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Heavy Metals Monitoring on NIPRD Botanical Garden

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ABSTRACT

Study of the level of heavy metals (Copper, Chromium, Lead and Zinc) in soil, organic manure and medicinal plants obtained from NIPRD Botanical Garden was carried out. The objective is to determined level of safety of the Botanical Garden towards realizing safe phytomedicine. Samples were collected, processed and analyzed for the specified heavy metals with Atomic Absorption Spectrophotometer using standard methods. The results obtained indicated the presence of Cu and Zn in the medicinal plants (8.17±3.36 mg/kg and 34.70±15.20 mg/kg), soil (13.43±1.91 mg/kg and 24.00±4.86 mg/kg) and the organic manure (33.50±0.40 mg/kg and 59.45±0.80 mg/kg), while Cr and Pb were not detected. The mean concentration of Cu and Zn obtained in soil, medicinal plants and organic manure at sampling sites A, B, C and D were below WHO and US (EPA) maximum permissible limits. In conclusion, NIPRD Botanical Garden is not polluted with the studied heavy metals; therefore, it is safe for domestication of medicinal plants.

Keywords: Botanical Garden, phytomedicine, Heavy metals, Pollution.

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INTRODUCTION

Heavy metals existence in soil and the environment has been on increase due to anthropogenic activities such as industrialization, modern agricultural practice and population growth [1]. These have resulted to soil, water, plants and ecosystem quality degradation, thus, posing a threat to

human and animal health [2]. Long term exposure to heavy metals contaminated products can result to physiological, neurological and muscular degenerative processes that initiates diseases conditions such as multiple sclerosis, Parkinson's disease, Alzheimer's disease, kidney failure, liver disease, cancers and muscular dystrophy [3].

The different parts of plant are important to human, animals and the environment but can be affected or damaged by pollutants such as heavy metals overloads [4]. The safety of phytomedicine for fighting Covid-19 and other disease conditions is determined by how safe the soil and the environment where the herbal materials are cultivated, collected, preserved or displayed [5]. Globally, more than 50% of sites of soil pollution were due to heavy metals/metalloids contamination. The economic impact of heavy metal pollution worldwide was estimated to be in excess of US $10 billion per year [2]. The cationic form of metals such as lead, cadmium, mercury, nickel, copper, zinc, chromium and manganese has been the major cause of several disease conditions such as diabetes, cardiovascular disease, chronic respiratory disease and Chronic liver disease and those suffering from such disease conditions are more susceptible to COVID-19 most especially in among older age group [1, 6-7]. Standards regulatory organization such as World Health Organization and US (EPA) has established quality and safety standards that clearly stipulated the maximum allowable limits for heavy metals in herbal remedies [8] and agricultural soil [9]. The study therefore aimed to determined level of safety of the NIPRD Botanical Garden by analyzing the soil, organic manure and medicinal plant grown-on for heavy metal content in order to ensure safe domestication, breeding and realization of phytomedicine in NIPRD.

1. Standard Permissible Limits for Heavy Metals in Plant and Soil

Heavy Metals	WHO Maximum Limit (mg/kg) in soil	US (EPA) (mg/kg) in soil	Permissible limit in medicinal plants (mg/kg)
Copper (Cu)	36	270	20
Chromium (Cr)	100	11	1.30
Lead (Pb)	85	200	10
Zinc (Zn)	50	1100	0.60

US (EPA) 2002, WHO (2007), (HE *et al,* 2015)

MATERIALS AND METHODS

Materials and Reagents Used

A GBC Avanta (version 2.0) Flame Atomic Absorption Spectrophotometer (FAAS), Analytical balance (JA-Series, Model-JA203H), water bath, electro-thermal heating mantle, porcelain mortar & pestle, porcelain crucibles, Whatman filter paper (No.1, size 110mm), Concentrated solutions of HNO_3 (Purity of 70%, ACS reagent grade for general purpose) and $HClO_4$ (Purity of 70%, ACS reagent grade for trace metal basis), deionized water (conductivity: 5.4µS/m), micropipette (Model: Excelpette, size 0-1000µl), reference standard solution of Cu, Cr, Pb and Zn (500ml, µg/ml from Aldrich, chemical company, Inc.USA) and appropriate sizes (class A & B) glassware.

Sample Collection

The aerial part of medicinal plant, soil and organic manure were collected from NIPRD botanical garden in the month of June, 2021. The samples were collected at four different sites (A, B, C & D1, D2) labeled, air-dried at room temperature in the laboratory.

Samples Preparation

The air-dried samples were further dried in an oven for 30 minutes at 105°C and powdered with a mortar and pestle. The samples were sieved and stored in air-tight polyethene bags for further processing.

Sample Digestion

Wet digestion method was used for digestion of all the samples. Accurately, 0.5 g of each of the homogenous powdered samples were weighed, transferred into digestion flask and added Aqua regia (7.5) to the soil and the organic manure samples, while concentrated nitric acid and Perchloric acid to the plant sample in the

ratio of 7:3 and swirled gently for proper mixing. The digestion flasks with the samples were placed on electrically powered regulated heating mantle and heated until white fume appear as a sign of completed digestion was observed. The digested samples were cooled and filtered through Whatman filter paper and diluted with deionized water to 50 ml in volumetric flask and transferred to labeled capped plastic sample bottle for the analysis [10].

Elemental Analysis

Flame Atomic Absorption Spectroscopy (FAAS) technique was used for the determination of Cu (324.70 nm), Cr (357.9 mn), Pb (217.0nm) and Zn (403.1nm) in the samples. The samples were analyzed based on the equipment operating conditions stated in Table 2 after calibration with reference standard solution of the selected elements. The data generated were processed using relation [11].

$$\text{Metal } (\mu g/g) = \frac{C \times V \times d.f}{W\ (g)}$$

Where; C is the concentration obtained from the AAS machine (mg/L); V is the volume of the undiluted sample solutions in mL; W is the sample's weight in grams.

RESULTS

The results obtained from the study are reported in table 2 below follows by the discussion of the result.

Table 2: Heavy Metals Content of Soil, Medicinal Plant and Organic manure from NIPRD Botanical Garden

Collection Sites	Samples	Mean Concentration (mg/kg)			
		Cu	Cr	Pb	Zn
Site A	Soil	15.00	0.00	0.00	26.50
	Plant	11.10	0.00	0.00	27.10
Site B	Soil	14.00	0.00	0.00	27.10
	Plant	8.90	0.00	0.00	52.20
Site C	Soil	11.30	0.00	0.00	18.40
	Plant	4.50	0.00	0.00	24.80
Site D1	Manure	16.40	0.00	0.00	58.10
Site D2	Manure	50.60	0.00	0.00	60.80

DISCUSSION

The results obtained indicated the presence of Cu and Zn, while Pb and Cr were not detected in all the samples. The concentration range of Cu in the medicinal plant, soil and the organic manure are 4.50 to 11.10 mg/kg, 11.30 to15.00 mg/kg and 16.40 to 50.60 mg/kg are, while that of Zn

were 24.80 to 52.20 mg/kg, 18.40 to 27.10 mg/kg and 58.10 to 60.80 mg/kg respectively. The mean concentration of Cu and Zn obtained in the soil, organic manure and the medicinal plant (*andrographis paniculata*) were lower than the maximum permissible limits specified by WHO, EPA and Chinese pharmacopeia [8-9].

CONCLUSION

The outcome of the study reveals that NIPRD botanical garden soil, organic manure and the medicinal plant (*andrographis paniculata*) obtained from it are safe from heavy metals contamination. This finding can therefore serve as a baseline reference data for subsequent future study.

REFERENCES

1. United States Department of Agriculture (USDA). 2000. Heavy Matal Soil Contamination. Soil Quality-Urban Technical Note No.3, Soil Quality Institute 411 S Donahue Dr Aubum AL 35832 Washington, D.C.
2. He, Z., Shentu, J., Yang, X., Baligar, V.C., Zhang, T. and Stoffella, P.J (2015) Heavy Metal Contamination of Soils: Sources, Indicators, and Assessment. *Journal of Environmental Indicators*, 9:17-18
3. Kočevar G.N., Djogo S., Ražić S., Kreft S and Marjan V (2017)- Accumulation of heavy metals from soil in medicinal plants *.Arh Hig Rada Toksikol* 2017;68:236-244)
4. Beckett, K. P., Freer-Smith, P. H., & Taylor, G. (2000). Particulate pollution capture by urban trees: effect of species and windspeed. *Glob Change Biol, 6*, 995-1003.
5. Spencer, R and Cross, R (2017) "The origin of botanic gardens and their relation to plant science with special interest to horticultural botany and cultivated plant taxonomy. *Muelleria* **35**:43-93).
6. World Health Organization (WHO, 2007). Guidelines for assessing quality of herbal medicines with reference to contaminants and residues. Geneva, Switzerland. P.24
7. United States Environmental Protection Agency (US EPA). 2002. Supplemental guidance for developing soil screening levels for superfund sites. Office of Solid Waste and Emergency Response, Washington, D.C.

   http://www.epa.gov/superfund/health/conmedia/soil/index.htm
8. Khan, S.Q. Cao, Y. M. Zheng, Y. Z. Huang, and Y. G. Zhu (2008)., "Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater

in Beijing, China," Environmental Pollution, vol. 152, no. 3, pp. 686–692, 2008.View at: Publisher Site | Google Scholar

9. Environmental Protection Ministry of China (EPMC). 2015. Standards of soil environmental quality of agricultural land. Huangbanhang 69: Office of Environmental Protection Ministry of China, Beijing, China.
10. Parvez, M.K (2020). COVID-19 and coronaviral hepatitis: evidence of collateral damage. *Future Virol*. (Epub ahead of print) 10.2217/fvl-2020-0065 C _ 2020 Future Medicine Ltd ISSN 1746-0794].
11. Samali, A**.,** Mohammed, M. I. and Ibrahim, M. B (2017). Analysis of Heavy Metals Concentrations in Kano Herbal Preparations for Major Disease Conditions. *ChemSearch Journal*, 8(2): 22 – 28