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Analysis of Trace Element & Heavy Metals in Common Spices marketed in Gurgaon, Haryana, India

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ABSTRACT

In present study, the concentrations of heavy metals such as Lead (Pb), Cadmium (Cd), Arsenic (As), Mercury (Hg, Copper (Cu), Nickel (Ni), Chromium (Cr), Zinc (Zn) and Iron (Fe) in 8 common spices (Turmeric, Cumin, Red chili, Coriander, Ginger, Garlic, Black Pepper & Cardamom) collected from the local markets in Gurgaon, Haryana, India were determined using inductively coupled plasma mass spectroscopy. The concentration of Pb, Cd, As, Hg, Cu, Ni, Cr, Zn and Fe ranged from ND-5.77 mg/kg, ND-1.23 mg/kg, ND-0.17 mg/kg, ND-0.14 mg/kg, ND-61.93 mg/kg, ND-32.9 mg/kg, ND-44.2 mg/kg, ND-35.53 mg/kg and ND-1386.7 mg/kg respectively, where the concentration of Pd, Cd, As, Cu & Zn were found above the standard limit approved by FSSAI, WHO & FAO. In this study, it is revealed that most of the spices available on the market are safe for human consumption as far as heavy metal levels are concerned.

Keywords: Heavy Metal, Spices, ICP-MS, ND (Not detected) & FSSAI (Food Safety Standard Authority of India)

I. INTRODUCTION

Since last ten years, the commoncontamination of heavy metals in food has become area of interest for research and study because of their essential and toxic nature [1]. The presence of basic metals like Copper, Iron and Zinc playsignificantlyrole for the sound development of the body however high levels are terrible and pose great threat to human and animal health. Even some metals like Lead, Cadmium etc. are toxic at very low concentrations [2]. Since these heavy metals might harm human health i.e. neurological disorders, growth retardation & immunological defense, substantial research is required to address this issue [4].Heavy metals beyond the acceptable limits affect the human health and may bring about sickness to human fetus, mental retardation in children and preterm labour [3].

Spices are dried parts of plants which have been utilized as diet components to enhance colour, smell and agreeableness of food [6]. The addition of spices contaminated with heavy metals to food as enhancer of taste may result in accumulation of these metals in human organs and may cause effect to health[9].

The main purpose of this study is to estimate the level of trace element and heavy metals (Pb, Cd, As, Hg, Cu, Ni, Cr, Zn and Fe) in common spices collected from the local markets of Gurgaon. Also, the level of investigated heavy metals was compared with the standard level approved by FSSAI, WHO & FAO.

II. METHODS AND MATERIAL

A. Sample Collection

Samples of 8 common spices (table 1) were collected from local markets in Gurgaon, Haryana, India during the Jan-April 2017. The spices were dried and powdered which were directly subjected to analysis.

All collected samples were analysed with quality control check (matrix blank) and recovery study were executed to verify the performance of instrument.

TABLE 1
Detail of Collected Different Spices

S. No.	Common Name	Scientific name	Family
1	Turmeric	*Curcuma longa*	*Zingiberaceae*
2	Cumin	*Cuminumcyminum*	*Apiaceae or Umbelliferae*
3	Red chili	*Capsicum*	*Solanaceae.*

		annuum	
4	Coriander	*Coriandrums ativum*	*Apiaceae or Umbelliferae*
5	Ginger	*Zingiberoffic inale*	*Zingiberaceae*
6	Garlic	*Allium sativum*	*Amaryllidaceae*
7	Black Pepper	*Piper nigrum*	*Piperaceae*
8	Cardamom	*Elettariacard amomum*	*Zingiberaceae*

B. Sample Preparation

All collected samples were carefully unwrapped and dried. 0.5 g sample was digested with 3:3 HNO3 /Milli Q water in Microwave Digester and then digested samplewas transferred into 50 mL tarsons and made up to mark with Milli Q water. This was subsequently done for all metal and mineral i.e. Pb, Cd, As, Hg, Cu, Ni, Cr, Zn and Fe by ICP-MS (Inductively coupled plasma mass spectroscopy). Standards were prepared by dilution of the high purity commercial metal standards analysis. Adequate quality assurance measures were carried out to ensure reliability of results. Glassware was properly cleaned and reagents (HNO3 and Milli Q water) were of analytical grade. Spikes and blanks were also introduced as QC check. Results reported are average of duplicates.

III. RESULTS AND DISCUSSION

The concentration of Pb, Cd, As, Hg, Cu, Ni, Cr, Zn and Fe in different spices collected from marketwere compared with specified permissible limit as per FSSAI (2011). As spices belong to a group of general foods so the levels of minerals and heavy metals were compared with the suitable safety standards which has determined the Maximum permissible Limit (MPL)

TABLE 2. Maximum Limit Values for Heavy Metals in Different Spices

S. No.	Name of Heavy Metal	Permissible Limit as per FSSAI(mg/kg)
1	Lead	2.5
2	Cadmium	0.1
3	Arsenic	0.1
4	Mercury	1.0
5	Copper	30.0
6	Nickel	-
7	Chromium	-
8	Zinc	25.0
9	Iron	-

TABLE 3. Heavy Metal concentration in different spices samples

S. No.	Spices Name	Pb	Cd	As	Hg	Cu
1	Turmeric	0.09-0.24	ND-0.01	0.01-0.03	ND	2.88-11.98
2	Cumin	0.13-0.23	0.04-0.05	0.09-0.17	0.13-0.14	7.47-10.05
3	Red chili	0.04-0.08	0.04-0.09	0.01-0.05	ND-0.06	6.52-7.53
4	Coriander	0.07-5.77	0.03-0.04	0.02-0.05	ND-0.02	10.36-11.98
5	Ginger	ND-0.01	ND-0.01	ND	ND-0.02	ND-0.69
6	Garlic	ND-0.09	0.00-1.23	ND	ND	ND-1.09
7	Black Pepper	ND-0.12	ND-0.01	ND-0.04	ND-0.01	0.00-61.93
8	Cardamom	ND-0.13	ND-0.04	ND-0.01	ND	ND-21.91

Results= Min-Max Value (mg/kg); ND= Not detected

TABLE 4. Heavy Metal concentration in different spices samples

S. No.	Spices Name	Ni	Cr	Zn	Fe
1	Turmeric	0.51-0.23	0.53-150	9.49-27.43	215-230
2	Cumin	1.23-32.9	1.05-44.2	34.43-35.53	183.03-1386.7
3	Red chili	0.56-1.69	0.49-1.22	9.11-12.51	53.19-354.16
4	Coriander	0.71-1.23	0.07-2.43	21.81-27.23	103.32-215.10
5	Ginger	ND-0.35	ND-0.04	ND-22.65	ND-0.43
6	Garlic	ND-0.11	ND-0.04	ND-4.10	ND-7.37
7	Black Pepper	ND-2.02	ND-0.69	ND-6.36	ND-90.18
8	Cardamom	ND-1.58	ND-1.23	ND-31.72	ND-78.74

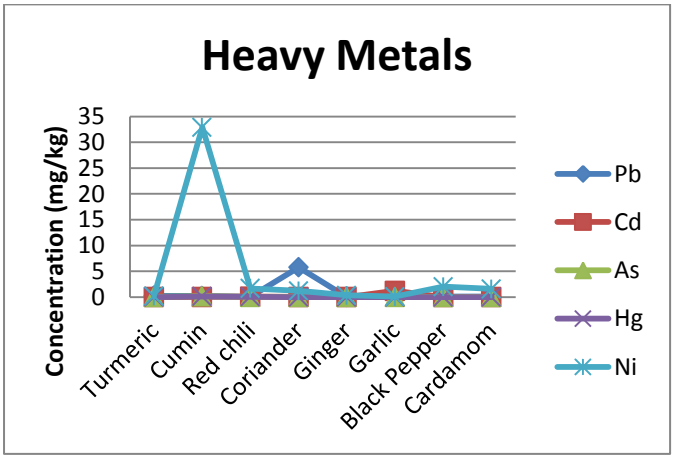

Figure 1: Maximum Concentration of Heavy Metals (Pb, Cd, As, Hg & Ni) in different spices samples.

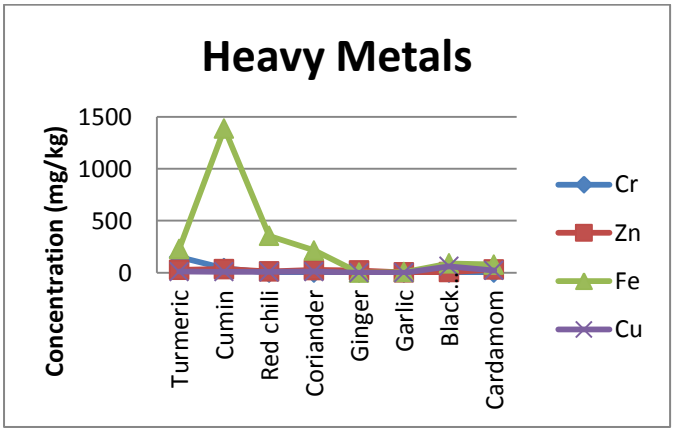

Figure 2: Maximum Concentration of Heavy Metals (Cr, Cu, Zn& Fe) in different spices samples.

Lead (Pb) – The concentration of lead contents in different spice samples are shown in table (Table 3). The maximum concentration of lead was found 0.24 mg/kg in turmeric, 0.23 mg/kg in Cumin, 0.08 mg/kg in red chili, 0.01 mg/kg in ginger, 0.09 mg/kg in Garlic, 0.12 mg/kg in black pepper and 0.13 mg/kg in cardamom. These values are below the MPL as recommended by FSSAI 2011 (as given in table 2) and can be considered as tolerable except 5.77 mg/kg in coriander. Lead is the most toxic environmental pollutant which reacts with many biomolecules and causes different disease adversely affecting reproductive, the nervous, renal, gastrointestinal, cardiovascular and immune system as well as many developmental processes [10]

Cadmium (Cd) – Cadmium has lethal effect even at a very low concentration and was known for having no functions in biochemical processes. Sources of its contamination include wastes from cadmium-based batteries, incinerators and runoff from agricultural soils where phosphate fertilizers are used since cadmium is a common impurity in phosphate fertilizers [11]. The concentration of Cd in all spice samples except garlic was found under the maximum permissible limit (0.1 mg/kg) as recommended by FSSAI 2011. The maximum concentration of cadmium were found as 0.01 mg/kg in turmeric, 0.05 mg/kg in Cumin, 0.09 mg/kg in red chili, 0.04 mg/kg in coriander, 0.01 mg/kg in ginger, 1.13 mg/kg in Garlic, 0.01 mg/kg in black pepper and 0.04 mg/kg in cardamom (Table 3).

Arsenic (As) - The maximum concentration of arsenic was found as 0.03 mg/kg in turmeric, 0.05 mg/kg in red chili, 0.05 mg/kg in coriander, ND in ginger, ND in Garlic, 0.04 mg/kg in black pepper and 0.01 mg/kg in cardamom (Table 3) which were within range recommended by FSSAI 2011, but 0.17 mg/kg in Cumin exceeded acceptable limit. The source of its high concentration includes the usage of certain fertilizers and pesticides. Higher concentration of Arsenic in food/spices can adversely affect lungs, liver, skin and bladder. Its lower concentration can affect and cause nausea, vomiting and even damage of the blood vessels.

Mercury (Hg) - As revealed by analysed results (see Table 3), mercury concentration in spices samples ranged from ND to 0.14 mg/kg. These values are below the maximum permissible limit as recommended by FSSAI (2011) and can be considered as tolerable.

Copper (Cu) - The copper concentration in tested 8 spices ranged from ND in ginger & garlic to 61.93 mg/kg in black pepper. The maximum permissible limit set by FSSAI (2011) in spices was 30 mg/kg which was only exceeded in case of black pepper. Rest all the spices contained Cu within the limit. However for spices, the permissible limits for copper set by China and Singapore were 20 ppm and 150 ppm respectively (WHO 2005). On one hand Cu plays a role in the oxidative defence system on the other hand at low concentrations, it causes nausea, vomiting, headache, and diarrhoea, and at higher levels of deposition, it leads to liver and kidney malfunctioning (USEPA, 1999).

Nickel (Ni) - Cumin showed maximum accumulation of 32.9 mg/kg, whereas garlic, ginger, black pepper & cardamom have minimum accumulation which was ND. As there is no permissible limit of Nickel particularly for spices as per FSSAI (2011) & WHO (2005), but the permissible limit set by FAO/WHO (2011) in edible

part was 1.63 mg/kg. All the above studied spices except turmeric accumulate Nickel above limit. Its toxicity is not very common occurrence and may cause health problem [7].

Chromium (Cr) - The concentration of chromium concentration in different spice samples are shown in table (Table 4). The maximum concentration of chromium was found as 150 mg/kg in turmeric, 44.2 mg/kg in Cumin, 1.23 mg/kg in red chili, 2.43 mg/kg in coriander, 0.04 mg/kg in ginger, 0.04 mg/kg in Garlic, 0.69 mg/kg in black pepper and 1.23 mg/kg in cardamom. There is no specified limit for chromium as per FSSAI (2011) but as experimentally found, its concentration is for health risk, So all the spices samples under study show source of Cr accumulation in body and are thus health hazards.

Zinc (Zn) – it is one of the essential trace elements for human and animals, but at low concentration zinc toxicity cause abdominal pain, nausea, vomiting and diarrhoea and at high concentration, it cause copper deficiency [13]. The maximum concentration of Zn was 35.53 mg/kg in cumin which was higher than permissible limit recommended by FSSAI (2011).

Iron (Fe) - As showed in Table 4, iron concentration in spices samples ranged between ND to 1386.7 mg/kg. There is no specified limit of Fe in particularly spices as per FSSAI (2011).it is an essential element, but Fe also aids the oxidation of carbohydrates, proteins and fat to control body weight which is an important factor in some diseases (diabetes) [8].

IV.CONCLUSION

It can be concluded on the basis of results that the majority of the spices marketed in local market of Gurgaon are not contaminated with heavy metals except a few cases as shown in Table 3& Table 4. As uptake of spices is very few grams per day, there are no harmful effects but excessive use of these could therefore pose a health hazard to consumers. It is also recommended to monitor spices samples regularly.

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