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Determination of Heavy Metals in Fenugreek and Spinach, Vegetables by ICP-MS

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Abstract

This study was designed to determine lead, Chromium, Cadmium, and Nickel levels in homegrown spinach and fenugreek), All samples were analysed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The transfer factor of HMs from soil to analysed vegetables was calculated, to exposure to analysed heavy metals. The heavy metals Ni, Pb Cr, and Cd concentrations in both vegetable roots, stem, and leaf exceeded the safe limits. in our study may threaten human health because of their heavy metal loads.

Keywords- *heavy metal;Contamination; health risk; vegetables; ICP MS method.*

1. INTRODUCTION

The release of heavy metals into the environment has a negative impact on food quality. Copper, zinc, manganese, and cobalt are trace metals that are essential for human and animal growth and development. Arsenic, lead, nickel, mercury, and cadmium, on the other hand, are poisonous metals for living organisms, and there is no known homeostasis mechanism in the body for these toxic metals [1]. earth's crust, mining, soil erosion, industrial discharges, effect of industrial and domestic wastes blending in to the seas, urban flow, sewage wastes, harmful agents applied to plants, and air pollution [1]. Heavy metal pollution in the soil and seas affects the nutritional quality of foods and can reach animals and humans through the food chain. The main sources that cause heavy metals to mix into nature are; mines, wastewater of various metal and paper industries, fertilizers, fossil fuels, pesticides, various chemicals, and household waste [2]. Lead, As, Cd and Hg are the most common heavy metals that cause soil pollution [3]. Long-term accumulation of heavy metals in soil can lead to a reduction in buffering capacity and pollution of groundwater [4].

Heavy metals present as particulates or vapor in the atmosphere can be taken into plants, Contamination of soil and crops with heavy metals (HMs) is presently a serious global concern. Toxic metals can pose serious health risks to all living species, especially humans if they are deposited above a certain threshold [5]. vegetables and fruits which have beneficial effects on health with rich vitamin-mineral content-heavy metals such as Cu, Zn, and Fe are used by human metabolism in many events, and heavy metals such as Hg, Cd, and Pb which have no beneficial effect and function, can be transmitted to the water in various ways. At the same time, the presence of these metals in high amounts of water leads to the death of many living creatures, as well as disrupting the natural balance of life [6]. Heavy metals in food are not found in safe concentrations and the consumption by humans for a long time causes heavy metals to accumulate chronically in the human body. The accumulation of heavy metals in the body can cause many biochemical processes to deteriorate

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and cause kidney, liver, heart, nerve, and bone diseases in humans. Therefore, the international and national regulations on food quality have reduced the permissible maximum levels of toxic

metals in foodstuffs as these metals increase the risk of food chain pollution [7]. The aim of this study was to determine the concentrations of Heavy metals Ni, Pb, Cr, and Cd in Homegrown Fenugreek and Spinach vegetables.

2. MATERIAL and METHOD

2.1 Sample Selection and Preparation

Fenugreek and spinach vegetable samples were homegrown in simple soil. after one month Both vegetable samples were washed under flowing warm water for 3 minutes. Non-renewable parts were removed then was done determining test of Heavy metals in both plant parts (root, leaf, stem).

2.2 Chemical Analysis

Analysis of the samples was carried out in AGSS analytical and Research Laboratory. Firstly, samples were digested by microwave digester. A wet ground weight (0.5 g) was digested with 6 mL of nitric acid (HNO3, 65%) and 2 mL of hydrogen peroxide (H2O2, 30%). The digested samples were evaporated to dryness and diluted to 20 mL with deionized water. Concentrations of heavy metals (Ni, Cr, Pb and Cd) in the digested samples were analyzed with Agilent 7700 ICP-MS. Standard 1: Agilent 8500-6940 2A (5% HNO3): Ni, Cd and Pb, standard 2: Agilent 8500-6940 Hg (5% HNO3): Cr, internal standard: Agilent 5188-6525(5% HNO3): all Concentration was 5,10,15 and 20ppm. tune solution: Agilent 5185-5959: Li, Y, Tl, Ce, Co, Mg (1ppb in 2% wt HNO3) solutions used during analysis.

2.3 Statistical Analysis

A one-way ANOVA was used to evaluate the differences among the found results data. data received by ICP-MS method was used to detect the significant differences between the means of different soil classifications and found or absorbed metals in soil and vegetable. The criterion for significance in the procedures was set at $p < 0.05$ (significant). All data were presented as arithmetic means with the standard error attached. All statistical analyzes were conducted using the software Excel 2016, and all statistics were produced using Origin Version 8.5 software (Corporation, USA).

3. RESULTS and DISCUSSION

Different amounts of heavy metals with 5,10,15 and 20 ppm were mixed in it and between fenugreek and spinach and were also tested for different metals in the soil, The results are tabulated in the table which is results as in Table 1 and Graph 1 is conclude graph is shown results study for selected Heavy metals found in simple soil and parts of Fenugreek Leaf stem and root. while Table 2 and Graph 2 are concluded graph is shown the result of heavy metals in simple soil and parts of Spinach Leaf, stem, and root.

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Table 1: Mean concentration of HMs in soil and Fenugreek vegetable samples of the study.

Nickel Concentration (Fanugreek) after digestion					
S. No	**Treatment with Ni**	**Leaf**	**Stem**	**Root**	**Soil**
1	**Control**	**0.8**	**1.2**	**4.4**	**16**
2	5 ppm	1.3±0.01	1.08±0.01	5.32±0.12	21.79±0.01
3	10 ppm	3.09±0.02	3.19±0.42	8.09±0.11	29.02±0.11
4	15 ppm	7.08±0.12	5.03±0.24	13.01±0.09	37.02±0.19
5	20 ppm	10.0.02±0.01	7.10±0.002	21.06±0.001	42.05±0.01
Lead Concentration (Fanugreek) after digestion					
S. No	**Treatment with Pb**	**Leaf**	**Stem**	**Root**	**Soil**
1	Control	BLQ	BLQ	BLQ	0.06
2	5 ppm	BLQ	0.06±0.001	0.40±0.13	6.13±0.17
3	10 ppm	BLQ	0.06±0.001	0.19±0.1	11.1±0.3
4	15 ppm	0.2±0.001	1.1±0.001	6.24±0.04	15.71±0.32
5	20 ppm	0.42±0.12	3.02±0.14	11.01±0.001	19.02±0.69
Chromium Concentration (Fanugreek) after digestion					
S. No	**Treatment with Cr**	**Leaf**	**Stem**	**Root**	**Soil**
1	**Control**	BLQ	BLQ	**1.2**	**6.44**
2	5 ppm	0.29±0.01	0.73±0.14	5.01±0.19	11.02±0.02
3	10 ppm	0.509±0.011	1.07±0.16	8.01±0.13	17.1±0.1
4	15 ppm	0.7±0.1	2.01±0.001	11.22±0.10	20.22±0.16
5	20 ppm	1.2±0.7	2.12±0.14	22.14±0.11	19.01±0.1
Cadmium Concentration (Fanugreek) after digestion					
S. No	**Treatment with Cd**	**Leaf**	**Stem**	**Root**	**Soil**
1	Control	BLQ	BLQ	BLQ	0.05
2	5 ppm	BLQ	0.41±0.14	2.01±0.01	6.19±0.14
3	10 ppm	0.02±0.1	0.8±0.1	3.02±0.09	11.08±0.19
4	15 ppm	0.049±0.01	1.2±0.006	5.17±0.33	14.62±0.02
5	20 ppm	1.20±0.11	2.01±0.04	7.2±0.10	22.18±0.10

Table 2: Mean concentration of HMs in soil and Spinach vegetable samples of the study.

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Nickel Concentration (spinach) after digestion					
S. No	**Treatment with Ni**	**Leaf**	**Stem**	**Root**	**Soil**
1	**Control**	BLQ	**1.2**	**1.88**	**15.2**
2	5 ppm	4.32±0.25	2.29±0.03	3.06±0.01	19.88±0.001
3	10 ppm	8.07±0.006	5.17±0.04	8.43±0.12	24.21±0.1
4	15 ppm	10.1±0.001	16.23±0.19	11.65±0.14	30.12±0.05
5	20 ppm	12.1±0.02	21.86±0.14	17.09±0.13	34.05±0.14
Lead Concentration (spinach) after digestion					
S. No	**Treatment with Pb**	**Leaf**	**Stem**	**Root**	**Soil**
1	**Control**	BLQ	BLQ	BLQ	1.98
2	5 ppm	BLQ	BLQ	BLQ	9.10±0.14
3	10 ppm	BLQ	0.45±0.12	1.54±0.16	10±0.35
4	15 ppm	0.31±0.01	1.1±0.001	3.04±0.14	15.01±0.1
5	20 ppm	0.8±0.004	1.02±0.07	4.47±0.27	17.11±0.22
Chromium Concentration (spinach) after digestion					
S. No	**Treatment with Cr**	**Leaf**	**Stem**	**Root**	**Soil**
1	**Control**	BLQ	BLQ	BLQ	6.24
2	5 ppm	BLQ	1.69±0.01	0.69±0.01	16.11±0.09
3	10 ppm	9.08±0.10	4.09±0.014	3.25±0.14	19.02±0.20
4	15 ppm	16.14±0.14	17.25±0.1	12.04±0.19	24.2±0.11
5	20 ppm	28.01±0.24	27.09±0.26	15.01±0.17	31.09±0.18
Cadmium Concentration (spinach) after digestion					
S. No	**Treatment with Cd**	**Leaf**	**Stem**	**Root**	**Soil**
1	**Control**	BLQ	BLQ	BLQ	0.01
2	5 ppm	BLQ	BLQ	BLQ	5.04±0.6
3	10 ppm	0.23±0.02	3.02±0.03	5.01±0.2	0.9±0.3
4	15 ppm	1.02±0.14	4.14±0.14	6.06±0.001	14.10±0.25
5	20 ppm	1.12±0.9	5.1±0.8	6.04±0.14	17.03±0.21

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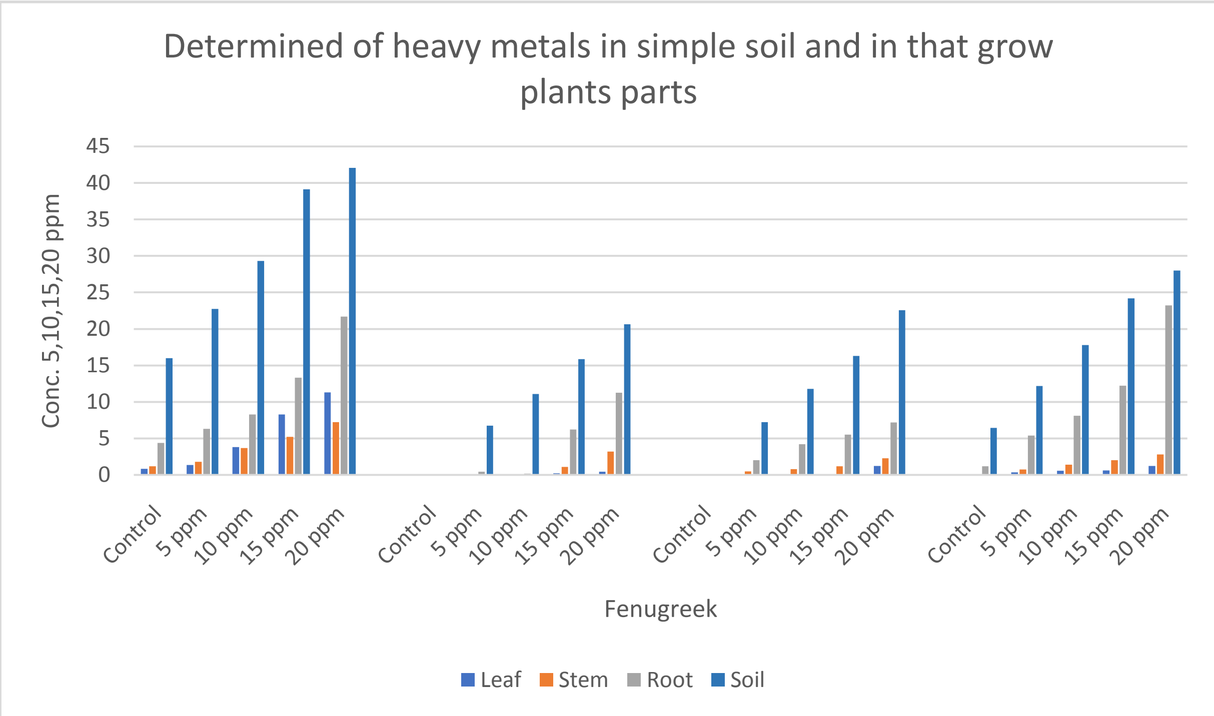
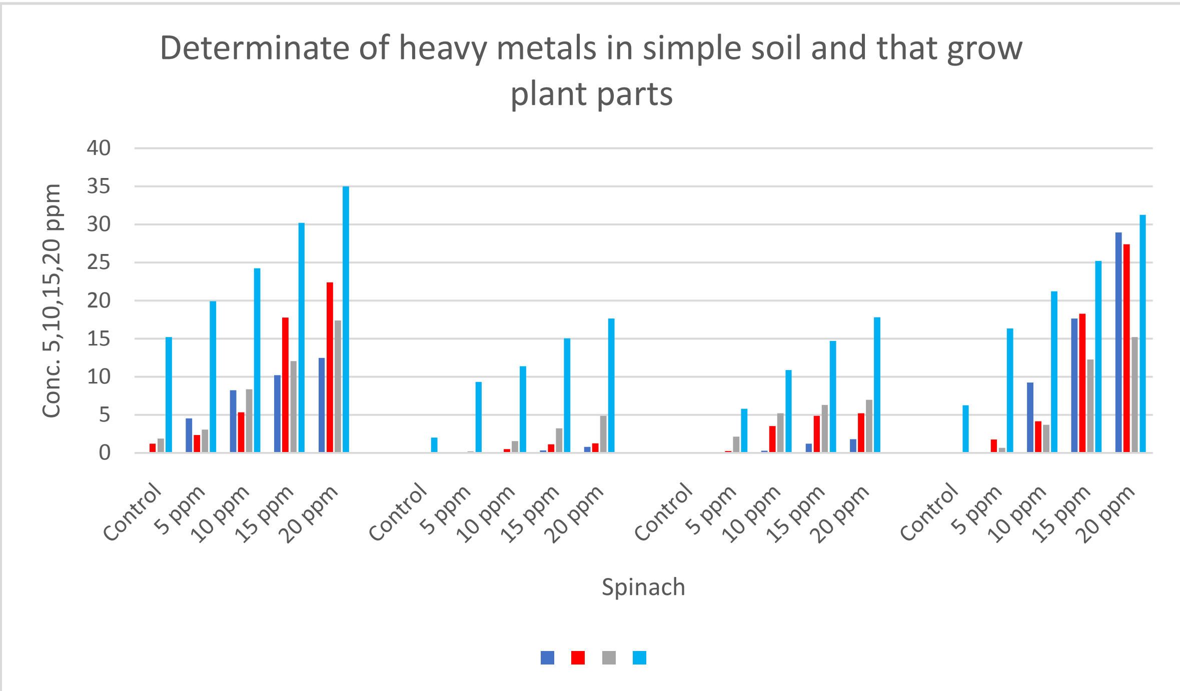


Graph1: Mean concentration of HMs in Simple soil and Fenugreek samples of the study.



Graph2: Mean concentration of HMs in Simple soil and Spinach samples of the study.

The relative abundance of heavy metals in fenugreek samples analysed follows the sequence in simple soil samples. Cr > Ni > Pb > Cd. The maximum absorbance in from simple soil to fenugreek was plant root which was at 20 ppm. Whereas the relative abundance of heavy metals in spinach samples analysed follows the sequence in simple soil samples. Cr > Ni > Cd > Pb. The maximum absorbance in from simple soil to Spinach was plant stem which with was at 20 ppm. Vegetable species differ widely in their ability to take up and accumulate heavy metals, even among cultivars and varieties within the leaf's vegetable species [8-9]. It has been reported that Cd uptake and accumulation in leafy vegetables are greater than in other vegetables [10-11]. In this study, significant differences were found in the concentrations of heavy metals in the edible parts of Fenugreek and Spinach vegetable parts; the concentrations decreased in the order of leafy vegetables-root > Stem > Leaf (Graph 1,2). In addition, the ability for heavy metal uptake and accumulation of spinach vegetables was higher than for the fenugreek vegetable parts. of Ni, Cd, Cr, and Pb (Table 2) were classified as.

4. CONCLUSION

The work verifies an efficient ICP-MS-based internal standard method to quantify the presence of Cr, Pb, Ni, and Cd in soils and plants. In this study, Certified Reference analysis methods contrast and recovery experiment different have been carried out. Overall results indicate that the presented method has satisfactory reproducibility, recovery, and accuracy for Cr, Cd, Pb and Ni, analysis in categories soils and plants. Thus, the proposed method can be used successfully to monitor the above four heavy metals in soil and which from soil to plant absorb heavy metals. so that other heavy metals determined which harm full effects on human health because This study conducted has not have enough data to comment on determining other heavy metals. and There is a very limited number of studies about the effects of foods with high heavy metal concentrations on human health. More comprehensive studies are needed to achieve the final results.

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