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ASSESSMENT AND HEALTH RISK STUDY OF SOME HEAVY METALS IN INSTANT SOUP AND CHICKEN STOCK PRODUCTS FROM JORDANIAN MARKET

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ABSTRACT

As a result of different human activities in different industrial and agricultural fields, heavy metal toxicity increases day by day. Some of these metals pose a severe threat to the human body, even if these are present in low quantities. These metals are therefore, referred as human carcinogens according to the United States of Environmental Protection Agency (USEPA) because they damage the organs in the human body as a result of their non-degradable nature, ability to accumulate, and having prolonged biological half-lives. There are many routes through which toxic heavy metals can enter the human body, including polluted water and soil and dietary intake. New food products have been widely spread out such as instant soup noodle products which are manufactured from different types of vegetables and spices and subjected to industrial processes. As a result, contaminations by some heavy metals is possible. The objective of this study was to assess the content of Manganese (Mn), Chromium (Cr), Cadmium (Cd) and lead (Pb) in different branded chicken stock powder from Jordanian market. The analytical method was based on the digestion of different types of chicken stock samples prior to their Atomic Absorption Spectrometry analysis. The selected heavy metal concentrations ranged from 0.0407 to 1.08, 0.0211 to 0.592, 0.0134 to 0.0923 and 0.227 to 0.645 mg/kg for Mn, Cr, Cd and Pb, respectively. The maximum levels of Pb and Cd were detected in different brands of powdered soup products. The results found were within the accepted levels compared to food samples from reported research. In order to assess the health effects of the selected heavy metals, a scientific survey was performed on a group of people to assess the daily intake of the studied soup products. As a result, Health Risk Assessment (HRA) was evaluated from the estimated daily intake (EDI) of metals from the selected food samples. The obtained results showed that the selected food samples are quite safe and healthy according to the maximum recommended metal levels taken by humans.

Key words: Heavy metals, Food samples, Atomic absorption spectrometry, Soup, Health Risk

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INTRODUCTION

The assessment of heavy metals in the human diet is a critical subject because of their dual effect as either essential or toxic to the human body [1]. Highly toxic heavy metals such as Mercury (Hg), Lead (Pb), Cadmium (Cd) and Arsenic (As) are not supposed to be present in human food, they can cause several damages to many biological processes leading to kidney, bones, brain, nervous and cardiovascular problems [2]. Unfortunately, heavy metals enter food through different media such as: soil, irrigation water and materials used in food industries [3]. The presence of different heavy metals has been assessed in different food types using Atomic absorption spectrometry and Inductively Coupled Plasma (ICP) in food samples including: fruits and vegetables [4-8], potato chips and biscuits [9, 10] and chicken stock and noodles [11-13]. Moreover, some studies have shown elevated concentrations of such heavy metals in varieties of food products [14, 15].

Instant chicken soup products are composed of dehydrated vegetables, meat products and seasonings, which are subjected to contamination by different heavy metals and other organic contamination during poultry farming and feeding. Different factors that may increase the possibility of the elevation of concentrations of heavy metals in these products is the drying steps in preparation of powder that concentrate such toxic metals in the final products. As a result of the growing demand for different types of easy-to-cook foods such as chicken soup due to their low price and ease of preparation, it is important to monitor the amount of heavy metals to assess the risk to human health.

Different regulatory organizations such as: The Food and Agricultural Organization (FAO), World Health Organization (WHO) and US Environmental Protection Agency (USEPA) have established the maximum permitted concentrations of toxic heavy metals in foodstuffs [16]. Some work has been done on detection of some heavy metals in different types of noodles [17].

Heavy metals may contaminate food through soil, water and materials used during food processing. As a result, FDA recommend the continuous monitoring of toxic heavy metals in different food samples [18].

The current study was carried out due to the lack of data on levels of different heavy metals: (Mn), (Cr), (Cd) and (Pb) in some soup products, especially that there is no information about the toxic metals' concentration on the packaging labels. Moreover, the selected soup products have been widely used in different types of meals in kitchens or restaurants in Jordan because of their low price and

easy use of different types of meals. In addition, this study aimed to assess the health risks associated with the estimated personal consumption of the selected soup products consumed in Jordan.

MATERIALS AND METHODS

Sample Collection

A total of 10 samples of soup powder brands were purchased from some local markets in Jordan in 2020. For each sample, 5.0 grams of powder was weighed and prepared for further procedure.

Sample preparation and treatment

The method of sample treatment and analysis was according to the (AOAC) standard method [19] with some modifications. Samples we preheated in the oven for 24 hours to make sure that they dried enough at temperatures of (70-80) °c. Then samples were ground into fine powder, transferred into a crucible and weighed, after which samples were heated in the muffle furnace at (450 – 550) °c for 4 hours. The residual ash was dissolved in 2% HNO_3, the solutions were filtered using (Whatman 11.0 cm) to remove the solid residue (black ash).

The filtrate was filtered again using a syringe driven filter unit (0.2 µm) in 100 ml V.F. The filtrate was transferred and complete to the mark using 2% HNO_3 and a blank sample was made using 2% HNO_3. Using Atomic Absorption Spectrometry, the results of the percentage of heavy metals in the filtrates were obtained.

Samples (6-10) with rich oil and carbohydrate content were first washed with Diethyl ether before the dry-ashing step to avoid combustion.

Standards

Standards of heavy metals of the desired concentrations were prepared from 1000 mg/L stock solutions for each metal and diluted to 100 ml volumetric flask with 2 % nitric acid solution

Instrumentation

Heavy metals of interest were analyzed using Atomic Absorption Spectrometry (TRACE AI1200 model). Measurements were made using standard hollow cathode lamps for Mn, Cr, Cd and Pb. The limit of detection (LOD) for each element was calculated as the average standard deviation of the blank multiplied by three, (LOD) values ranged from 0.001 to 0.003 mg/kg for all the analyzed elements.

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The standard operating conditions for the analysis of heavy metals using atomic absorption spectrometry used in the experiments are given in Table 1.

RESULTS AND DISCUSSION

In this study, the heavy metals content of Mn, Cr, Cd and Pb in selected soup powder collected from different sites from the Jordan market were reported. The resultant amounts of Pb, Cd and Mn in the instant soup product were compared with the suggested limits as reported by the FAO/WHO in 1999.

The average concentrations (mg/Kg) using three triplicates, with the range of metals found in soup powder sampled from the local markets in Jordan are summarized in Table 2.

As shown in Table 2, the concentrations of Mn, Cr, Cd and Pb were observed in the range of 0.0492–1.080, 0.021–0.592, ND–0.0921 and ND-0.645 mg kg−1, respectively.

The sequence of concentration of metal ions as average concentration (mg kg−1) in all food formulations is as follows: Mn (0.364), Cr (0.2889), Pb (0.144), Cd (0.034).

The relatively high concentrations of manganese and chromium may be due to the initial content of these metals from raw materials of soup contents and from agricultural and industrial processing. The highest concentration of lead was found in Knorr chicken powder, which may be due to the widespread anthropogenic environmental air pollution of lead and its compounds.

The presence of cadmium was noticed in some samples although the concentration was below the accepted limit set by FAO/WHO for Cd. The maximum accepted limits according to WHO are (0.4, 1.3, 0.2 and 0.3 mg/Kg) for Mn, Cr, Cd and Pb, respectively.

Estimation of daily intake of metals (DIM)

For estimation of the average consumption of food soup samples, field survey data was needed.

In this survey, the mass of soup consumed by adults on a daily basis was evaluated, and the value obtained was 100 g on the average. The daily intake of each was calculated by multiplying the respective concentration in each food by

the food weight (100 g) and dividing the product by the body mass of a typical adult of 50 kg [20].

DIM values of selected toxic metals were computed by the use of the following formula:

$$DIM = CXD/B$$

The C, D and B are the values of the heavy metal concentration of the sample (mg/Kg), daily intake of food samples and average body weight of the person, respectively.

Health Risk Assessment (HRA)

In order to evaluate the risk of toxic heavy metals on human health, it is convenient to know the intake of these toxic metals. The health risk index (HRI) value is given from the following formula:

$$HRI = DIM/Rf_D$$

Rf_D is the oral reference dose or the daily intake (mg/Kg) [21]. These values were considered to be 0.004 and 0.001 (mg/Kg) for Pb and Cd, respectively according to ATSDR [22].

The data obtained is listed in Table 3 below.

The values of the Health Risk Index of highly toxic heavy metals (Cd and Pb) revealed that the levels of these metals are within the accepted limits according to ATSDR [23].

CONCLUSION

The chicken soup products chosen from the Jordanian market were analyzed for heavy metal content. The content of the selected metals was within the safe limits suggested by the WHO in 1999. This is an essential outcome since human health is directly affected by these products. Monitoring of heavy metals in these food products needs to be continued due to the increasing demand of such fast food products and bioaccumulation factor. Health risk assessment of the metals shows no risk fear of the selected foodstuff. It is recommended to investigate sources of pollution such as soil, water, raw materials and additives in order keep the amount

of heavy metals within the accepted limits. In addition, the analysis of heavy metals in human biological samples would be recommended.

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CONFLICT OF INTEREST

No conflict of interest was declared by the author.

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Table 1: Standard operating conditions for the analysis of heavy metals using atomic absorption spectrometry

Metals	Wavelength (nm)	Lamb Current (mA)	Slit width (mm)
Pb	283.3 12	5	0.2
Cd	228.8 6	5	0.2
Cr	357.9	10	0.2
Mn	279.5	5	0.2

Acetylene flow was 2.5 $Lmin^{-1}$ and air flow was 10 $Lmin^{-1}$ for all analysis

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Table 2: The concentration (mg/Kg) of heavy metals using atomic absorption spectrometry

Sample number	Brand name	Mn	Cr	Cd	Pb
1	Knorr powder (chickens tock)	0.135 ±0.083	0.451 ±0.173	0.037 ±0.065	0.645 ±0.047
2	Maggie (chicken stock)	0.134 ±0.082	0.297 ±0.213	0.0042 ±0.003	0.227 ±0.066
3	Zaghloul (chicken stock)	0.989 ±0.612	0.298 ±0.042	0.0384 ±0.002	0.228 ±0.017
4	Virgil (chicken stock)	0.336 ±0.342	0.281 ±0.342	0.0134 ±0.342	0.345 ±0.342
5	Chiqitov (chicken stock)	0.0492 ±0.032	0.393 ±0.151	0.0632 ±0.042	ND
6	Cream of mushroom	0.407 ±0.112	0.382 ±0.054	0.0923 ±0.042	ND
7	Instant noodles (chicken flavor)	0.327 ±0.254	0.592 ±0.318	0.0921 ±0.012	ND
8	Knorr(mushroom soup)	0.0735 ±0.040	0.111 ±0.017	ND	ND
9	Indomi noodles (chicken)	0.113 ±0.104	0.064 ±0.002	ND	ND
10	Indomi noodles (vegetable)	1.080 ±0.084	0.0211 ±0.005	ND	ND

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Table 3: The weekly intake and HRI of Cd and Pd

	Sample	Weekly intake (µg/Kg) body weight		Health Risk Index	
		Cd	Pb	Cd	Pb
1	Knorr powder (chicken stock)	0.150	4.52	0.021	0.161
2	Maggie (chicken stock)	0.029	1.59	0.0041	0.057
3	Zaghloul (chicken stock)	0.269	1.60	0.038	0.057
4	Virgil (chicken stock)	0.094	2.41	0.013	0.086
5	Chiqito (chicken stock)	0.091	ND	0.013	ND
6	Cream of mushroom	0.664	ND	0.095	ND
7	Instant noodles (chicken flavor)	0.654	ND	0.093	ND
8	Knor (mushroom soup)	0.777	ND	0.111	ND
9	Indomi noodles (chicken)	0.448	ND	0.064	ND
10	Indomi noodles (vegetable)	ND	ND	ND	ND

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