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Heavy Metal Determination by ICP-MS in Fenugreek and Spinach Vegetables

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Abstract: Lead, Chromium, Cadmium, and Nickel levels in cultivated spinach and fenugreek were the focus of this study. Inductively Coupled Plasma Mass Spectrometry was used to analyse all of the samples (ICP-MS). The transfer factor of HMs from soil to examined vegetables and exposure to examined heavy metals was computed. Vegetable roots, stems, and leaves have higher percentage quantities of the heavy metals Ni, Pb, Cr, and Cd than has considered acceptable. Due to their high metal content, in our study may endanger human health.

Keywords: Heavy Metal, Contamination, Health Risk, Vegetables, ICP MS Method.

1. INTRODUCTION

Food quality suffers as a result of heavy metal emissions into the environment. Trace metals including copper, zinc, manganese, and cobalt are essential for both human and animal growth and development. On the other hand, toxic metals including arsenic, lead, nickel, mercury, and cadmium are hazardous to living things and do not have a recognized homeostasis mechanism in the body [1].

Earth's crust, mining, soil erosion, industrial discharges, the result of residential and industrial wastes mixing in the oceans, urban flow, sewage wastes, toxic chemicals used on plants, and air pollution [2] are some examples of environmental factors. The nutritional value of food is impacted by heavy metal contamination in the land and oceans, which can also harm animals and people through the food chain. Mines, wastewater from various metal and paper industries, fertilisers, fossil fuels, pesticides, other chemicals, and household waste are the primary sources that contribute to the admixture of heavy metals in the environment [3]. The most frequent heavy metals that pollute soil are lead, as, cadmium, and mercury [4]. The long-term buildup of heavy metals in soil can reduce its ability to act as a buffer and contaminate groundwater [5].

Heavy metal contamination of soil and crops (HMs) is currently a critical worldwide problem. Heavy metals present in the environment as particles or vapor can be taken up by plants. If they

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are deposited over a specific level, toxic metals can offer major health concerns to all living things, notably humans [6]. Vegetables and fruits that are high in vitamins, minerals, and heavy metals like Copper, Zink, and Iron are used by human metabolism in many processes, and heavy metals like Mercury, Cadmium, and Lead that have no beneficial effects and functions can be transmitted to water in a number of ways. In addition to upsetting the natural balance of life, the presence of heavy metals in significant concentrations in water also causes the death of several living things [7]. Since there are no acceptable levels of heavy metals in food, eating it often over a long period of time leads to chronic heavy metal accumulation in the body. Heavy metal buildup in the body can impair several biochemical processes and result in human liver, kidney, heart, nerve, and many diseases. As a result, the maximum quantities of hazardous metals that can be present in food without causing food chain contamination have been lowered by international and national regulations on food quality [8]. Hence this study's objective was to find out how much of the heavy metals Nickel, Lead, Chromium, and Cadmium were present in homegrown both vegetables (spinach &fenugreek).

Sample Preparation

Vegetable samples of fenugreek and spinach were grown at home in plain soil. After above 1 month, both vegetable samples were cleaned for 10-15 minutes under warm water. Non-renewable sections were removed before a heavy metals test was performed on both plant components (root, leaf, and stem).

Chemical Analysis

The samples were analyzed in the AGSS analytical and research laboratory. The materials were first digested using a microwave digester. 6 mL of nitric acid (HNO_3, 65%) and 2 mL of hydrogen peroxide (H_2O_2, 30%) were used to digest 0.5 g of wet ground weight. The digested samples were dried and diluted with deionized water to 20 mL. Heavy metal concentrations (Ni, Cr, Pb, and Cd) in digested samples were measured using an Agilent 7700 ICP-MS. Agilent 8500-6940 2A (5% HNO_3): Ni, Cd, and Pb, Agilent 8500-6940 Hg (5% HNO_3): Cr, and Agilent 5188-6525 (5% HNO_3): all concentrations were 5, 10, 15, and 20ppm. Agilent 5185-5959: Li, Y, Tl, Ce, Co, and Mg (1ppb in 2% wt HNO_3) solutions were employed throughout analysis.

Data Analysis

To assess the differences between the observed findings data, a one-way ANOVA was performed. The ICP-MS data was utilized to discover significant variations between the means of different soil categories and metals identified or absorbed in soil and vegetables. In the procedures, the criterion for significance was set at $p < 0.05$. Whole data were accessible as calculation revenue with usual mistake. Completely numerical analyzes were approved out using the Excel 2017 program, and all statistics were generated using the Origin Version 8.5 software (Corporation, USA).

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2. RESULTS AND DISCUSSION

5,10,15, and 20 ppm were mixed in it, as well as between fenugreek & spinach, and the soil was also tested for various metals. The results are recorded in a table, and Graph 1 concludes. The findings of a research for selected HM identified in plain soil & portions of Fenugreek Leaf stem & root are displayed in the graph. While Table 2 and Graph 2 have been completed, the graph depicts the results of heavy metals in simple soil & selected parts of Spinach.

Table 1: Mean con of Heavy metals in Fenugreek vegetable & soil samples.

Ni Concentration after digestion				
Treatment in Ni (ppm)	**Leaf**	**Stem**	**Root**	**Soil**
Control	**0.6**	**1.1**	**4.3**	**17**
5	1.2±0.01	1.07±0.01	5.22±0.12	23.79±0.01
10	3.09±0.02	3.19±0.42	8.09±0.11	29.02±0.11
15	7.06±0.12	5.05±0.24	12.01±0.09	34.02±0.19
20	10.0.02±0.01	9.10±0.002	23.06±0.001	44.04±0.01
Pb Concentration after digestion				
Treatment in Pb (ppm)	**Leaf**	**Stem**	**Root**	**Soil**
Control	BLQ	BLQ	BLQ	0.06
5	BLQ	0.06±0.001	0.40±0.13	6.13±0.17
10	BLQ	0.06±0.001	0.19±0.1	11.1±
15	0.4±0.001	1.2±0.001	6.24±0.04	17.72±0.32
20	0.47±0.12	2.02±0.14	11.01±0.001	21.02±0.69
Cr Concentration after digestion				
Treatment in Cr (ppm)	**Leaf**	**Stem**	**Root**	**Soil**
Control	BLQ	BLQ	**1.2**	**6.44**
5	0.28±0.01	0.73±0.14	5.01±0.19	11.02±0.02
10	0.566±0.011	1.07±0.17	9.01±0.13	19.1±0.1
15	0.9±0.1	2.01±0.001	11.22±0.10	19.22±0.16
20	1.2±0.7	2.12±0.14	21.14±0.11	20.01±0.1
Cd Concentration after digestion				
Treatment in Cd (ppm)	**Leaf**	**Stem**	**Root**	**Soil**
Control	BLQ	BLQ	BLQ	0.05
5	BLQ	0.41±0.14	2.01±0.01	6.19±0.14
10	0.02±0.1	0.8±0.1	3.02±0.09	11.08±0.19
15	0.049±0.01	1.2±0.006	5.17±0.33	14.62±0.02
20	1.18±0.11	2.01±0.04	6.2±0.10	23.19±0.10

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Table 2: Mean concentration of Heavy metals in Spinach vegetable & soil samples.

Ni Concentration after digestion				
Treatment in Ni (ppm)	**Leaf**	**Stem**	**Root**	**Soil**
Control	BLQ	**1.2**	**1.88**	**15.2**
5	3.22±0.25	2.26±0.03	2.06±0.01	20.78±0.001
10	8.04±0.006	5.16±0.04	8.25±0.12	22.21±0.1
15	10.1±0.001	14.23±0.19	10.565±0.14	29.10±0.05
20	10.1±0.02	21.86±0.14	17.09±0.13	32.12±0.14
Pb Concentration after digestion				
Treatment in Pb (ppm)	**Leaf**	**Stem**	**Root**	**Soil**
Control	BLQ	BLQ	BLQ	1.98
5	BLQ	BLQ	BLQ	9.10±0.14
10	BLQ	0.45±0.12	1.54±0.16	10±0.35
15	0.31±0.01	1.1±0.001	3.04±0.14	15.01±0.1
20	0.8±0.004	1.02±0.07	4.47±0.27	17.11±0.22
Cr Concentration after digestion				
Treatment in Cr (ppm)	**Leaf**	**Stem**	**Root**	**Soil**
Control	BLQ	BLQ	BLQ	6.42
5	BLQ	1.69±0.01	0.69±0.01	16.11±0.09
10	9.11±0.10	4.10±0.014	3.22±0.14	19.12±0.20
15	16.12±0.14	17.15±0.1	12.24±0.19	24.12±0.11
20	28.21±0.24	27.03±0.26	15.05±0.17	31.19±0.18
Cd Concentration after digestion				
Treatment in Cd (ppm)	**Leaf**	**Stem**	**Root**	**Soil**
Control	BLQ	BLQ	BLQ	0.01
5	BLQ	BLQ	BLQ	5.04±0.6
10	0.22±0.02	3.11±0.03	5.21±0.2	1.9±0.3
15	1.11±0.14	4.23±0.14	8.06±0.001	12.10±0.25

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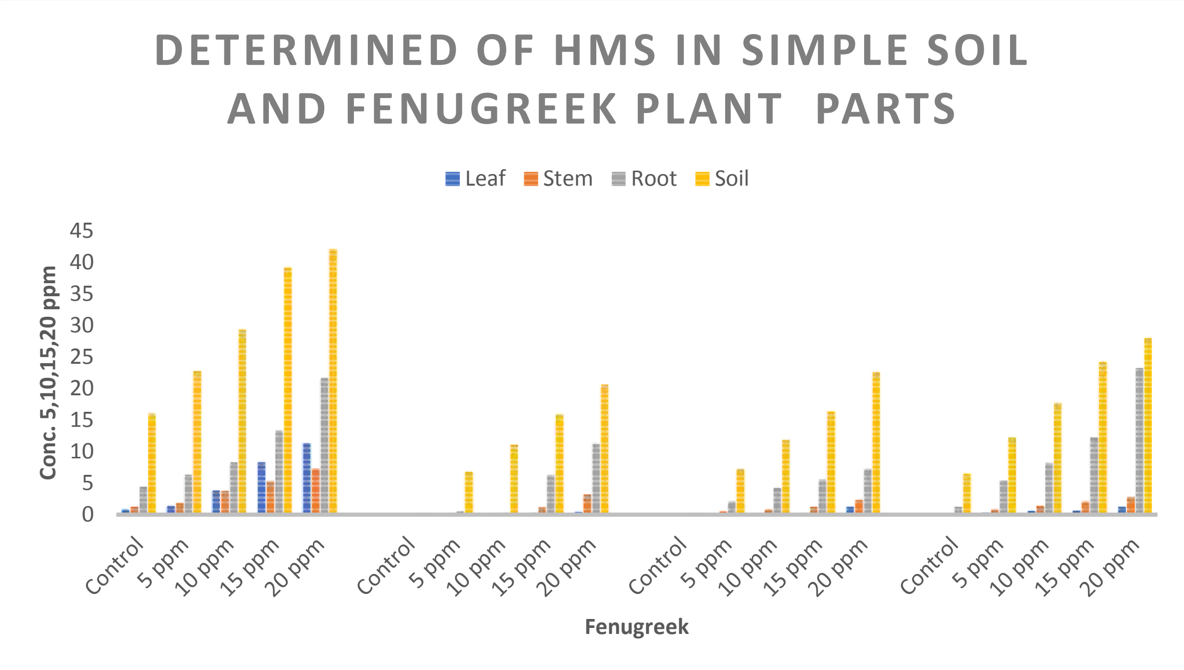
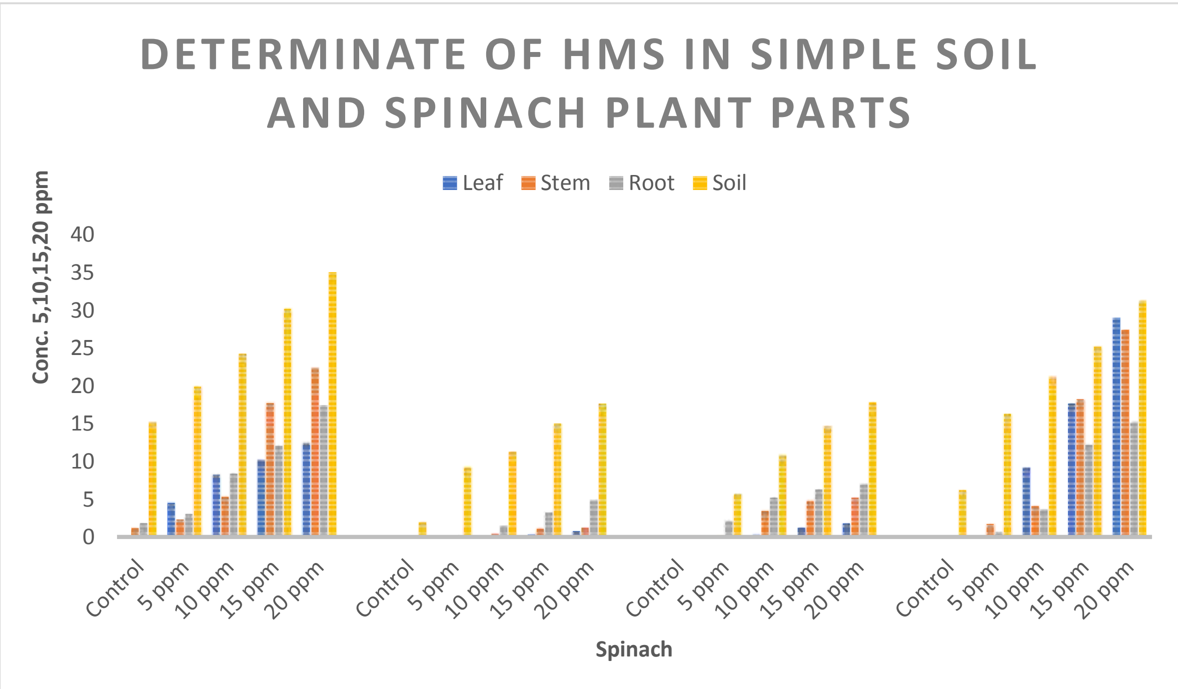
20	1.10±0.9	5.13±0.8	6.24±0.14	17.01±0.21



Graph. 1: Mean concentration of HMs in Fenugreek & soil samples.



Graph. 2: Mean concentration of HMs in Spinach & soil samples

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The relative quantity of HMs in fenugreek samples examined followed the same pattern as in plain soil samples. Chromium > Nickel > Lead > Cadmium. The plant root had the highest absorption from plain soil to fenugreek at 20 ppm. In contrast, the comparative presence of heavy metals in the spinach samples examined followed the same pattern as in basic soil samples. Chromium > Nickel > Cadmium > Lead. The plant stem had the highest absorption from plain soil to Spinach, at 20 ppm. Vegetable spp range greatly in their propensity to absorb and accumulate HMs, even among cultivars and variations within the same vegetable [9–10]. Cd absorption and accumulation have been observed to be higher in leafy greens than in other vegetables [10–12]. Significant variations in heavy metal concentrations were detected in the edible sections of Fenugreek and Spinach vegetable components in this study; concentrations declined in the sequence of leafy vegetables—root > stem > leaf (Graph 1,2). Furthermore, the ability of spinach vegetables to absorb and accumulate heavy metals was developed than that of fenugreek vegetable, Cd, Ni, Pb & Cr were classified as in table 2.

3. CONCLUSION

The study validates an effective internal standard approach based on ICP-MS for quantifying the levels of Ni, Cr, Cd, and Pb in soils and plants. Specialized Orientation analysis methodologies difference and recapture research dissimilar were carried out in this study. General, the findings show that the given technique has good repeatability, recapture, and accurateness for Cr, Cd, Pb, and Ni measurements in plants & soil. Thus, the planned method can be efficaciously used to monitor the above all 4th HMs in the soil, which absorb heavy metals from the soil to the plant, so that other heavy metals that harm the full effects on human health can be determined because the data from this study is insufficient it will provide feedback on the determination of other HMs. There has been relatively little research on the impact of foods with high heavy metal content on health. Further extensive research is required to achieve the final results.

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