

Leachate as a Fertilizer

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ABSTRACT

No one is unaware of the massive volumes of waste produced on a daily basis by human society. All waste produced from household and industrial sources decompose in open spaces throughout the urban waste process. After that, leachate including high quantities of common cat ions, dioxins, heavy metals (such Pb, Ni, Cu, Hg, and organic compounds), Zn, S, NH₃, and Cl, as well as common cat ions, is created as a result of the waste's breakdown. The concentration of heavy metals in the leachate is negatively impacting the environment, soil, and vegetation. The goal of this research is to offer an alternative to leachate for its effective usage as fertilizer. This occurs when the material is thrown untreated on soil or in any landfill. This will provide an active, practical solution to India's leachate problem, which at the moment poses a major environmental concern.

Keywords : Heavy Metals, Landfill, Leachate, Trash, Decomposition.

I. INTRODUCTION

1.1 WHAT IS LEACHATE ?

Any liquid that, when passing through a substance, extracts soluble or suspended particles or any other component of the material is called a leachate. The environmental sciences frequently use the term "leachate," which describes a liquid that has dissolved or entrained potentially hazardous substances for the environment. The most frequent use case for it is when putrescible or industrial trash is being landfilled. Therefore, in the limited sense of the term "environment," "leachate" refers to any liquid that runs off of land or accumulates in piles and has noticeably

higher quantities of unwanted material that came from the substance that went through it.



Fig.1: Composition of Leachate (Source:Abdel-Shafy, Hussein & Ibrahim, Amr & Makki, Ahmed & Okasha, Raouf. (2023))



Fig.2 : Leachate from Landfills (*J. Environ. Monit.*, 2010,12, 2032-2047)

1.2 THE CHEMICAL COMPOSITION OF LEACHATE

Water helps bacteria and fungus in their breakdown process when it seeps through garbage. In turn, these activities generate breakdown products and quickly exhaust any oxygen present, resulting in the formation of an anoxic environment. When the temperature rises and the pH falls quickly in actively decomposing waste, many metal ions that are relatively insoluble at neutral pH get dissolved in the expanding leachate. As more water is released throughout the breakdown processes, the leachate volume rises. Leachate also modifies the chemical composition of materials that are difficult to break down, like gypsum- and cement-based building materials, fire ash, and other materials. Large amounts of hydrogen sulfide can be produced by the reaction of leachate with gypsum in sites that have a lot of building waste, particularly those that contain gypsum plaster. This hydrogen sulfide can then be discharged into the leachate and potentially make up a significant portion of the landfill gas.

A landfill leachate is a water-based solution containing four different types of contaminants: heavy metals (Pb, Ni, Cu, Hg); xenobiotic organic compounds (pcbs, dioxins, etc.); dissolved organic matter (alcohols, acids, aldehydes, short chain sugars, etc.); and inorganic macro components (common cations and anions, including sulphate, chloride, iron, aluminium, zinc, and ammonia).

Leachate appears as a foggy black, yellow, or orange liquid and has a distinct odour when it exits a typical garbage site. The smell is disagreeable and acidic; because of the hydrogen, nitrogen, and sulphur atoms, it may be extremely potent. The quantity and kind of trash deposited, together with the amount of precipitation, all affect the leachate's composition. Leachate usually contains nonhazardous characteristics that are common in most groundwater systems, in addition to a few hazardous elements (see table above). These components include salts (like sodium and chloride), dissolved metals (like iron and manganese), and a wide range of common anions and cations (like bicarbonate and sulphate). Nevertheless, leachate frequently contains these components in concentrations that are an order of magnitude (or greater) greater than those found in naturally occurring groundwater systems. Leachate from MSW dumps usually has a pH ranging from mildly low to moderately low, high total dissolved solids, and a high chemical oxygen demand. Hazardous substances like heavy metals and volatile chemical compounds can be found in MSW leachate. Leachates from wood waste are frequently high in lignin, tannins, manganese, and iron. Compared to other leachates, ash landfill leachate usually has a higher pH and contains more metals and salts.

Table 1 : Composition Chemical Properties

Organic compounds that are volatile or semi-volatile are excluded from the average leachate quality of municipal garbage.		
Parameter	Typical Range (milligrams per litre, unless otherwise noted)	Upper Limit (milligrams per litre, unless otherwise noted)
Total Alkalinity (as CaCO_3)	730–15,050	20,850
Calcium	240–2,330	4,080
Chloride	47–2,400	11,375
Magnesium	4–780	1,400

Sodium	85–3,800	7,700
Sulphate	20–730	1,826
Specific Conductance	2,000–8,000 $\mu\text{mhos/cm}$	9,000 $\mu\text{mhos/cm}$
Total Dissolved Solids	1,000–20,000	55,000
Chemical Oxygen Demand	100–51,000	99,000
Biological Oxygen Demand	1,000–30,300	195,000
Iron	0.1–1,700	5,500
Total Nitrogen	2.6–945	1,416
Potassium	28–1,700	3,770
Chromium	0.5–1.0	5.6
Manganese	Not detected – 400	1,400
Copper	0.1–9.0	9.9
Lead	Not detected – 1.0	14.2
Nickel	0.1–1.0	7.5

1.3 SOURCE OF LEACHATE

1.3.1. Main Source –

Domestic and Industrial sources

Produced as a result of both decomposition and waste degradation.

Table 2 : Different Source of Leachate

Source	Typical waste generators	Solid waste types
Residential	Single-family and multi-family homes.	Paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, and special wastes (such as large objects, consumer electronics, white goods, tires, oil, and batteries) are among the waste materials that can be found in the home.
Industrial	locations for building and fabrication, factories producing both light and heavy goods, and chemical and power plants.	packaging, food wastes, hazardous wastes, ashes, construction and demolition debris, and housekeeping wastes are some examples of waste materials.
Commercial	retail establishments, motels, eateries, marketplaces, office buildings, etc.	cardboard, paper, glass, metals, plastics, wood, food wastes, hazardous wastes, and special wastes.

Institutional	School, hospitals, prisons, government centres.	Same as commercial
Construction & demolition	New construction sites, road repair, renovation sites, demolition of buildings.	Wood, steel, concrete, dirt etc.

Table 3 : Impact of Leachate on Soil, Vegetation & Nature

Leachate component	Short term impact	Long term impact
High suspended solids	Diminished light levels that hinder the growth of macrophytes, sedimentation that chokes out aquatic life, and an increase in organic particles that deplete oxygen through microbial degradation	Habitat alteration, adsorbed Pollutants increase toxicity
High dissolved solids	Elevating salinity modifies the environment and reduces surface waters' abstraction value.	Groundwater contamination
Dissolved toxic compounds	Direct toxicity to aquatic life (e.g., fish poisoning from ammonia) or to humans (e.g., poisonous metals, trace chemical compounds)	Biomagnifications, Bioaccumulation
Immiscible organic chemicals (e.g. Oils and solvents)	Oil coating of plants and animals, direct toxicity, and reduced rates of deoxygenation via the water's surface.	Carcinogenic and mutagenic effects on aquatic life. Deoxygenating.

1.4.1. Leachate's Impact on Receptors

- In one or more of the following categories, receptors may be useful:
- Surface waterways and groundwater.
- Abstractions: the use of public and private water for industrial, agricultural, or other permissible purposes;
- Amenity: a surface water body used for recreational activities (such as sailing or fishing);
- Biodiversity (ecological value): surface water bodies, including wetlands supporting a range of living organisms.

1.4.2. Impacts On Health

1.4.2.1. Health effects of leachates on humans

- Leachate: This is the process by which water that has been incorrectly disposed of seeps into the

ground and contaminates it, often bringing with it harmful materials from the waste.

- Rain or water found in the trash itself are two possible sources. After that, the leachate contaminates the water with these compounds, rendering the neighbouring water sources unsafe to drink.
- Leachates from landfills may cause long-term, chronic health impacts, or acute, brief exposure.

1.4.2.2. Chemical/metal Health effects from acute exposure

- Lead: sickness, diarrhea, convulsions, disorientation, and drowsiness
- Mercury = dehydration, renal failure, and bloody diarrhea
- Cadmium compounds: skin irritation, nausea, vomiting, chest discomfort, and metallic taste

- Nickel: dermatitis, diarrhea, gum disease, and skin irritation
- Toluene: coma, convulsions, and tremors

1.4 TODAY'S SCENARIO OF LEACHATE

Leachate is currently dumped on land that has not received adequate treatment; only basic treatment is present. Thus, the leachate discharge on the soil has an adverse effect on the public's health in that area. This includes respiratory, cardiovascular, and bronchitis issues, among other health impacts. It also has a significant impact on the plants and soil nutrients. Leachate disposal has been found to cause a 60% reduction in soil nutritivity and a 20% increase in salinity.

By diluting leachate, this research aims to offer an effective substitute for it as fertilizer.

1.5 CASE STUDY- MOSHI LANDFILL SITE

The dump is located at Moshi, Pimpri Chinchwad. Latitude: 18.61 degrees North and 73.80 degrees East; altitude: 1870 feet. 50% humidity Temperature per year: 31 degrees Celsius soil texture: loamy, dark soil



Figure 3 : Landfill Site Moshi, Pimpri Chinchwad. (Photograph taken by author)

1.5.1 Moshi site condition

1.5.1.1 Environmental impact assessment of Moshi landfill site.

We discovered that the unique disposal of trash, particularly concentrated leachate, without effective treatment results in the contamination of over an 80-acre Moshi landfill site. At the Moshi landfill site, the leachate treatment equipment is currently not operating well, so whatever waste is collected from

industrial and home sources is just dumped onto the earth. With time, all of this dump material decomposes and produces leachate, which has a high concentration of heavy metals. Examples include dioxins, common cat ions, Zn, S, NH₃, Cl, Pb, Ni, Cu, and Hg, as well as organic molecules. It has been discovered that untreated leachate contaminates soil.

1.5.1.2 Current scenario of effects of leachate of Moshi landfill site

Leachate is spilled on soil that has not had enough treatment; just basic treatment is present. Therefore, the leachate dumping on the soil near the Moshi site has a harmful effect on the public's health in that area. This includes respiratory, cardiovascular, and bronchitis issues, among other health impacts. It also significantly impacts vegetation and soil nutrients.

1.6 SOLUTION – LEACHATE AS A FERTILIZER

Leachate is now dumped on land without any effective treatment; only basic treatment is present, but it is insufficient. Thus, the leachate discharge on the soil has an adverse effect on the public's health in that area. This includes respiratory, cardiovascular, and bronchitis issues, among other health impacts. It also significantly impacts vegetation and soil nutrients. Leachate disposal has been found to cause a 60% reduction in soil nutritivity and a 20% increase in salinity.

Thus, this study will offer the ideal substitute for the traditional one. Using it as a fertilizer to boost crop development is the ideal answer.

II. LITERATURE REVIEW - EFFECT OF LEACHATE ON PLANT NUTRITION IN IRAN

The study was conducted in a farm situated at 32 degrees 39 minutes latitude and 51 degrees 48 minutes longitude, east of Esfahan. 1555 meters is the altitude. This area has 120 mm of rainfall on average and 16 °C on average per year. In the research area, every soil type is an arid soil. The region's irrigation water use levels are deemed typical, according to the assessment of izer and sekat regarding water quality criteria. The irrigation water's pH was 7.01, its electrical

conductivity was 4.19 s/m, and the soil texture was loamy.

An Iranian study carried out in Isfahan examines the impact of leachate, when applied as fertilizer, on soil nutrients in randomized blocks. Additionally, the nutrients (N, P, and K) that make up a plant. Therefore, 25% leachate and 75% regular well water are used in the project. Two months after treatment, a cassia seedling establishment and operation started in the established plots with the planting of 36 seedlings at random and two 36-year-old sycamore seedlings.

The utilization of arid and effluent waste water from agricultural, industrial, urban, and rural areas should be considered as the water resources due to the scarcity of water in places like Iran. Given the state of water resources today, wastewater utilization is unavoidable. However, the issue that results in an inability to purify all sewage is the growth in the volume of sewage. Less than 1% of organic matter is typically found in the arid and semi-arid soils of central Iran. Because manure supplies are limited, it is therefore preferable to employ organic fertilizers from other sources, such as leachate and sewage sludge.

There are two main reasons to use organic fertilizers: first, they are a mixture that helps the soil retain more water and improve its physical structure; second, the organic material contains a variety of plant nutrients that aid in the soil's elemental balance.

III. METHODOLOGY

The dilution process of the leachate

Dilution process involves 3 stage dilution. We all know that leachate contains heavy metals of high concentration which is very toxic to health , environment,soil.

1st stage dilution (int conc.)

2nd stage dilution (conc. less)

3rd stage dilution (conc. less)



Fig 4: Leachate + Water (Photograph taken by author)

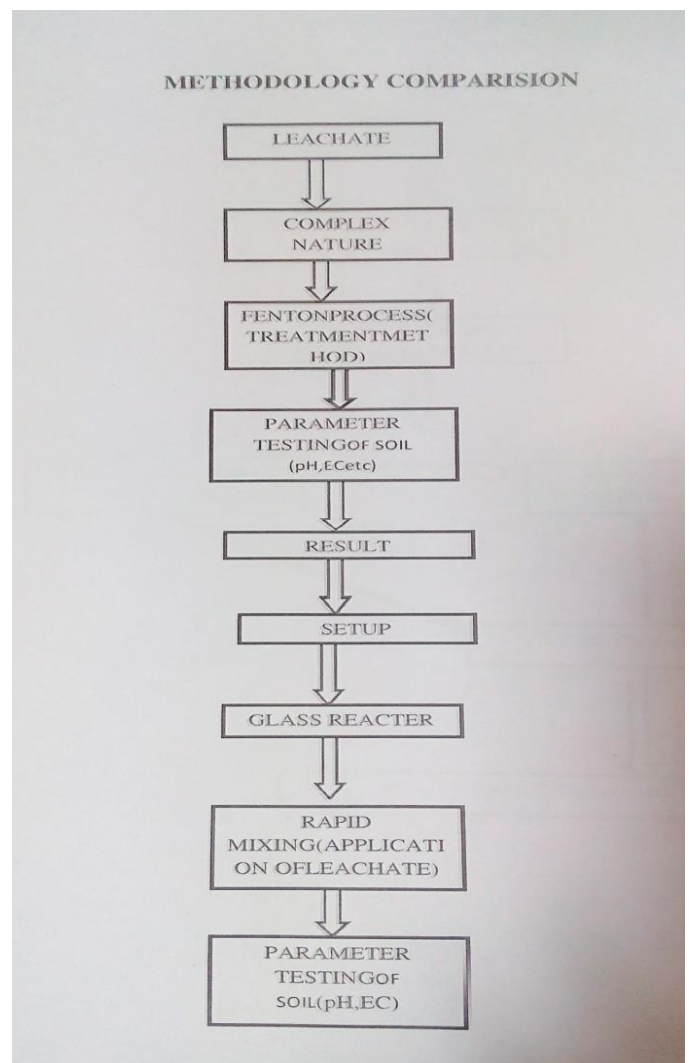


Figure 4: Methodology Chart (Created by author)

Application

1. Leachate is mostly applied to agricultural fields as a fertilizer.
2. In addition, it contributes significantly to the improvement of soil properties, which improve the soil's attributes and suit it for farming any kind of crop.
3. It can also be used for ornamental plants, shrubs, and small-scale plants.
4. It can be applied to a variety of laboratory plant tissue culture techniques.
5. The leachate fertilizer's pH and EC are in harmony, which improves its properties.

IV. RESULTS

- 1) Since there is less nitrogen present than previously found, leachate irrigation improves it.
- 2) pH level, conductivity etc. Founds within range.
- 3) Soil fertility increases provides micro and macro nutrients

V. CONCLUSION

We are all aware that the typical annual garbage produced in today's globe is called LEACHATE, and it contains a high concentration of heavy metals and is extremely dangerous. Waste is abundant, surveys and reports demonstrate that improperly treated leachate dumping on soil poses serious risks to human health, the environment, etc. The purpose of this study is to improve the application of leachate, or the use of it as fertilizer that works best as a substitute for traditional fertilizer. It will undoubtedly increase the yield and the state of nutrition of the soil. Applying leachate as fertilizer will enhance soil qualities and increase crop output. Utilizing it also has a significant impact on the environment's balance with nature, the wellbeing of living creatures, and the NEED OF FUTURE

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