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Growth Response and Phytoremediation of Copper and Chromium in Dumpsite Leachate by Common duckweed (*Lemna minor* L.): A Case Study of A Market Dumpsite in Maiduguri, Nigeria

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INTRODUCTION & AIM

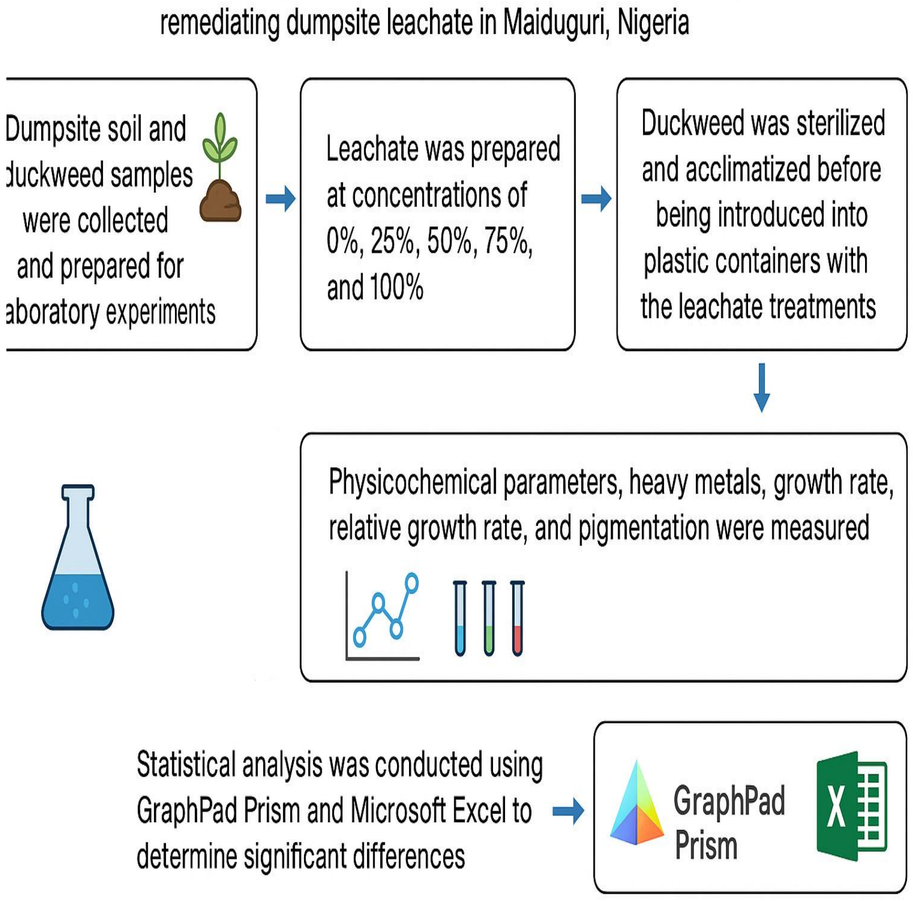
The prevalence of heavy metals in water worldwide is a serious environmental problem due to its toxicity, non-biodegradability, biological accumulation, and carcinogenic tendency, which endanger human health as well as the aquatic ecology. In comparison to other physico-chemical techniques for cleaning up heavy metals-contaminated locations, phytoremediation techniques have been demonstrated to be secure and ecologically sound (Oladoye *et al*., 2022). Plants have been demonstrated in studies to be effective at removing heavy metals, organic pollutants, radionuclides, antibiotics, and pesticides (Kafle *et al*., 2022). *Lemna minor* is an excellent aquatic plant that can be utilized as a phytoremediator for a variety of contaminants (Imron *et al*., 2021). However, the global distribution of duckweeds as well as their resistance to heavy metals, other contaminants, and stressors, are significant characteristics underlining its potential for application in the purification of agricultural, municipal, and some industrial wastewater (Zhou *et al*., 2023). This species can lower the concentration of various aquatic contaminants, including heavy metals, nanomaterials, and organic compounds like medicines, hydrocarbons, poisons, and dyes (Buta *et al*., 2023).

This study aims to determine the potential of a floating aquatic plant, duckweed (*Lemna minor* L.) *for* phytoremediation of heavy metals (Cu and Cr) in dumpsite leachate and to evaluate its growth responses under varying leachate concentrations, in Maiduguri, Nigeria .

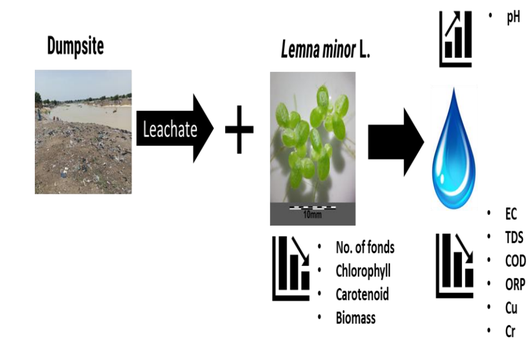
METHOD

Fig. 1: Aerial imagery of dumpsite near Veterinary Clinic, Maiduguri, Nigeria (Source: Google Earth, 2023)

The study investigated the efficacy of duckweed (Lemna minor) in remediating dumpsite leachate in Maiduguri, Nigeria



RESULTS & DISCUSSION



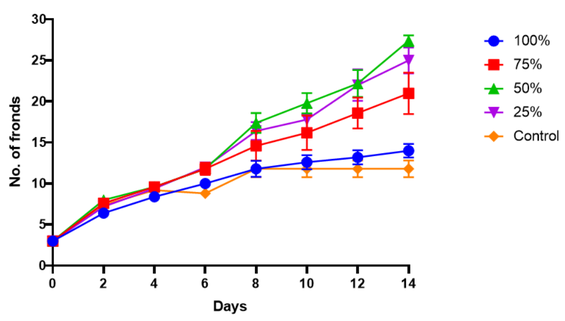


Fig. 2: Number of fronds (n = 3) of *Lemna minor* exposed to different concentrations of dumpsite leachate for 14 days. Error bars = standard deviation (SD).

Table 2: Concentrations of chromium and copper in dumpsite leachate before and after introduction of Lemna minor

		Time				
Heavy metal (mgL^{-1})	Conc. (%)	Before	After	t-value	P-value	% Reduction
Chromium (Cr)	100	0.84 ± 0.0	0.73 ± 0.0	133.0	0.0001	13.9
	75	0.63 ± 0.0	0.52 ± 0.0	122.0	0.0001	17.1
	50	0.42 ± 0.0	0.32 ± 0.0	120.9	0.0001	25.3
	25	0.21 ± 0.0	0.17 ± 0.0	67.00	0.0002	20.8
	0	0.03 ± 0.0	0.03 ± 0.0	-	ns	2.9
Copper (Cu)	100	1.88 ± 0.0	1.43 ± 0.0	673.0	0.0001	23.9
	75	1.41 ± 0.0	1.02 ± 0.0	383.0	0.0001	27.2
	50	0.94 ± 0.0	0.54 ± 0.0	685.9	0.0001	42.2
	25	0.47 ± 0.0	0.30 ± 0.0	261.5	0.0001	36.9
	0	0.09 ± 0.0	0.08 ± 0.0	-	ns	6.5

ns = nonsignificant, - = no value

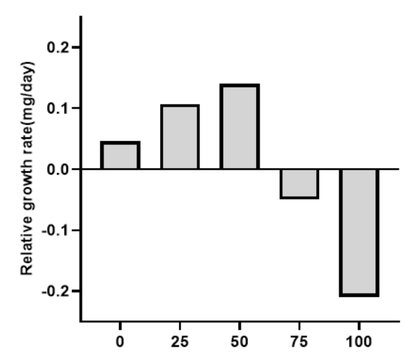


Fig. 4: Relative growth rate of *Lemna minor* (n = 3) in different concentrations of dumpsite leachate.

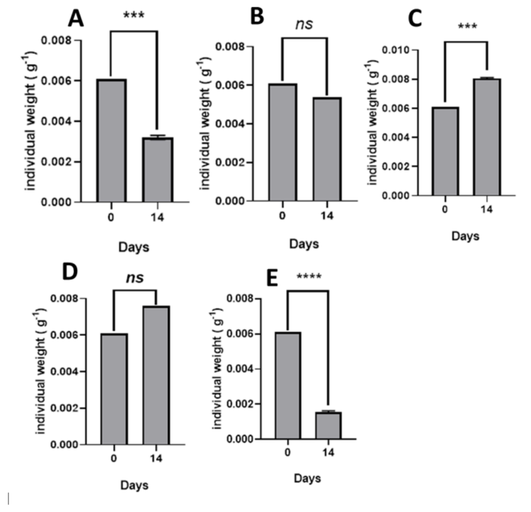


Fig. 3: Biomass of *Lemna minor* (n = 3) exposed to dumpsite leachate at 14 days post-exposure (dpe). A) 100% treatment B) 75% treatment C) 50% treatment D) 25% treatment and E) 0% treatment. Error bars = standard deviation (SD).

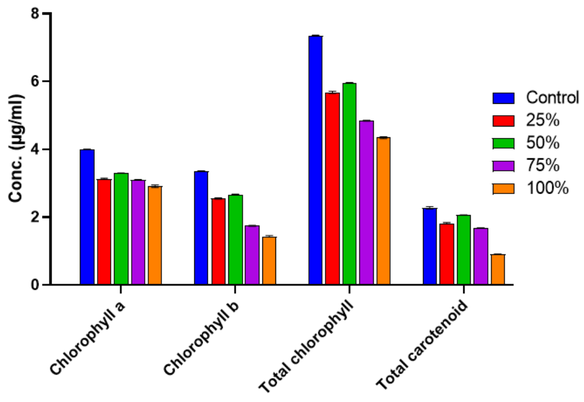


Fig. 5: Fond pigmentation of *Lemna minor* (n = 3) before and after exposure to different concentrations of dumpsite leachate. Error bars = standard deviation (SD).

Results indicate that *L. minor* effectively reduced physicochemical parameters such as Electrical Conductivity (EC), Total Dissolved Solids (TDS), Oxidation-Reduction Potential (ORP), and Chemical Oxygen Demand (COD) in the leachate over a 14-day period. The plant demonstrated efficacy in reducing COD by utilizing organic matter for growth and enhancing reducing conditions. The pH of the leachate shifted from neutral to alkaline (7.1 to 9.5), possibly due to the release of alkaline substances by *L. minor* or the uptake of acidic components. *L. minor* also showed significant removal of copper (Cu) and chromium (Cr), attributed to its hyper-accumulation capabilities, with metal uptake influenced by leachate concentration and exposure time (Rana *et al*., 2018). Lower leachate concentrations stimulated *L. minor* growth (increase in frond number and fresh weight), while higher concentrations proved inhibitory, potentially due to toxic substances. Conversely, chlorophyll content (chlorophyll a, chlorophyll b, total chlorophyll, and carotenoid) decreased across all leachate concentrations, with the most substantial reduction observed at high concentrations, suggesting the accumulation of toxic substances that disrupt photosynthetic processes.

CONCLUSION

After 14 days The results show a significant reduction ($p<0.05$) of copper (Cu); 42.2%, chromium (Cr); 25.3% electrical conductivity (EC); 42.4%, total dissolved solids (TDS); 37.4%, salinity; 37.4%, oxidation-reduction potential (ORP); 61.9% and chemical oxygen demand (COD); 17.8%; at 50%v/v. Meanwhile, the pH increased from slightly alkaline (7.1) to more alkaline (9.5) at the same concentration (50%v/v). The frond number,biomass, relative growth rate and leaf pigmentation decreased significantly at 100%v/v which indicates stress symptoms. This finding shows that *L. minor* can tolerate and remediate 50% v/v of the dumpsite leachate. Further studies to evaluate other environmental and ecophysiological factors to improve phytoremediation of leachate by this plant were recommended

FUTURE WORK / REFERENCES

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