 2.55 g/kg at the end of the vermicomposting process. The increase in total available Potassium (TAK) contents is a direct action of earthworms gut enzymes.

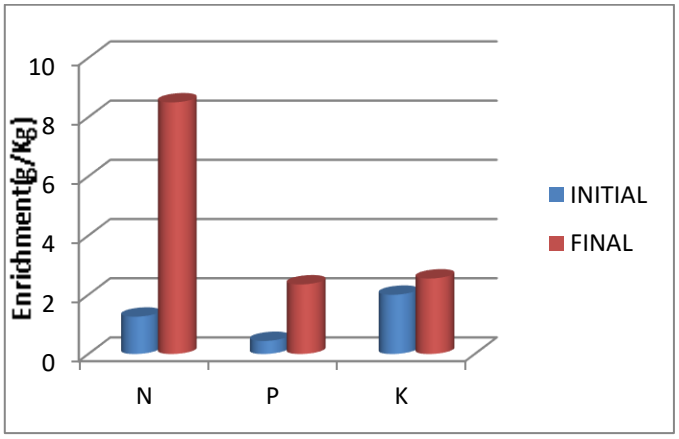

Fig.NPK enrichment in the process of vermicomposting

3.2. Heavy metal content in vermicomposted sludge

Analyzing heavy metals in industrial sewage sludge is crucial for understanding its environmental impact and ensuring proper disposal or treatment. Industrial activities can introduce various heavy metals into sewage sludge, posing risks to the environment and human health if not managed appropriately. The heavy metal concentration of Industrial sewage sludge was found to be lower, after they were treated in vermicomposting process. The heavy metal reduction percentage in the final compost were observed as 25% to

47.5% (Fe), 26% to 53% (Cu) and 72% to 85% (Zn) respectively. Vermicomposting has been found to be an effective method for removing heavy metals from industrial sewage sludge. The process involves using earthworms to decompose organic materials in the sludge, which in turn reduces the concentration of heavy metals. The resulting vermicompost is then safer to use as a soil amendment. Studies have shown that vermicomposting can significantly reduce the levels of heavy metals such as iron, copper, and zinc in sewage sludge, making it a promising approach for waste management and soil remediation in industrial areas.

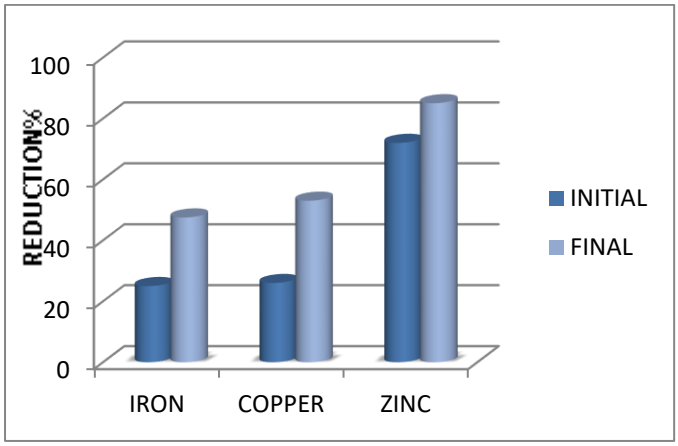

Fig. Heavy metal reduction in the process.

4. CONCLUSION

The study effectively demonstrated that vermicomposting serves as an efficient method for alleviating heavy metal contamination in industrial sewage sludge, rendering it suitable for safe disposal or beneficial application in agriculture. The research highlights the robust tolerance of Eisenia fetida to varying concentrations of heavy metals (Zn,Cu,andFe).

However, no significant increase in earthworm population was observed across all experimental beds during the 25-day period. While vermicomposting shows promise for treating and repurposing industrial sewage sludge, its successful adoption necessitates careful consideration of regulatory compliance, environmental repercussions, and market acceptance. With adequate management and supervision, vermicomposting can promote sustainable waste management practices and the development of valuable soil supplements, while mitigating potential hazards to human health and the environment.

5. ACKNOWLEDGEMENT

This research work was supported by Department of Civil Engineering, Zeal College of Engineering and Research Pune, India. And special thanks to Nilesh Aynodkar sir without whose cooperation and direction of experimentation of project would be impossible.

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