

Effect of Heavy Metal Content of some Common Spices Available in Local Markets in Erbil City on Human Consumption

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ABSTRACT

Herbs and spices are sources of many bioactive compounds that can improve the taste of foods as well as their influence on digestion and metabolism processes. They can also contain some undesirable components that can be harmful, e.g. micotoxins, pesticides, heavy metals, and polycyclic carbohydrates residues.

The objective of this study was to determine metals content in the most popular spices and herbs used in local market in Erbil. The content of these metals was assayed by Atomic absorption spectrophotometric method. The study showed differences in metal concentration according to the plant part (Rhizomes, Seed, Leaf, and fruit). The concentration ranged on dry basis were : (6.1- 47.0), (56-650), (6-44), (10.5-22.5), (8.5-26.5), (26-88.6), (1.25-14.6), and (0.045-1.35) mg/kg for the metals, Zn, Fe, Cu, Cr, Co, Mn, Pb, and Cd respectively.

Most of the metal levels in the spices were acceptable with the exception of Pb, Cu and Cd which were above the standard limit approved by World Health Organization (WHO) and Food Agriculture Organization (FAO), Pb was above the standard level for fenugreek, cinnamon, Cd was above the standard level for ginger.

Consumers of these spices would not be exposed to any risk associated with the daily in take of 10g of spices per day containing the following metals; Zn, Fe, Cu, Cr, Co, Mn.but there are danger from fenugreek and cinnamon for Pb, while the danger of ginger is from Cd.

Generally most of the spices available in the market are safe for human consumption except for Pb and Cd.

Keywords: Heavy Metals, Spices, A.AS (Atomic Absorption Spectrophotometer).

(micotoxins)

(AAS)

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(22.5-10.5) (44 -6) (650 - 56) (47 - 6.1)

/ (1.32-0.012) (14.6 -1.25) (88.6-26) (26.2 -8.5)

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INTRODUCTION

In the last three decades, mainly because of their medicinal values, the use of spices and other herbs has increased markedly in most regions of the world, including Europe and North America. For instance, during this period, herbal medication in the USA has grown into an industry worth an average of 5 billion per year, with projected annual growth of 15 % (Abebe, 2006).

Many common spices have outstanding antimicrobial effects. On the other hand, the process of preparation and handling can make them a source of food poisoning (Sherman and Billing, 1998). With the current emphasis on eating more healthy diets that are low in fat and salt, people are turning to various herbs and spices to flavor their food. The culinary herbs and spices that are used to enhance the flavor of vegetables, soups, stir-fry, and pasta dishes can be derived from the bark, buds, flowers, leaves, fruits, seeds, rhizome, or roots of a plant (Wahid *et al.*, 1989). The presence of essential metals like iron, copper, manganese

and zinc are very useful for the healthy growth of the body though very high levels are in tolerable, while metals like lead, cadmium etc are toxic at very low concentrations.

The addition of spices that may be contaminated the food as that may result in accumulation of these metals in human organs and lead to different health troubles (Al-Ed *et al.*, 1997) these metals may reach and contaminate plants, vegetables, fruits and canned foods through air, water and soil during industrial processing and packaging (Ozores *et al.*, 1997). The study of these heavy metals is crucial because they have potential hazardous effect, not only on compounds but human health as well. This is due to their cumulative behavior and toxicity although they are generally present in agricultural soils at low levels contamination (Ozkutlu *et al.*, 2006). Monitoring the levels of heavy metal toxicity in spices would help ascertain the health impact of taking these spices, and provide relevant data on spices in the country.

Thus several studies were done to determine the concentration of heavy metals in spices, dry fruits and plant nuts (Gilbert, 1984; Husain *et al.*, 1995) and to study their dangerous effect.

Kurdistan region imports spices among a lot of food stuffs from several countries. These spices may be subjected to contamination by so many ways as mentioned above, however, there is little information available about the safety of these spices with respect to heavy metals.

The main objective of this study was to determine the content of some heavy metals (Zn, Fe, Cu, Cr, Co, Mn, Pd, and Cd) as available in local market of Erbil city in Kurdistan region.

MATERIAL AND METHODS

Sampling and Classification

Samples of common spices were collected from the local markets and divided according to the used part of the plant, their scientific, and local names are shown in (Table 1). Samples were kept in polythene bags and kept in a cool dry cardboard prior to analysis.

Table 1: Spice samples with their scientific and common name

Common name	Scientific name	Family	Used part
Black seed	Nigella Sativa	Anacardiaceae	Seed
Cinnamon	Cinnamonum	Z(y)lanicum Lauraceae	Rhizomes
Mint	Menthe	Lamiaceae	Leaf
Fenugreek	Trigonella foenumgraecum	Legomnoseae	Seed
Black peper	Capsicum nigrum	Piperaceae	Seed
Ginger	Zingiber afficenalis	Zingiberaceae	Rhizomes
Turmeric	Cuccuma longa	Zingiberaceae	Rhizomes
Omani lime	citrus aurantifolia	Rutaceae	Fruit
Coriander	Coriandium sativum	Umbellifeae or Apiaceae	Seed
Sumac fruit	Rhus Coriaria	Folium	Fruit
Cumin	Cuminum cyminum	Umbellifeae or Apiaceae	Seed
Cardamon	Elettaria cardamonum	Zingiberaceae	Seed

Experimental Procedures

Samples were cleaned and oven-dried at 80 °C for \approx 12 hrs before chemical analysis. The dried samples were ground in a mortar with pestle till, a fine powder was obtained. The powder was sieved with a 0.5 mm mesh and kept dry for analysis.

Instrumental: metal measurement was performed with (Pye unicam SP9) Atomic Absorption Spectrophotometer, double beam and deuterium background correction. Measurement were done against metal standard solution. For flaming air-acetylene was used.

Standards: The standard stock solutions for the following metals were prepared as follows:

Zn: 1000 ppm of Zn was prepared by dissolving 0.8040 gm of zinc oxide in 5 ml of deionized water followed by 25 ml of 5 M hydrochloric acid. Diluted to 1 liter in volumetric flask with deionized water.

Fe: 1000 ppm of Fe was prepared by dissolving 1.000gm of iron powder in 20 ml of 5 M hydrochloric acid and 5ml of nitric acid. Diluted to 1 liter in volumetric flask with deionized water.

Cu: 1000 ppm of Cu was prepared by dissolving 1.000 gm of Cu metal in 50 ml of 5 M nitric acid. Diluted to 1 liter in volumetric flask with deionized water.

Cr: 1000 ppm of Cr was prepared by dissolving 7.690gm of chromium nitrate in 250 ml of deionized water. Diluted to 1 liter in volumetric flask with deionized water.

Co: 1000 ppm of Co was prepared by dissolving 4.0380 gm of cobalt(II) chloride in 200 ml of deionized water. Diluted to 1 liter in volumetric flask with deionized water.

Mn: 1000 ppm of Mn was prepared by dissolving 3.6077 gm of manganese dichloride in 50 ml hydrochloric acid. diluted to 1 liter in volumetric flask with deionized water.

Pb: 1000 ppm of Pb was prepared by dissolving 1.5980 gm of lead nitrate in 100 ml of deionized water. Diluted to 1 liter in volumetric flask with deionized water.

Cd: 1000 ppm of Cd was prepared by dissolving 1.1423 gm of cadmium oxide in 20 ml of 5 M hydrochloric acid. Diluted to 1 liter in volumetric flask with deionized water.

For determination of heavy metal concentrations, a wet digestion of the dried samples was done according to the method described by Jones and Case (1990) using mixture of concentrated H_2SO_4 and 30% H_2O_2 . To a 0.5 g of dry- ground sample was added 3.5 ml of 30 % H_2O_2 and 2 ml of H_2SO_4 . The mixture was heated to 100 °C, and the temperature was gradually increased to 250 °C, and left at this temperature for 30 min then cooled and an additional 1 ml of 30 % H_2O_2 (v/v) was added, the mixture were reheated. The digestion process was repeated more than one time until a clear solution was obtained (Kalra, 1998). The clear solution was transferred into a 25 ml volumetric flask, and completed to the mark with double distilled water. A blank digestion solution was made for comparison, containing 3.5 ml of 30% H_2O_2 (v/v) and 2 ml of concentrated H_2SO_4 , the solution transferred into 25 ml volumetric flask and completed to the mark with double distilled water. Calibration standards were prepared by dilution of the high purity commercial metal standard for atomic absorption analysis, metal measurement was performed with (Pye unicam SP9) Atomic Absorption Spectrophotometer, double beam and deuterium background correction. Measurement were done against metal standard solution.

RESULTS AND DISCUSSION

Essential metal (Zn, Fe, Cu, Cr, Co, Mn) and Heavy metal (Pb and Cd) analyses have been performed on 12 local spices and the outcome has been presented in (Table 2). The Values of metal concentration were compared with maximum permissible standard concentration of 50, 300, 20, 30, 50, 100, 10, 0.2 mg/kg respectively as recommended by WHO 2005.

The WHO limit of Zinc is not to be exceeded 50 mg/kg. However, the range of zinc was 6.1 mg/kg for fenugreek to 47.0 mg/kg for black seed (Fig. 1). It was very well below the limit and may be considered tolerable. A study in Nigeria on food however was showed relatively low levels of zinc 0.06 - 56.9 mg/kg (Oninwa *et al.*, 2001).

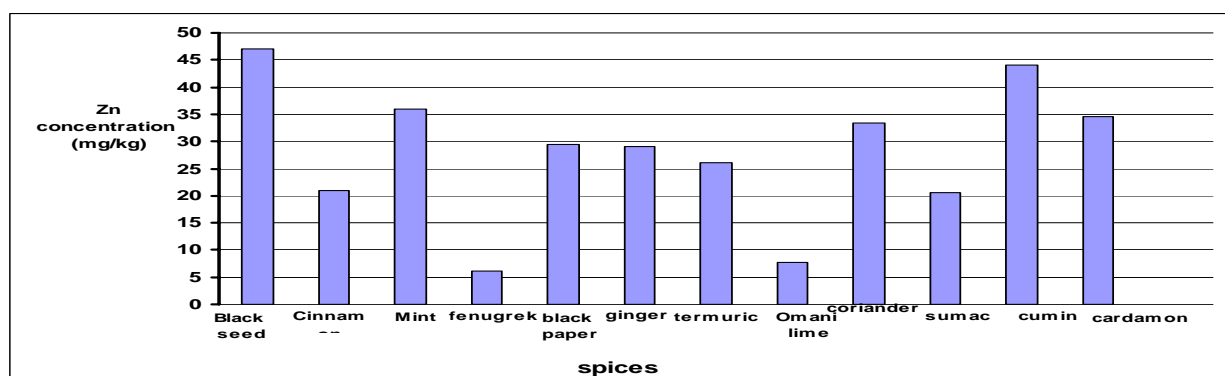


Fig. 1 : Levels of Zn in different spices

Iron has a relatively high WHO level in foods. As revealed by analytical results (Table 2) iron content of spices samples ranged between 56.0 mg/kg for cardamom and 650 mg/kg for mint (Fig. 2). Although there was a high content of iron in all the samples. Iron intake from spices has no effect on health.

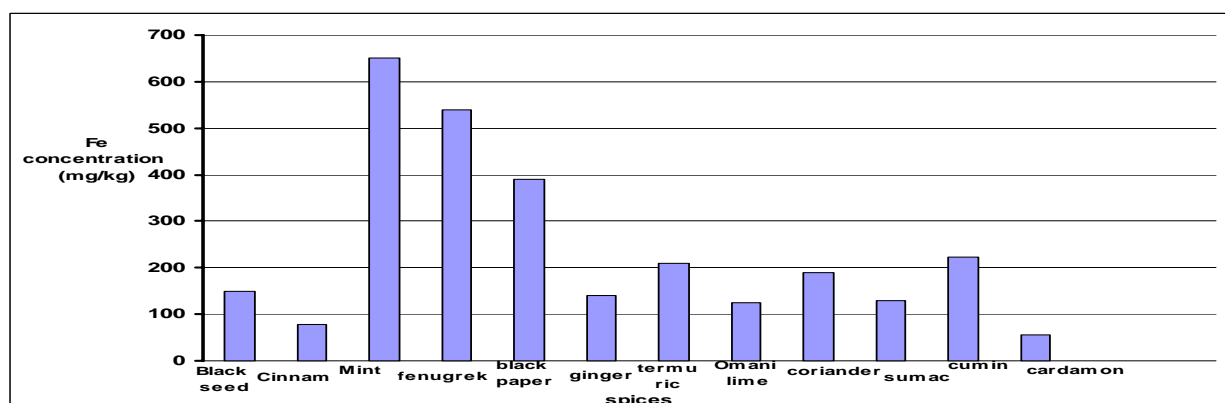
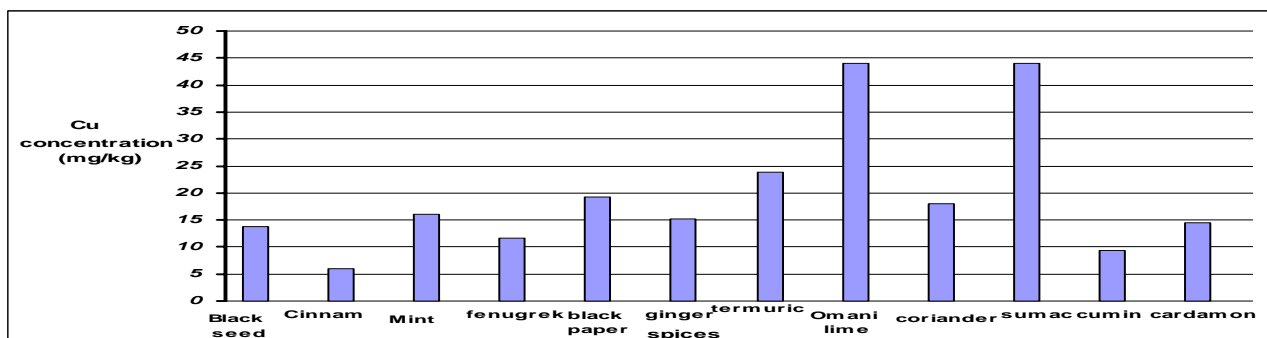


Fig. 2 : Levels of Iron in different spices

Table 2: Elements concentration (mg/kg) on dry weight basis of studied common spices.

Name of spices	Zn	Fe	Cu	Cr	Co	Mn	Pb	Cd
Black seed	47.0 ±2.1	150±1.0	13.7±0.24	10.5±1.0	15.3±1.2	45.0±1.2	2.1±0.1	0.156±7.6*10 ⁻³
Cinnamon	21±0.10	78.0±0.7	6.0±2.2	12.5± 0.1	11.1± 0.5	58.0±1.74	11.7±0.12	0.18± 0.02
Mint	36.0±0.86	650±1.9	16.0±1.6	22.5± 0.1	14± 0.4	45.0±0.3	6.6±1.2	0.05±0.1
Fenugreek	6.1±0.1	540±2.6	11.6±1.51	18.5± 0.2	8.5±0.1	73.0±1.34	14.6±1.31	0.033±0.034
Black paper	29.4±1.77	390±1.6	19.2±2.2	11.5± 0.53	9.5± 0.2	52± 2.2	3.8±1.99	0.046±0.02
Ginger	29.0±0.4	140±1.9	15.2±1.44	16.0± 0.1	8.6± 0.45	88.6±1.99	7.2±1.11	1.32± 0.022
Termuric	26.0±0.29	210.± 2.3	23.8± 2.1	16.0± 0.3	15.0±0.42	26.8± 1.43	3.9± 0.1	0.012± 0.01
Omani lime	7.7±2.1	125±1.8	44.0± 0.26	13.5±0.17	19.0±0.56	51.5±1.33	3.7± 0.14	0.019± 0.1
Coriander	33.4±2.2	190±0.93	18.0± 0.078	18.45± 0.11	26.2± .066	29.9± 2.1	4.1±0.13	0.061± 0.045
Sumac	20.5±0.51	130±0.67	44.0± 0.12	10.5± 0.15	5.0±0.21	26.0± 1.43	5.5± 0.17	0.045± 0.02
Cumin	44.0± 0.53	222.3± 1.6	9.3± 0.56	13.9±0.12	10± 0.43	26.9±1.57	2.2± 0.15	0.13± 0.055
Cardamon	34.5±0.32	56.0± 0.42	14.45±0.32	12.5± 0.16	15± 1.1	81.4± 0.71	1.25±0.1	0.14± 0.24

Copper content of spices samples ranged between 6.0 mg/kg for cinnamon to 44mg/kg, for sumac and Omani lime (Fig. 3). The Daily intake was much less than maximum permission limit. Copper intake from spices has no effect on health if it is taken in trace amount but can be toxic in high level.

**Fig. 3: Levels of copper in different spices**

In case of chromium highest mean concentration was found for mint leaf 22.5 mg/kg and lowest was for black seed, sumac 10.5mg/kg (Fig. 4). Chromium particularly Cr (III) plays an important role in the body function in trace amount but it is toxic in excess amount. Daily intake values were less than the maximum permission limit values and it is not a bright line for health risk.

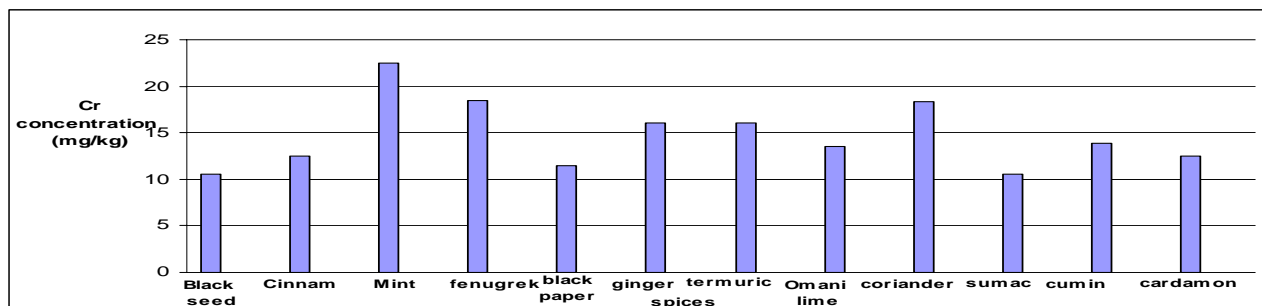


Fig. 4 : Levels of chromium present in different spices

In case of cobalt there was varied level in concentration for all samples ranging from 8.5mg/kg for fenugreek to 26.2mg/kg for coriander (Fig. 5). Daily intake values were found to be much lower than maximum permission level values so there is no effect on health due to cobalt intake, from spices. Although cobalt is toxic at elevated levels, however the body needs small amount of cobalt in the form of vitamin B12 which is in active physiological form (Weir *et al.*, 1999).

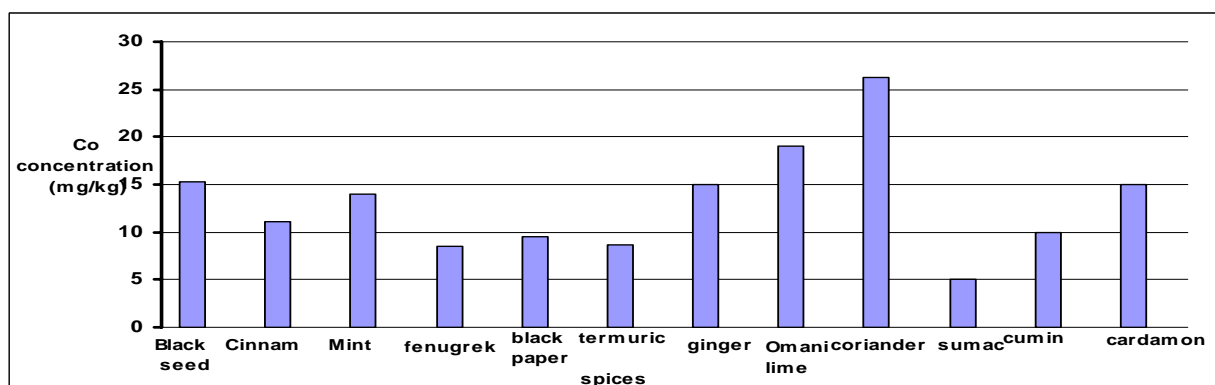


Fig. 5 : Levels of cobalt in different spices

In case of Manganese there was small variation in concentration for all the samples ranging from 26.0 mg/kg for sumac and 88.6mg/kg for ginger (Fig. 6). Daily intake were found lower than maximum permission level value.

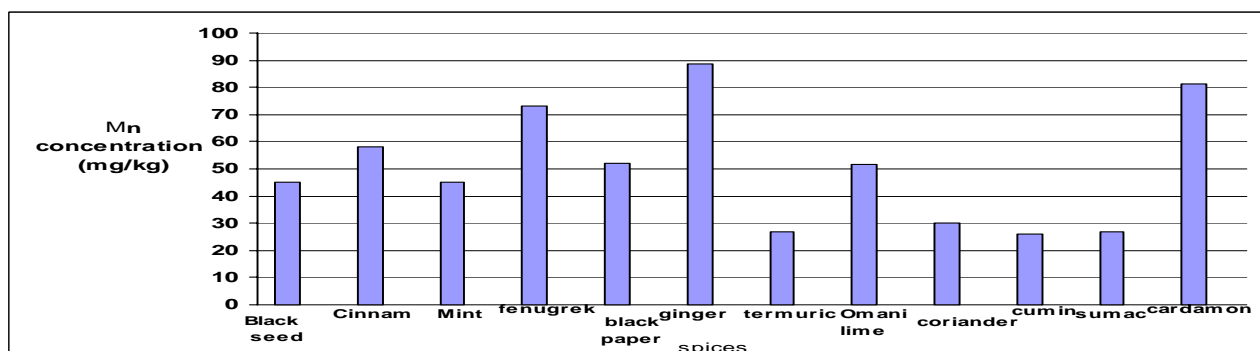


Fig. 6 : Levels of Manganese in different spices

Lead content in cinnamon and fenugreek have levels of 11.7 and 14.6 mg/kg respectively, which are marginally above the WHO limit of 10 mg/kg (Fig. 7). The

relatively high levels of lead might have resulted from accumulation of lead through air pollution, inclusion or absorption at the mill during grinding, and from some pesticides, such as lead arsenates, applied during cultivation. It means intake of spices under this study can cause lead accumulation in body. It has been reported to competitively inhibit lead uptake in cells (Loum *et al.*, 1991). Lead is a heavy metal poison which forms complexes with oxo-groups in enzymes to affect virtually all steps in the processes of hemoglobin synthesis and porphyrin metabolism (Ademorati, 1996). Toxic levels of lead in man have been associated with encephalopathy seizures and mental retardation (Schumann, 1990).

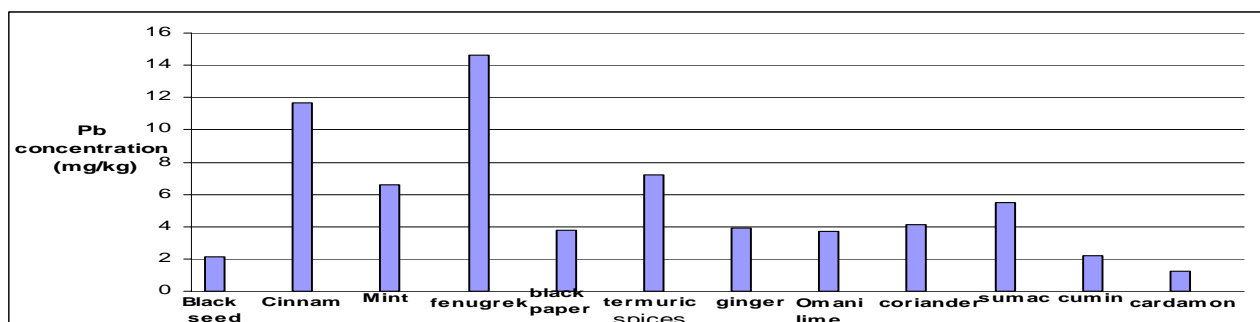


Fig.7 : Levels of lead in different spices

There was a little variation in case of cadmium. The concentration ranged between 0.012mg/kg for turmeric to 1.3mg/kg, for ginger (Fig. 8). The maximum permissible limit concentration (0.2 mg.kg^{-1}) of cadmium is referred by (FAO/WHO 1984). The high level of cadmium might be due to the use of cadmium-containing fertilizers or from the practice of growing this plant with sewage sludge or both, these result may agree with what reported by (Chizzola *et al.*, 2003).

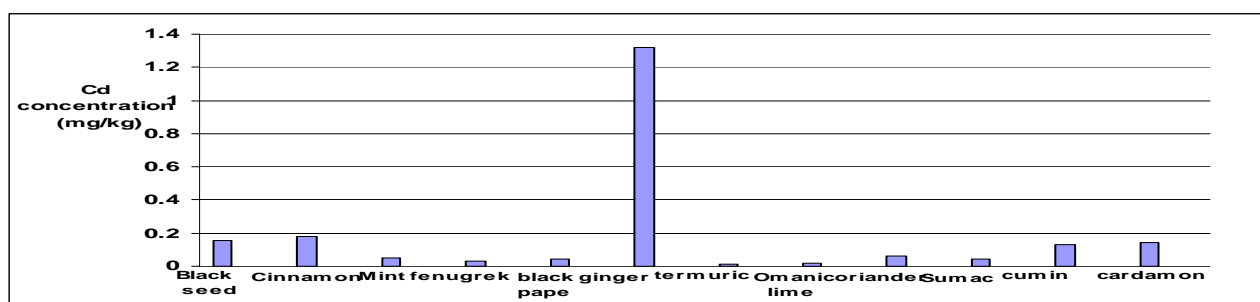


Fig. 8 : Levels of cadmium in different spice

CONCLUSION

The content of toxic metals in plant spices was generally found to be low, the analyzed sample was shown to be elevated in lead and cadmium respectively.

The highest content of lead and cadmium was shown in fenugreek, ginger and cinnamon. The contents of zinc, chromium, cobalt, and manganese in spices was relatively low and met the appropriate safety standard and was high at some range for iron and copper which has no effect on the health.

On the basis of results it can be concluded that the majority of the spices used in the Erbil are not contaminated with heavy metals except a few cases of cinnamon, ginger and fenugreek. Excessive use of these could therefore pose a health hazard to consumers.

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