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Effect of Earthworm on Physicochemical Parameter of Domestic Greywater: A Review

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Abstract - *The fundamentals Due to rising water demands, water scarcity has become one of the world's most pressing challenges. According to reports, around 80% of the water supply consumed by society returns to the sewer system as household wastewater. Earthworms play a critical role in the purification of wastewater and solid stabilization in the Vermifiltration principle. Earthworms are extremely sensitive to changes in atmospheric conditions as well as soil, water, and wastewater qualities. Eisenia Fetida will be the finest species to treat diverse wastewaters among various categories. Heavy metal ions, on the other hand, do not interact. The Vermifiltration technique has applications in both urban and domestic water treatment.*

Key Words: *Vermifiltration, Earthworms, Wastewater*

1. INTRODUCTION

Due to insufficient treatment infrastructure, wastewater creation and treatment has become a significant health issue in developing countries. The most significant source of contamination of water resources is the discharge of untreated wastewater into surface and subsurface watercourses. For the treatment of domestic wastewater, the majority of the population in rural and urban areas of developing countries rely on onsite systems. For the treatment of rural home wastewater, treatment systems with minimal costs, energy, and maintenance are preferable [1]. Due to rising water demands, water scarcity has become one of the world's most pressing challenges. According to reports, around 80% of the water supply consumed by society returns to the sewer system as household wastewater. The vast majority of the many types of effluents discharged by various companies are disposed of in the open environment, polluting soil and water resources. Individual wastewater treatment, whether physical, chemical, or biological, is frequently quite expensive and produces a lot of sludge. As a result, alternative therapeutic methods are required. [2] Vermifiltration of wastewater with earthworms is a relatively recent concept. The general method of "ingestion and biodegradation of organic wastes, heavy metals, and solids" has been discovered to remove the 5 days BOD (BOD5), COD, total dissolved solids (TDS), and total suspended solids (TSS) from wastewater by earthworms. [4] They are absorbed through the body walls and from wastewater. By boosting the number of soil microorganisms, earthworms propel and assist microbial activity in Vermifilter. Except for pumping, vermifiltration requires no external energy. As a result, it can be extremely beneficial to small towns, colonies, and villages. Because other wastewater treatment technologies, such as a manmade wetland, stabilization pond, and other typical technologies, require more space than term filtration, vermifiltration is more dependable. Furthermore, the term filtration method has been shown to be as effective as the activated sludge procedure. There is no sludge production in the process, which eliminates the need for additional landfill disposal costs. This procedure is also odourless, and the resulting vermifiltered water is safe to use in parks and gardens, as well as for farm irrigation. [4]

Vermiremediation Process

Earthworm's works Natural Bioreactor

Vermifiltration is a more efficient and recently developed method. Vermifiltration is a low-cost, odourless, and labor-intensive intense technique of wastewater treatment that does not require a great amount of space to set up. Because of its efficacy in eliminating contaminants from wastewater and its good environmental consequences, vermifiltration technology has been extensively researched (Natarajan et al., 2015). Vermifiltration is a relatively new method that uses earthworms to filter biologically contaminated wastewater. Microbes play a vital part in the vermifiltration system in this technology, and they also give extracellular enzymes to aid the earthworm in the fast breakdown of organic compounds in the Vermifilter bed. [2] Earthworms have 600 million years of garbage and environmental management experience. They were dubbed the "unheralded soldiers of mankind" by Charles Darwin, and the "intestine of earth" by Greek philosopher Aristotle, implying that they digested a vast variety of organic components from the ground, including waste organics. Earthworms are segmented organisms with no bones that are long, cylindrical, slender, and bilaterally symmetrical. The body is dark brown, gleaming, and completely covered in cuticle. After 8–10 weeks, they weigh around 1,400–1,500 milligrams. 2,000 adult worms weigh 1 kg on

average, while one million worms weigh about 1 tons. An earthworm's life span is usually 3–7 years, depending on the species and the ecological condition. [4] Temperatures of 20–25°C and moisture levels of 60–75% are ideal for worm function. [8] Earthworms are bisexual organisms that reproduce quite quickly. Earthworms can reproduce by 28, i.e. 256 worms every 6 months, if the ideal parameters of temperature, moisture, and feeding materials are met. The worms' whole life cycle is approximately 220 days. Within their life span, they generate 300–400 young. Light, touch, and dryness are all particularly sensitive to earthworms. Low temperatures do not bother them as much as high temperatures do. In the winter, their movement is severely delayed, yet heat can kill them fast. [4] Temperatures of 20–25°C and moisture levels of 60–75% are ideal for worm function. [8] Earthworms are bisexual organisms that reproduce quite quickly. Earthworms can reproduce by 28, i.e. 256 worms every 6 months, if the ideal parameters of temperature, moisture, and feeding materials are met. The worms' whole life cycle is approximately 220 days. Within their life span, they generate 300–400 young. Light, touch, and dryness are all particularly sensitive to earthworms. Low temperatures do not bother them as much as high temperatures do. In the winter, their movement is severely delayed, yet heat can kill them fast. [4]

Fig: 1 Photograph of Eisenia Fetida

The Impact of Earthworms on Wastewater Physicochemical Parameters

Sr. No	Parameter	How It Reduces.	Species	Reference
1	BOD	According to reports, the filtering technique is an effective and environmentally beneficial way to treat wastewater from homes. During swallowing, the earthworm consumes residual suspended particles in the filter, reducing BOD by more than 90%. The most common species used in treated residential wastewater are Esenia fetida and Eudrilus Eugenie.	Eisenia fetida & Eudrilus eugeniae	Bhavini, Kavita Kanaujia, et.all (2015) Earthworm Assisted Remediation of Effluents and Wastes.ISBN 978-981-15-4521-4 ISBN 978-981-15-4522-1.[6]
2	COD	The vermifiltration process has been used to treat domestic wastewater and has proved to reduce COD significantly. COD in the 80–90% range, as well as a considerable fall in nutritional concentration.	Eisenia fetida	Sinha RK, et.all (2007) Removal of high BOD and COD loadings of primary liquid waste products from dairy industry by vermifiltration technology using earthworms. Indian J Environ Prot 27(6):486–501.[7]

3	TDS	Microorganisms decomposed organic debris, which was then digested by earthworm colonies dwelling in bedding material. The decomposition of solid substances was also driven by actinomycetes found in the guts of earthworms. Earthworms (Eisenia fetida) have been found to increase bacterial diversity in waste water, particularly in response to nutrients in their casts, according to studies. Vermi Filter ingests and biodegrades organic wastes and other waste water containments with the help of earthworms and microorganisms. This improves sewage treatment efficiency by extending the food chain in regular bioprocesses. During the process, TDS is reduced by 90–92%.	Eisenia fetida	Sinha, R K., Bharambe, G., and Bapat, P. 2006 , Removal of high BOD and COD loading of Primary liquid waste products from Diary industry by vermifiltration technology using Earthworms , IJEP 27 (6) : 486-501.[8]
4	PH	The concentration of hydrogen ions in a liquid is measured by PH. The earthworms in the Vermifilter bed neutralized the raw sewage water's average pH (6.45) to a pH of around 7.0. The pH of treated sewage without earthworms improved to 6.6, although not to the same extent as that of the vermifilter. By elevating the pH, earthworm activity created an in-built pH buffering ability, balancing the sewage effluent pH.	Eisenia fetida	S. A. Azuar and M. H. Ibrahim, "Comparison of sand and oil palm fiber vermibeds in filtration of palm oil mill effluent (POME)", UMT 11th International Annual Symposium on Sustainability Science and Management, 09th-11th July 2012, Terengganu, Malaysia, pp. 1414- 1419, 2012.[9] Municipal Program Development Branch, Environmental Sciences Division, Environmental Service, "Guidelines for municipal wastewater Irrigation", Alberta Environment, pp. 1-24, 2000. [10]
5	Fluoride	The worms were subjected to NaF concentrations ranging from 0.1 to 4.0 parts per million (ppm), which is below and above the currently recommended 0.7 ppm. Municipal water systems have faded. 2 Treatment solutions were produced from a stock solution in distilled-demonized water, with water-only as a control.	Eisenia fetida	Department of Health and Human Services. HHS and EPA announce new scientific assessments and actions on fluoride: agencies working together to maintain benefits of preventing tooth decay while preventing excessive exposure.[cited 2012 January 6].Available from: http://hhs.gov.news/press/2011pres/01/20110107a.html.[11]
6	Pb (lead)	Both available and total metal concentrations in soil can be altered by earthworms. Earthworms partially store heavy metals in their tissues during their feeding activities and also leave a portion of heavy metals in the soil environment through their casting	Aporrectodea caliginous	Beyer WN, Hensler G, Moore I (1987) Relation of pH and other soil variables to concentrations of Pb, Cu, Zn, Cd and Se in earthworms. Pedobiologia 30:167–172 [12]. Lee KE (1985) Earthworms: their

		operations, reducing their role in the soil food chain. Heavy metals can accumulate in high amounts in earthworm tissues, although their faces can have a smaller amount of metals.		ecology and relationships with soils and land use. Academic, Sydney, Australia Lee KE (1985) Earthworms: their ecology and relationships with soils and land use. Academic, Sydney, Australia Lee KE (1985) Earthworms: their ecology and relationships with soils and land use. Academic, Sydney, Australia[13] Lavelle P, Brussaard L, Hendrix P (1999) Earthworm management in tropical agroecosystems.CABI Publishing, Wallingford, Oxford, UK [14]

Table 1: Earthworm Niche Diversification

Earthworm species	Weight adult Worm(g)	Temperature Tolerance (oC)	Moisture Tolerance (%)	Active phase	Distribution
Eudrilus eugeniae	1.5-2.5	18-35	20-40	Throughout the year	South America and tropical Africa
Eisenia fetida	0.3-0.7	15-30	20-40	Throughout the year	Europe's temperate zones, North America's, and India's
Perionyx excavatus	0.8-1.2	8-30	30-50	Throughout the year	Tropical countries
Dichogaster bolaui	0.04-0.07	20-28	20-30	July- October	Tropical countries
Dicogaster affinis	0.04-0.07	20-28	20-30	July- October	Tropical countries
Drawida barwelli	0.2-0.5	20-30	40-50	August-November	Shade is necessary for establishment in tropical countries.
Lampito mauritii	0.8-1.5	18-28	20-40	June-august	Indian Peninsula Plains

Table 2: The Use of Vermifilter in Sewage Treatment

Sr.No	Type Of Waste Water	Earthworm Species	Organics Removal (%)	Nutrient Removal (%)	Bed Material And Size	HLR (m3/m2 d)	HRT (hour)
1	Sewage	Eisenia fetida	BOD 98, COD 45,TSS 90	-	Pure Soil Sand (10-12mm),Gravel (7.5,of 3.5-4.5	-	1-2
2	Synthetic Sewage	Eisenia fetida	COD 83.6	TN 63, TP 86.7,NH_3-N 70.5	Cobblestones(6-10 cm),Soil Sawdust	0.2	48,72,96
3	Urban Waste water	Perionyx sansibaricus	COD 80-90,88.6,TDS 99.8	No3 92.7, Po 3-4 98.3	Surface vegetation, soil, Dried leaves, Sawdust Small Stones(5-7 cm),:Large Stones (10-15 cm)	-	1
4	Sewage	Eisenia fetida	BOD 98 ,COD 70, TSS 95	-	Garden Soil, Sand, Aggregates (3-5, 7-8 cm)	-	2
5	Rural Domestic sewage	Eisenia fetida	BOD 78,COD 67.6, TSS 89.8	NH_{4n} 92.1	Ceram site (3-5 mm)	4.2	-
6	Synthetic wastewater	Eisenia fetida	BOD 96 ,COD 90, TSS 82	-	Vermicomposting, riverbed material(6-8 mm), Sand (1-2 mm), gravels (10-12.5 mm)	1.5,2,2.5,3	-
7	Urban Wastewater	Eisenia fetida	BOD 98.5,COD 74.3, TSS 96.6	$NH_4$99.1	Vermicomposting, Quarts Sand, gravel (40mm)	2.6,1.3,0.8,0.6	2,4,6,8
8	Synthetic Wastewater	Eisenia fetida	BOD 70-81,COD 59-72, TSS 55-75	-	Vermicomposting sand (2-4mm),riverbed material ,wood coal, glass balls, mud balls, gravel (10-12.5mm)	1.5	-

Earthworm Density Variation

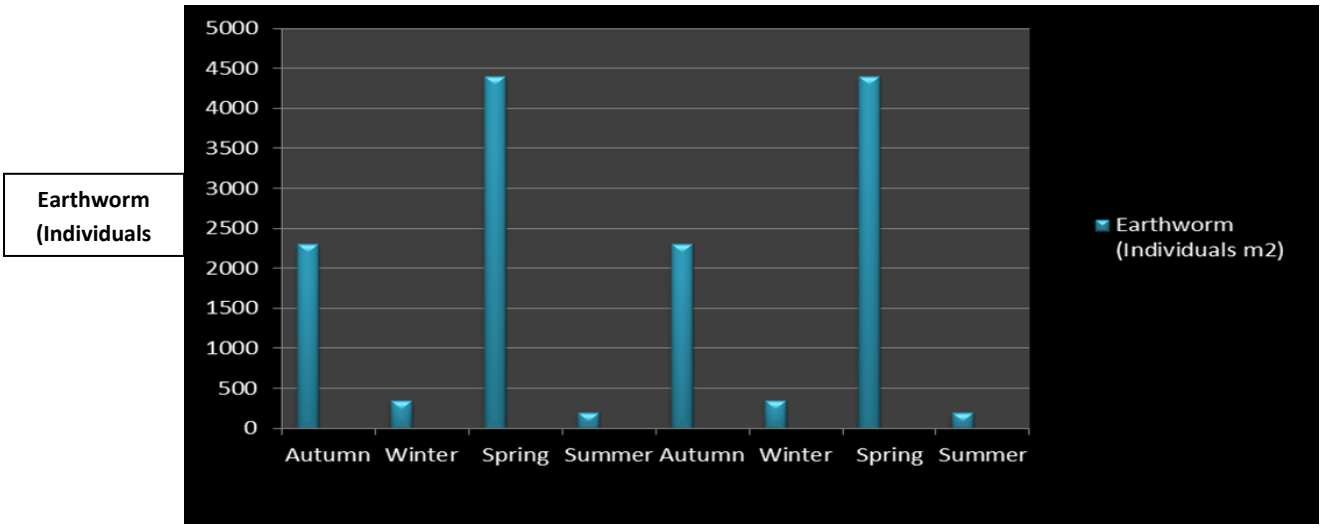

Fig: 2 Seasonal Fluctuations in Earthworm Density in a Field Population of the Earthworm Eisenia Fetida [7]

i. Earthworm classification.

- **Earthworms have Epigeic origins**

Because these worms do not create burrows and instead live among decomposing organic materials on the soil Surface, the Greek word Epigeic means "on the earth." Because they reside on the surface of the soil among piles of leaves or compost heaps, they are sometimes known as compost earthworms or surface-dwelling earthworms.

They are little, ranging in length from less than an inch to seven inches.

- **Earthworms that are Endogeic**

Endogeic means "inside the ground" in Greek, and these worms dig beneath the top layers of soil, rarely coming to the Surface, preferring instead to live literally within the earth. They are most typically found in the soil's higher layers.

These worms are small, measuring from one to twelve inches in length. They aid in the mixing of minerals and air Inside the soil, as well as aeration, by eating the soil itself.

- **Earthworms that are Anecic**

Although these worms dwell underground, they come up to the soil level for nourishment, hence the name "Anecic."

These worms tunnel vertically in the soil's mineral layers, making permanent burrows as deep as six feet below ground Level. Their burrow systems are enormous, with some measuring up to one inch in diameter. These worms take organic Debris from above ground, such as fallen leaves, and drag it back below to their burrows. They have been observed Eating earth and some litter. They come in a wide range of sizes, ranging from one inch to sixty inches in length.

- **The Redhead Worm**

This worm is endemic to Western Europe, but it has spread throughout North and South America, becoming an invasive species. It can be found in the top layers of soil or among piles of rotting leaves, and it is particularly Frequent in coniferous forests. The common name 'Redhead worm' comes from the red-purple coloring on one end of the worm.

- **Earthworm in general**

This species of earthworm, sometimes known as the 'dew worm' or 'lob worm,' is endemic to Western Europe, yet it Has spread throughout North and South America, Asia, Africa, and Oceania as a result of the transportation of plants And worms for fish bait. It is an invasive species that feeds on leaf piles on the soil's surface and the soil's upper layers.

They have powerful muscles that let them to flee from predators like foxes, shrews, and birds. They are most visible During wet weather and may burrow under the top layers of soil during dry seasons to avoid both heat and predators.

- **Green Worm is a fictional character**

This Endogeic worm is the most common type of earthworm found in the United Kingdom, accounting for 34% of all earthworms identified. Green worm gets its name from the fact that some of these worms have bilin pigment, which gives them their green hue. The pink variants have a somewhat yellow coloured ring around their top end, and three suckers-looking discs can be seen on the underside of the saddle if you look closely. These worms grow to be around two inches long as adults.

- **European Night crawler**

This worm is also known as the 'Greenhouse worm,' or 'Compost worm,' due to its increasing popularity as a Composting worm, however it is most usually employed as a fishing bait worm. Compost heaps, manure heaps, and Piles of rotting leaves or other organic garden waste, or bark are all good places to look for these worms.

- **Brandling Worm**

These epigean worms live on the surface and are rarely seen in the soil layers. They eat decaying plants, dung, And Compost to survive this worm is also known as the 'Tiger worm,' or 'Trout worm,' and it is endemic to Europe, though it has been brought to every continent except Antarctica.

1. Earthworm taxonomy

Phylum	Annellida
Class	Oligochaeta
Subclass	Clitelata
Order	Haplotaxia
Suborder	Lumbricina
Super family	Lumbricoidea
Family	Lumbricidae
Subfamily	Lumbricidae
Genus And Species	Eisenia Fetida

2. Factor affecting the culturing of earthworm.

i. Climate
ii. Soil properties
iii. Food
iv. Competition
v. Predation
vi. Parasitism and Disease

vii. Land management
viii. Mining And Industrial Wastes
ix. Deforestation
x. Afforestation
xi. Grassland Management
xii. Arable Cropping
xiii. Manures And fertilizers
xiv. Pesticides and Pollutants
xv. Soil Water Management

This is a factor that is influenced by earthworm cultivation. [8]

3. The impact of earthworms on wastewater physical and chemical characteristics.

After vermicomposting, Eisenia fetida survival was very high (98%) while earthworm mortality was very low (2%). Sludge vermicomposting had a PHS that was within the ideal range for plant growth. The PHS of sludge vermicomposting before and after has dropped from 7.4 to 6.3. Subler et al. found that vermicomposts had a lower pH than composts as a group, just as this study found. During their research on the vermicomposting of some organic residues, Haimi and Huhta came to the conclusion that the lower pH in the end product (vermicomposts) could be due to the production of CO2 and organic acids by microbial decomposition during the bioconversion process of various substrates. Heavy metal concentrations in organic matter in vermicomposting were significantly lower than in the initial sludge, while heavy metal concentrations in earthworm tissues increased. Because of anthropogenic sources, heavy metals emerge in the sludge. For example, dust, paint chips, batteries, and so on. Because to adsorption by Eisenia fetida, heavy metal concentrations (Cu, Ni, Cd, Pb, and Zn) in the vermiform post were substantially lower than in the original sludge. The five heavy metals in Eisenia fetida were ranked as Cd>Zn>Cu>Ni>Pb in the BAFs of x W C ss The BAF) ((1) 422 Fei Liu et al. / Procedia Environmental Sciences 16 (2012) 418–423. [9]

4. Heavy metal interactions with earthworms

Pesticide and heavy metal combinations in soil have eco toxic effects on earthworms. The nature of interactions between each mixture's components is specified. Pesticide and metal ion combinations were studied for synergistic, antagonistic, and additive effects. The most intriguing aspect is that many mixes can exhibit dual behavior, with both synergism and antagonism present depending on the dose-effect levels. Exposure to insecticides and metal ions in combination can have negative consequences for soil organisms. Pesticide and metal combination contamination may alter genome expression in earthworms, cause oxidative stress, decrease sexual development, diminish cocoon production and hatchability, influence juvenile viability, cause death, and affect population size, abundance, and species diversity. Earthworm populations were studied using gene expression analysis to clearly identify processes of tolerance and adaptation. The supplemental resources contain more information on the harmful effects of pesticides and metal combinations on various organisms. [10]

5. Vermiremediation's Advantages

i. Vermifiltration treatment uses little energy and has a distinct advantage over all other biological wastewater treatment systems, such as the Activated Sludge Process, Trickling Filters, and Rotating Biological Contactors, which use a lot of energy, are expensive to install and maintain, and generate no revenue.

ii. The Vermifilter method captures 100% of organic materials, has lower capital and operating expenses, and produces a high-value-added final product (vermicomposting).

iii. Sludge is discharged as excreta (vermicomposting) in the Vermifilter bed, which is a useful soil additive for agriculture and horticulture.

iv. Because the earthworms stop the rotting and degradation of all putrescible materials in the wastewater and sludge, there is no bad odour.

v. After the first year of vermitreatment, large amounts of worm biomass will be available for cattle, poultry, and fish husbandry.

vi. It can make use of waste organics that would otherwise be wasted by other methods.

vii. Increase the usage of waste materials in ways that other technologies cannot. [4]

CONCLUSIONS:

According to a detailed literature analysis, earthworms play an important role in the purification of wastewater and solid stabilization in the principle of Vermifiltration. The earthworm is extremely sensitive to changes in atmospheric conditions as well as soil, water, and wastewater properties. Eisenia Fetida will be the finest species to treat diverse wastewaters among various categories. However, heavy metal ions have little interaction. The Vermifiltration technique has applications in both urban and home wastewater treatment.

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