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ASSESSMENT OF HEAVY METALS FROM THREE RENOWED LANDFIL LEACHATES ON *Citrullus lanatus* (WATERMELON) SEEDLINGS

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Abstract

This study aimed to assess the levels of heavy metals (As, Cd, Co, Cu, Cr, Fe, Pb, Mo, Mn, Ni, and Zn) in the seedlings of *Citrullus lanatus* and landfill leachate. Leachates were collected from three different landfill sites: Oko-Filling (Ok), Ojota (Oj), and Abule-Egba (AE), and were used to grow contaminated seeds of *C. lanatus*. The seeds were planted in three replicates each. They were placed in 9 cm Petri dishes lined with filter papers and moistened with 0.03 ml of the respective leachate at varying concentrations of 25%, 50%, 75%, and 100%. Untreated samples served as controls (0%). Seed germination parameters, including plumule length (PL), radicle length (RL), seed vigor index (SVI), total seed length (TSL), fresh weight (FW), and dry weight (DW), were measured in the seedlings. Results showed that seeds had 100% germination at 25% and 50% leachate concentrations from Abule-Egba, while other samples exhibited poor germination rates. Control treatments had a lower germination percentage compared to other treatments. Olusosun landfill leachate contained the highest heavy metal concentrations, followed by Oko-Filling and Abule-Egba landfill leachate. The levels of heavy metals in both *C. lanatus* seedlings and landfill leachate were below the WHO/FAO standard limits. Zinc (Zn) was found to be highest in seedlings treated with AE50% leachate (0.06 ± 0.00) and lowest in those treated with AE25% leachate (0.02 ± 0.00). The results indicate that *Citrullus lanatus* seedlings may be susceptible to heavy metal contamination when exposed to higher concentrations of these metals.

Keywords: Olusosun, Abule-Egba, Oko-Filling, , Landfill, Leachate, *Citrullus lanatus*, Growth Inhibitors.

Introduction

Watermelon (*Citrullus lanatus*), a member of the Cucurbitaceae family, is native to Africa and has been introduced to Asia, Europe, and the Americas. Although commonly classified as a vegetable, watermelon is botanically considered a fruit and is primarily used as a dessert (Perkins-Veazie et al., 2012a).Watermelon thrives in sandy loam soil rich in organic matter with good drainage and a pH range of 6.5-7.5 (Kumar et al., 2013). Consequently, many farmers utilize any available land, including abandoned landfills, to cultivate watermelon. Landfilling is one of the most prevalent methods for disposing of municipal solid waste (MSW) globally (Kaza et al., 2018), with approximately 1.4 billion tons of MSW disposed of in landfills or open dumps annually, accounting for 70% of total MSW. However, landfills are often problematic for many cities due to the large amounts of odor, methane, and leachate they generate (Cai et al., 2015; Yang et al., 2015; Powell et al., 2016). Leachate produced from landfills results from complex physical, chemical, and biological processes, including precipitation infiltration, organic fraction biodegradation, and waste compaction.

Landfill leachate is a type of wastewater with diverse compositions and high pollutant levels, typically containing four groups of pollutants: Degradable Organic Matter (DOM), Inorganic Macro Components (IMC), Heavy Metals (HM), and Xenobiotic Organic Compounds (XOCs) (Kjeldsen et al., 2002). Organic component concentrations in leachate can be very high in the early aerobic phase of landfilling (e.g., COD > 6000 mg/L; BOD5 > 3000 mg/L) and then decrease and stabilize during the methanogenic phase (Chen and Xue, 2013).

Landfill leachate contains numerous pollutants that may leak into the surrounding water and soil environments due to inappropriate site selection, design, and landfill operations (Vaccari et al., 2019). Even in sanitary (or controlled) landfills, long-term operations can lead to geomembrane deterioration and drainage system blockages, reducing anti-seepage quality and causing environmental leakage (Madon et al., 2019; Paul et al., 2019). Rana et al. (2018) assessed leachate pollution risks in open dumps in three Indian cities and found that nearby groundwater quality was seriously polluted. Bouzayani et al. (2014) demonstrated heavy metal contamination (e.g., Cr, Cu, Ni, Pb, and Zn) in the soil environment near an unlined leachate storage pond of a landfill. Parvin and Tareq (2021) indicated that the total carcinogenic risks of Ni and Pb in crops planted near landfills in Bangladesh were very high.

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Therefore, it is crucial to study the soil environment near unlined leachate storage ponds of landfills, as they may be heavily contaminated with heavy metals (e.g., Cr, Cu, Ni, Pb, and Zn). This contamination can significantly affect crops planted near landfills in Nigeria.

Materials and Methods

Site Description

Sampling Site

Landfill leachates were collected from three locations in Lagos State, Nigeria: Oko-Filling (Ok), Olusosun (OJ), and Abule-Egba (AE). The coordinates for these sites are as follows: Oko-Filling (6°30'36.1"N, 3°16'06.5"E), Olusosun (6°23'N, 2°42'N), and Abule-Egba (6°38'28.1"N, 3°18'59.8"E).

Abule-Egba Landfill. The Abule-Egba landfill is located on the north-northwest flank of Lagos along the Lagos-Abeokuta Expressway. It covers an area of approximately 10.2 hectares in the Alimosho Local Government area and receives waste from densely populated regions. Opened in 1978, the landfill had a capacity of 2,628,726 metric tons as of 2009, before it was temporarily closed. This facility handles about 50% of Lagos's municipal waste and is expected to close permanently within a few years.

Oko-Filling Landfill

The Oko-Filling landfill is situated along the Lagos State University - Iba Road, covering an area of 7.8 hectares, with an average lifespan of five years. The landfill has been inactive since October 5, 2006. Four Vertical Electrical Sounding (VES) points were established: VES 1 in the central area of the landfill, VES 2 at the western limit, VES 3 in a recently dumped area with fairly unconsolidated refuse, and VES 4 near the Lagos State University/Ojo - Idimu roadway, which served as a control.

Olusosun Landfill

The Olusosun landfill is located in the northern part of Lagos within the Ikeja Local Government area and receives approximately 40% of Lagos's total waste deposits. Spanning 42.7 hectares, it has a residual lifespan of 20 years. It is the largest landfill in Africa and one of the largest in the world. The landfill has been active since November 19, 1992; it was originally a burrow pit used to obtain laterite for road construction in Lagos. The landfill was designed to receive 7,365,000 tons of solid waste during its operational lifespan of 10 years. This locations are indicated with red colors as presented in figure 1.

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Figure 1: Map showing sampling locations of the three landfill sites in Lagos State; Oko-Filling (Ok), Olusosun (OJ), and Abule-Egba (AE).

Sampling Collection and Preservation

Samples of landfill leachate were collected from the Oko-Filling landfill in Lagos State. A 0.03L sample of landfill leachate was collected in pre-sterile bottles and transported to the Department of Botany, Lagos State University (LASU), Ojo laboratory immediately after sampling. The samples were stored at a temperature of 4°C ± 1 for 24 hours. The collected samples were analyzed for heavy metal content (Cd, Cr, Ni, Pb, Mo, Zn, Co, Fe, Mn, As, Sb, Se, Ca, Mg, K) in the analytical laboratory.

Sources of Seeds

Commercially available certified *Citrullus lanatus* (watermelon) seeds were obtained from East-West Seed International, Lagos State. The seeds were identified at the herbarium unit of the Department of Botany, Lagos State University, Ojo, Lagos. Fifteen (15) seeds were selected for the experiment and were washed in

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100 ml of sodium hypochlorite and deionized sterile water before planting.

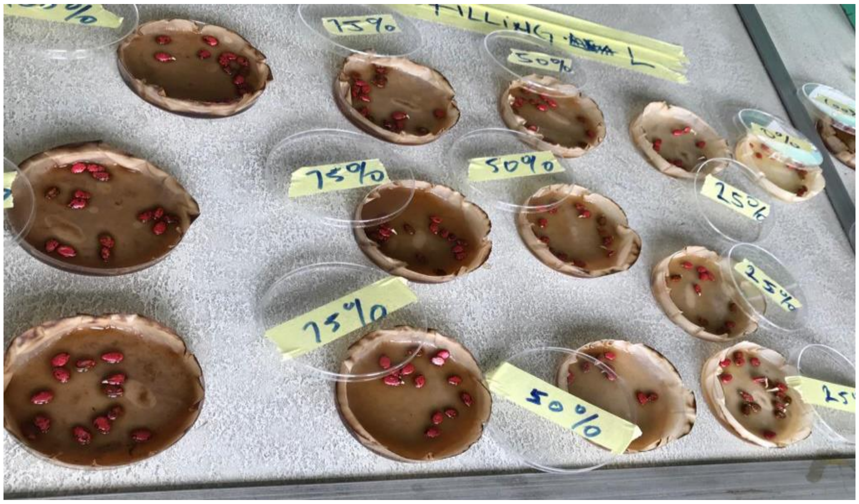

Plate 2: Seeds of *Citrullus Lanatus* Planted Inside Petri Dishes Containing Different Concentrations of Landfill Leacheates

Experimental Design

The experimental setup included five (5) Petri dishes containing 15 watermelon seeds each, with leachate samples labeled (A-E) in three (3) replicates. The experiment was conducted in the Department of Botany laboratory at Lagos State University. Seeds were placed in 9 cm Petri dishes lined with filter papers and moistened with 0.03 ml of the respective leachate at different concentrations (25%, 50%, 75%, and 100%). Untreated samples were set aside to serve as controls. This setup was watered daily with 10 ml of each concentration.

Methods

Determination of Growth Parameters

The parameters used to determine seedling growth included radicle length (RL), plumule length (PL), dry weight (DW), fresh weight (FW), total seed length (TSL), seedling vigor index (SVI), germination percentage (G), germination index (G1), mean germination rate (MGR), mean germination time (MGT), and time to 50% germination (T50). Data were recorded from randomly selected three seedlings of each treatment, and the mean values were calculated. The seedlings were removed by hand from the Petri dishes, and the root length was measured using a meter rule. Measurements were taken for 14-day-old seedlings.

Heavy Metals Determination

Heavy metals were determined in prepared sample solutions using inductively coupled plasma spectrometry. A reagent blank was used against a 5-point calibration curve plotted for the standard metal solutions. The metal concentration in each sample was computed from the calibration curve using Agilent Expert II software.

- Quantitation of metal content in plant samples:

  Metal (mg/100g)=Metal (mg/L)×Vfinal ×FWeight of sample taken (g)\text{Metal (mg/100g)} = \frac{\text{Metal (mg/L)} \times \text{Vfinal} \times F}{\text{Weight of sample taken (g)}}Metal (mg/100g)=Weight of sample taken (g)Metal (mg/L)×Vfinal×F
- Quantitation of metal content in leachate samples:

  Metal (mg/kg)=Metal (mg/L)×VfinalWeight of sample taken (g)\text{Metal (mg/kg)} = \frac{\text{Metal (mg/L)} \times \text{Vfinal}}{\text{Weight of sample taken (g)}}Metal (mg/kg)=Weight of sample taken (g)Metal (mg/L)×Vfinal

  Where:
  - mg/L = concentration of nutrient in the digest or extract
  - 0.1 = conversion factor to mg/100g
  - Vfinal = final volume of the digest or extract (ml)

Determination of Phosphorus and Nitrogen

Phosphorus was determined by measuring the color of the mixture with a spectrophotometer at 800 nm. A 10 ml aliquot of the digested sample was added to the contents of one PhosVer 3 Phosphate Reagent Powder Pillow (Hach). The mixture was shaken and allowed to stand for 5 minutes.

Phosphorus content in plant samples:

P (mg/100g)=P (mg/L)×Vfinal×FWeight of sample taken (g)\text{P (mg/100g)} = \frac{\text{P (mg/L)} \times \text{Vfinal} \times F}{\text{Weight of sample taken (g)}}P (mg/100g)=Weight of sample taken (g) P (mg/L)×Vfinal×F

Phosphorus content in leachate samples:

P (mg/kg)=P (mg/L)×VfinalWeight of sample taken (g)\text{P (mg/kg)} = \frac{\text{P (mg/L)} \times \text{Vfinal}}{\text{Weight of sample taken (g)}}P (mg/kg)=Weight of sample taken (g)P (mg/L)×Vfinal

Where:
- mg/L = concentration of nutrient in the digest or extract
- 0.1 = conversion factor to mg/100g
- Vfinal = final volume of the digest or extract (ml)

Nitrogen was determined by measuring the color of the mixture with a spectrophotometer at 500 nm. A 10 ml aliquot of the digested sample was added to the contents of one NitraVer 5 Nitrate Reagent Powder Pillow

(Hach). The mixture was shaken and allowed to stand for 5 minutes.

- Nitrogen content in plant samples:
  N (mg/100g)=N (mg/L)×Vfinal×FWeight of sample taken (g)\text{N (mg/100g)} = \frac{\text{N (mg/L)} \times \text{Vfinal} \times F}{\text{Weight of sample taken (g)}}N (mg/100g)=Weight of sample taken (g)N (mg/L)×Vfinal×F
- Nitrogen content in leachate samples:
  N (mg/kg)=N (mg/L)×VfinalWeight of sample taken (g)\text{N (mg/kg)} = \frac{\text{N (mg/L)} \times \text{Vfinal}}{\text{Weight of sample taken (g)}}N (mg/kg)=Weight of sample taken (g)N (mg/L)×Vfinal
  Where:
    - mg/L = concentration of nutrient in the digest or extract
    - 0.1 = conversion factor to mg/100g
    - Vfinal = final volume of the digest or extract (ml)

Statistical Analysis

Data were analyzed using the Statistical Analysis System (SPSS, 2020). The data are expressed as mean ± standard deviation. Means were calculated using one-way analysis of variance (ANOVA) and separated using Duncan's Multiple Range Test (DMRT) at P<0.05P < 0.05P<0.05.

Results

The results of this study revealed that radicle length (RL), plumule length (PL), total seedling length (TSL), fresh weight (FW), dry weight (DW), and seedling vigor index (SVI) of the seedlings were significantly affected by leachate application ($p \leq 0.05$) (Appendix I). The highest values for RL (1.70 ± 1.73 cm), PL (7.53 ± 2.00 cm), and TSL (9.23 ± 3.73 cm) were observed in the AE25% treatment. In contrast, seedlings subjected to AE (75%, 100%), OK (25%, 50%, 75%, and 100%), and OL (25%, 50%, 75%, and 100%) treatments did not germinate fully (Table 1).

The treated seedlings at AE50% exhibited the best FW (1.11 ± 0.00 g) and DW (0.94 ± 0.00 g), while seedlings in the AE25% treatment had lower FW (1.00 ± 0.001 g) and DW (0.17 ± 0.001 g). The SVI was highest in the AE25% treatment (923.3 ± 372.9).

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Table 1: Analysis of growth parameters of *C. lanatus* seedlings.

Treatment	Radicle Length (cm)	Plumule Length (cm)	Total Seedling Length (cm)	Fresh Weight (g)	Dry Weight (g)	Seed Vigor Index
0%	0.93 ± 0.55abc	4.60 ± 1.18b	5.53 ± 1.60b	1.00 ± 0.001a	0.17 ± 0.00a	528.4 ± 164.3b
AE 25%	1.70 ± 1.73a	7.53 ± 2.00a	9.23 ± 3.73a	0.32 ± 0.00e	0.16 ± 0.00b	923.3 ± 372.9a
AE 50%	1.30 ± 1.30ab	5.20 ± 0.62b	6.50 ± 1.80b	1.11 ± 0.00a	0.94 ± 0.00e	650.0 ± 180.3b
AE 75%	0.00 ± 0.00bc	0.00 ± 0.00b	0.00 ± 0.00b	0.00 ± 0.00d	0.00 ± 0.00d	0.00 ± 0.00b
AE 100%	0.00 ± 0.00abc	0.00 ± 0.00b	0.00 ± 0.00b	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00b
OK 25%	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00f	0.00 ± 0.00f	0.00 ± 0.00c
OK 50%	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00f	0.00 ± 0.00f	0.00 ± 0.00c
OK 75%	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00f	0.00 ± 0.00f	0.00 ± 0.00c
OK 100%	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00f	0.00 ± 0.00f	0.00 ± 0.00c
OL 25%	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00f	0.00 ± 0.00f	0.00 ± 0.00c
OL 50%	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00f	0.00 ± 0.00f	0.00 ± 0.00c
OL 75%	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00f	0.00 ± 0.00f	0.00 ± 0.00c
OL 100%	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00c	0.00 ± 0.00f	0.00 ± 0.00f	0.00 ± 0.00c

Germination percentage of *C. lanatus* seedlings: (Include any relevant information or data here regarding the germination percentage, if available.)

The MGT, MGR, GI and T50 had its maximum value at OJ25% treatment (57.8 ± 50.0) (Figure 2)

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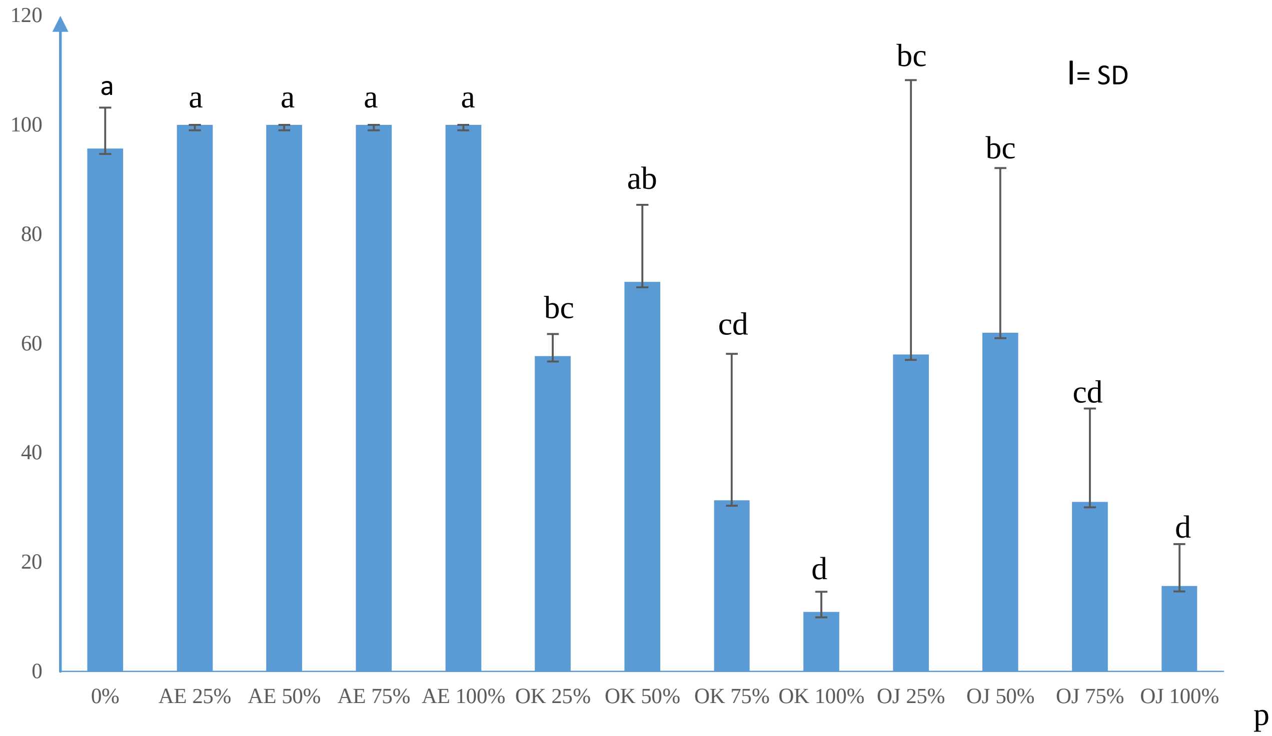

Value with different superscript in the same column for each parameters are significantly different at ($P < 0.05$) to each other. Values are presented as mean ± standard deviation (SD)

Figure 1: Germination percentage (G) of *C. lanatus*

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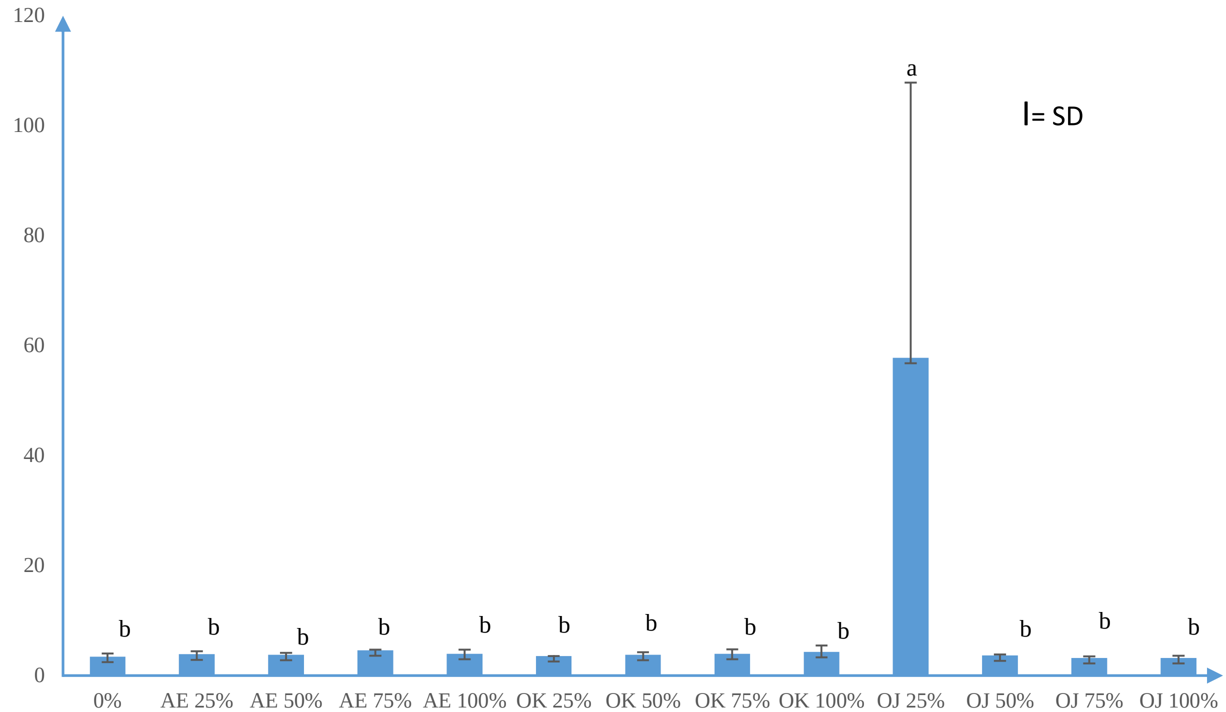

Value with different superscript in the same column for each parameters are significantly different at (P < 0.05) to each other. Values are presented as mean ± standard deviation (SD)

Figure 2: Mean germination time (MGT) of *C. lanatus*

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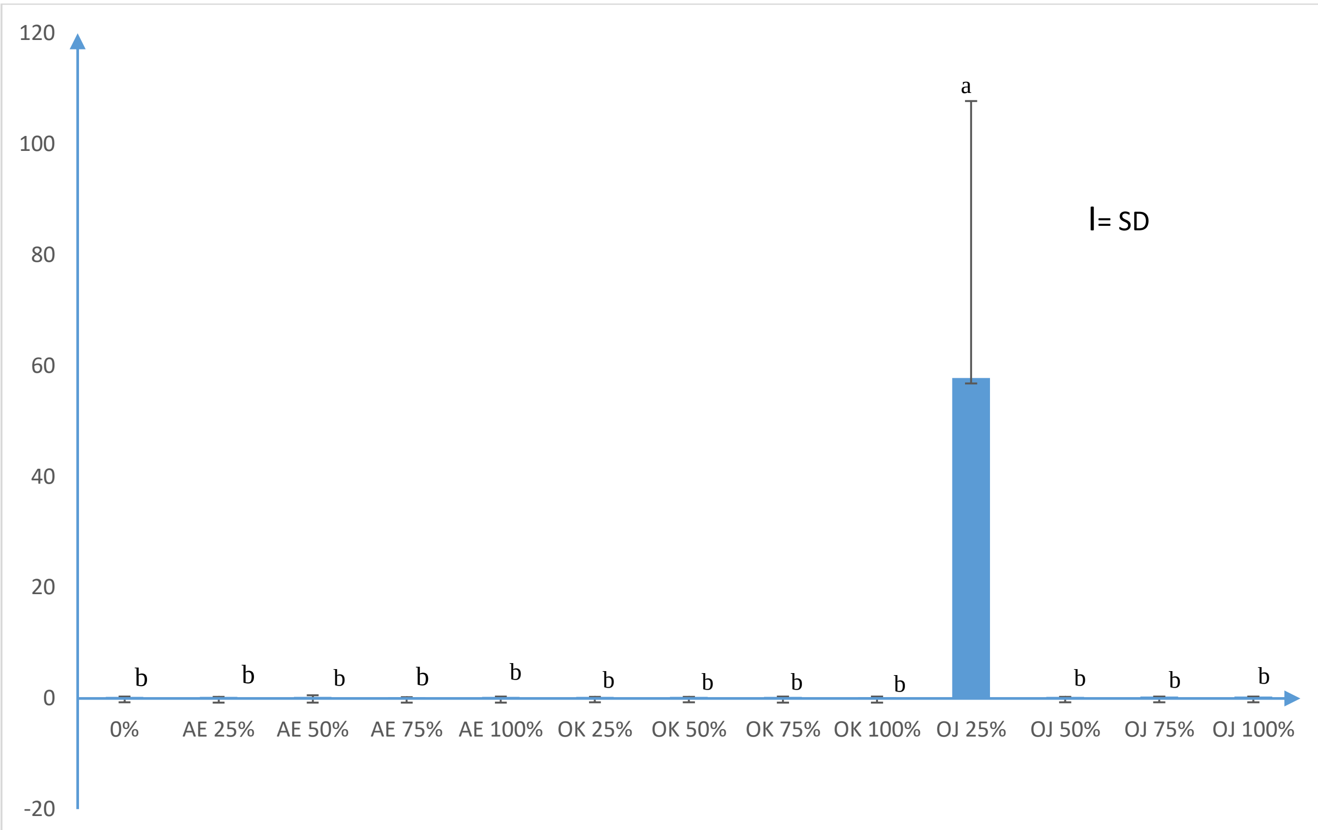

Value with different superscript in the same column for each parameters are significantly different at (P < 0.05) to each other. Values are presented as mean ± standard deviation (SD)

Figure 3: Mean germination rate (MGR) of *C. lanatus*

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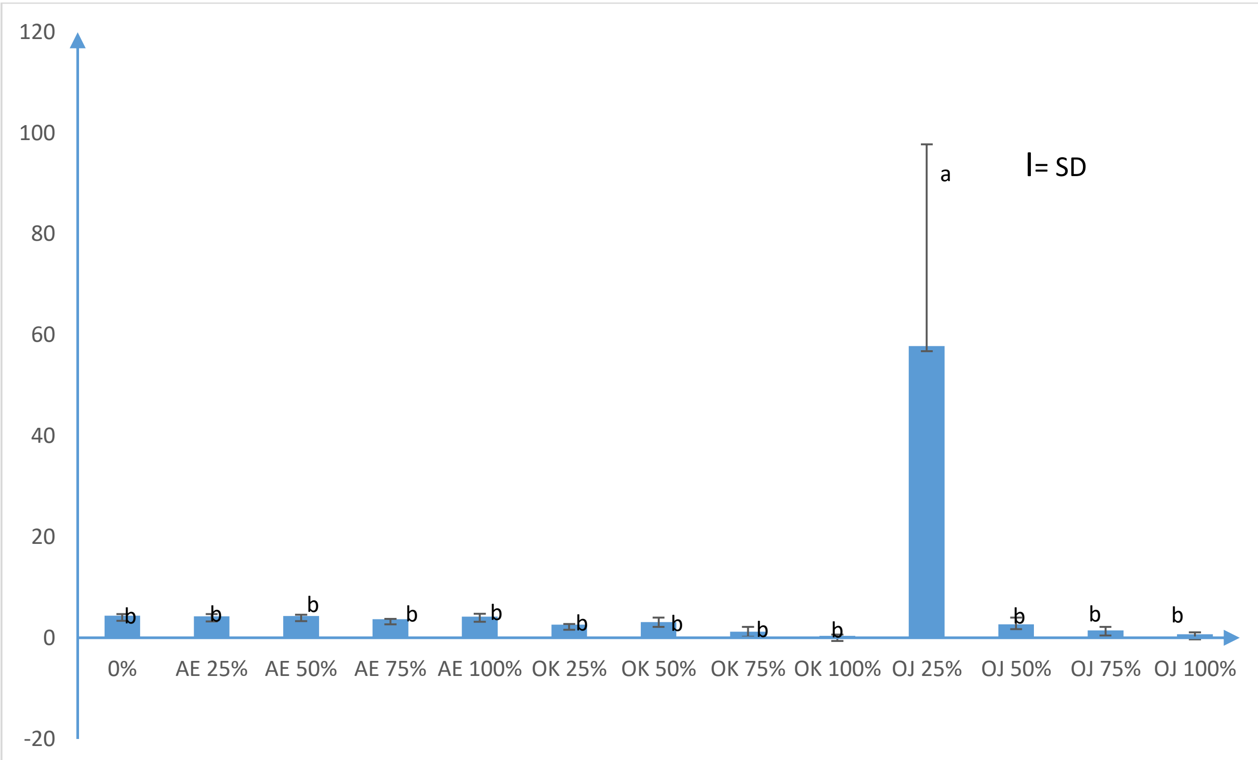

Value with different superscript in the same column for each parameters are significantly different at (P < 0.05) to each other. Values are presented as mean ± standard deviation (SD)

Figure 4: Germination index (G1) of *C. lanatus*

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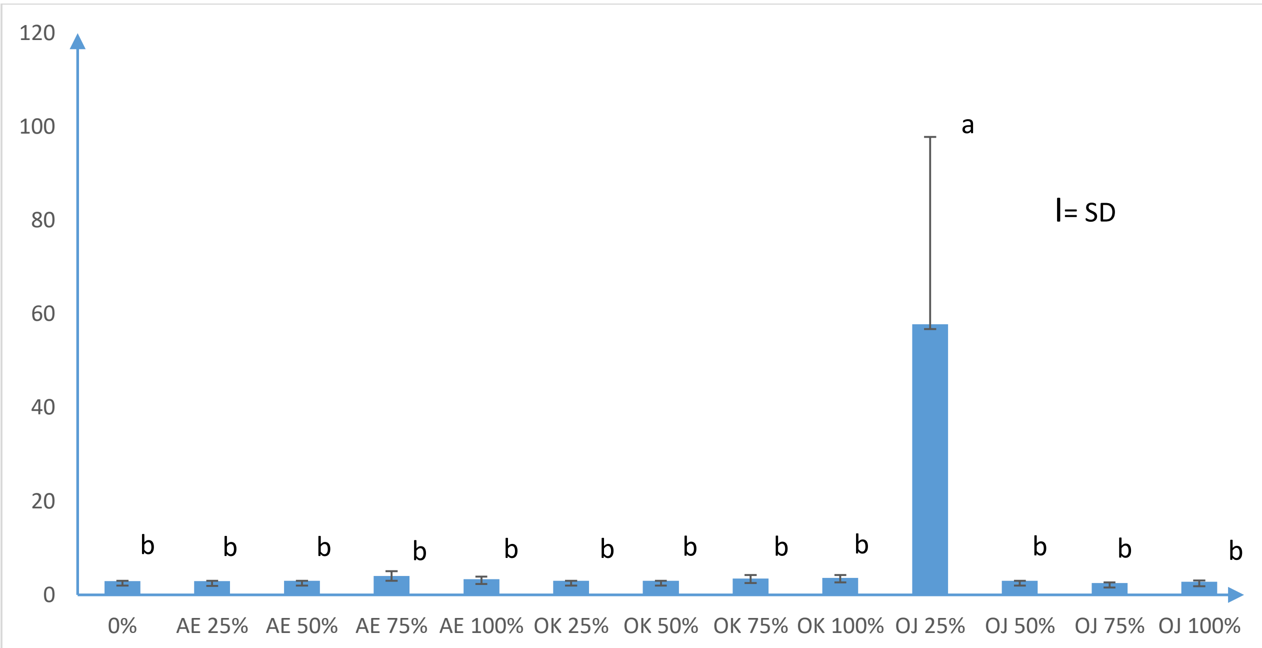

Figure 5. Time to 50% germination (T50) of *C. lanatus*

Concentration of Heavy Metals Found in *C. lanatus* Seedlings

The accumulation of heavy metals (As, Cd, Co, Cu, Cr, Fe, Pb, Mo, Mn, Ni, and Zn) in *Citrullus lanatus* seedlings from two selected plates is presented in Table 2. The study revealed that the levels of As, Cd, Co, Cr, Pb, Mo, Ni, and Zn were not significantly different ($p < 0.05$). However, the concentrations of Cu, Fe, and Mn were significantly different ($p < 0.05$).

Heavy Metals Accumulation in *C. lanatus* Seedlings

The results indicated variations in the heavy metal content of *Citrullus lanatus* seedlings grown with landfill leachate from a specific location. The highest quantity of Cu (0.03 ± 0.02) was recorded in the AE25% treatment, followed by the AE50% treatment (0.01 ± 0.00). The concentration of Fe was highest in the AE50% treatment (0.04 ± 0.03), while the lowest concentration was recorded in the AE25% treatment (0.01 ± 0.01). The highest concentration of Mn was found in the AE25% treatment (0.01 ± 0.00). Zn concentration was higher in the AE50% treatment (0.06 ± 0.00) compared to the AE25% treatment (0.02 ± 0.00). Cr was more accumulated in the AE50% treatment (0.01 ± 0.00).

Seeds planted in AE (75%, 100%), OK (25%, 50%, 75%, 100%), and OL (25%, 50%, 75%, 100%) treatments did not germinate well. No quantities of As, Cd, Co, Pb, Mo, and Ni were detected in the treatments.

Table 2: Heavy metals content of *C. lanatus* seedlings grown with landfill leachates

Heavy Metals (Mg/Kg)	AE25	AE50
Arsenic	0.00 ± 0.00	0.00 ± 0.00
Cadmium	0.00 ± 0.00	0.00 ± 0.00
Cobalt	0.00 ± 0.00	0.00 ± 0.00
Copper	0.03 ± 0.02	0.01 ± 0.00
Chromium	0.00 ± 0.00	0.01 ± 0.00
Iron	0.01 ± 0.00	0.04 ± 0.03
Lead	0.00 ± 0.00	0.00 ± 0.00
Magnesium	0.01 ± 0.00	0.00 ± 0.00
Molybdenum	0.00 ± 0.00	0.00 ± 0.00
Nickel	0.00 ± 0.00	0.00 ± 0.00
Zinc	0.02 ± 0.00	0.06 ± 0.00

Heavy Metals Component of Landfill Leachates

This section presents the concentration of heavy metals in leachate samples collected from three different dumpsites (Abule Egba, Olusosun, and Oko-Filling). Table 3 shows that the heavy metals content in the leachate was not significantly different ($p \leq 0.05$). The results revealed that the quantity of Zn obtained from the Olusosun landfill was the highest (1.81 ± 0.01), while the quantity of Zn obtained from the Oko-Filling landfill was the least. The concentration of Fe was highest in the Abule Egba landfill sample (0.30 ± 0.01), whereas the least amount was found in the Oko-Filling landfill (0.05 ± 0.00). Arsenic detected in the Olusosun landfill was higher (8.33 ± 0.01) than in Abule Egba (0.00 ± 0.00) and Oko-Filling

(7.79 ± 0.01). The highest quantities of Cd (1.09 ± 0.01) and Co (1.33 ± 0.01) were found in the Ojota landfill sample, while the lowest quantities were recorded in the Abule Egba landfill sample (0.00 ± 0.00). The highest quantity of Cu was recorded in the Olusosun landfill sample (0.16 ± 0.00), while the lowest was recorded in the Oko-Filling landfill sample (0.12 ± 0.00). The highest concentration of Cr was found in both Olusosun and Oko-Filling landfill samples (0.36 ± 0.00), while the least concentration was recorded in the Abule Egba landfill sample (0.24 ± 0.00). The Olusosun landfill leachate had the highest heavy metals content, followed by the Oko-Filling and Abule Egba landfill leachates.

Table 3: Heavy metals content detected in the landfill samples

Heavy Metals (Mg/Kg)	Olusosun (OL)	Oko-Filling (OK)	Abule-Egba (AE)
Arsenic	8.33 ± 0.01	7.96 ± 0.01	0.00 ± 0.00
Cadmium	1.09 ± 0.01	0.01 ± 0.00	0.00 ± 0.00
Cobalt	1.33 ± 0.01	0.13 ± 0.00	0.00 ± 0.00
Copper	0.16 ± 0.00	0.12 ± 0.00	0.13 ± 0.01
Chromium	0.36 ± 0.00	0.36 ± 0.00	0.24 ± 0.00
Iron	0.24 ± 0.00	0.05 ± 0.00	0.30 ± 0.01
Lead	0.01 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Magnesium	0.48 ± 0.00	0.13 ± 0.00	0.00 ± 0.00
Molybdenum	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Nickel	0.01 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Zinc	1.81 ± 0.01	0.36 ± 0.00	0.12 ± 6.01

Discussion, Conclusion, and Recommendation

Landfill leachate contains various contaminants, including organic and inorganic pollutants, which vary with geographical location, waste composition, age, pH, moisture content, and other landfill site characteristics (Bove et al., 2015). The effect of heavy metals in landfill leachate on *C. lanatus* seedlings can be significant. Heavy metals such as As, Cd, Co, Cu, Cr, Fe, Mn, Ni, and Zn can accumulate in the soil and water surrounding landfills and can easily find their way into plants and animals living nearby.

The results indicated that landfill leachate at higher concentrations has a wide range of negative effects on plant growth. Seeds grown in control (0%) conditions exhibited less growth than those grown with leachates from OK, OL, and AE. Seeds planted in AE (75%, 100%), OL leachate, and OK leachate experienced growth inhibition, while seeds planted in AE (25%, 50%) germinated. The Olusosun landfill leachate had the highest heavy metals content, followed by the Oko-Filling and Abule Egba landfill leachates.

The presence of Zn in landfill leachates is attributed to wastes from cosmetics, dyes, dry cell batteries, fungicides, and soaps found at these sites (Pegnova and Eder, 2004). The high level of Cu in landfill leachates can be attributed to the presence of photovoltaic solar cells, plumbing pipes, and electrical cables (Sucheckan et al., 2006). Zinc concentrations in the leachates were within the acceptable limit set by WHO (2006). No quantity of Mo was found in any of the landfill leachates.

The results of this study reveal that seeds planted in leachate treatments at lower concentrations (25% and 50%) grew better than seeds planted in leachate treatments at higher concentrations (75% and 100%). The increase in the rate of germination of seeds treated with lower concentrations of leachates may be attributed to the increased concentration of other constituents such as phosphate and nitrates present in the leachate, which are good sources of plant nutrients and aid growth at lower concentrations. The impact of leachates on the germination and growth of *C. lanatus* seedlings is a function of the content and concentration of the different components making up the leachate. At higher concentrations, landfill leachates tend to be more harmful than beneficial to plant survival, verifying that leachates induce both positive and negative reactions in plants.

References

Bouzayani, F., Aydi, A., and Abichou, T. (2014). Soil contamination by heavy metals in landfills: measurements from an unlined leachate storage basin. *Environmental monitoring and assessment*, 186, 5033-5040.

Bove, D., Merello, S., Frumento, D., Arni, S. A., Aliakbarian, B., and Converti, A. 2015. “A Critical Review of Biological Processes and Technologies for Landfill Leachate Treatment.” Chemical Engineering & Technology 38(12):2115–2126

Cai, B., Wang, J., Long, Y., Li, W., Liu, J., Ni, Z., and Zhang, L. (2015). Evaluating the impact of odors from the 1955 landfills in China using a bottom-up approach. *Journal of Environmental Management*, 164, 206-214.

Kaza, S., Yao, L., Bhada-Tata, P., and Van Woerden, F. (2018). *What a waste 2.0: a global snapshot of solid waste management to 2050*. World Bank Publications.

Kjeldsen, P., Barlaz, M. A., Rooker, A. P., Baun, A., Ledin, A., and Christensen, T. H. (2002). Present and long-term composition of MSW landfill leachate: a review. *Critical reviews in Environmental Science and Technology*, 32(4), 297-336.

Kumar R, Dia M and Wehner TC (2013). Implications of mating behavior in watermelon breeding. Hort Sci. 48(8), 960-964

Madon, I., Drev, D., and Likar, J. (2019). Long-term risk assessments comparing environmental performance of different types of sanitary landfills. *Waste Management*, *96*, 96-107.

Paris, H. S., Janick, J., and Daunay, M. C. (2011). Medieval herbal iconography and lexicography of Cucumis (cucumber and melon, Cucurbitaceae) in the Occident, 1300–1458. *Annals of Botany*, 108(3), 471-484.

Parvin, F., and Tareq, S. M. (2021). Impact of landfill leachate contamination on surface and groundwater of Bangladesh: a systematic review and possible public health risks assessment. *Applied water science*, 11(6), 100.

Paul, S., Choudhury, M., Deb, U., Pegu, R., Das, S., and Bhattacharya, S. S. (2019). Assessing the ecological impacts of ageing on hazard potential of solid waste landfills: A green approach through vermitechnology. *Journal of Cleaner Production*, *236*, 117643.

Peganova, S. and K. Eder, 2004. Zinc. In: Elements and their Compounds in the Environment, Merian, E., M. Anke, M. Ihnat and M. Stoeppler (Eds.)., Vol. 2. Wiley-VCH., Weinheim, Germany, pp: 1203-1227.

Powell, J. T., Townsend, T. G., and Zimmerman, J. B. (2016). Estimates of solid waste disposal rates and reduction targets for landfill gas emissions. *Nature Climate Change*, 6(2), 162-165.

Suchecka, T., Lisowski, W., Czykwin, R., and Piatkiewicz, W. (2006). Landfill leachate: water recovery in Poland. *Filtration & Separation*, *43*(5), 34-38.

Vaccari, M., Tudor, T., and Vinti, G. (2019). Characteristics of leachate from landfills and dumpsites in Asia, Africa and Latin America: an overview. *Waste management*, *95*, 416-431.

World Health Organization. (2006). *WHO guidelines for the safe use of wasterwater excreta and greywater* (Vol. 1). World Health Organization.

Yang, G., Ma, S., Zhou, C., Pan, J., Sun, C., Liu, Y and Zhao, Z. (2022). Leachate from municipal solid waste landfills in a global perspective: Characteristics, influential factors and environmental risks. *Journal of Cleaner Production*, *333*, 130234.

Yang, N., Damgaard, A., Kjeldsen, P., Shao, L. M., and He, P. J. (2015). Quantification of regional leachate variance from municipal solid waste landfills in China. *Waste management*, *46*, 362-372.