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Determination of Some Heavy Metals in Yemeni Green Coffee

Qais Abdullah Nogaim[1]; Sam Al-Dalali[2]; Abdu Al-Badany[3] ,Majed Farh[4]

Food Science and Technology Department, Ibb University, Yemen

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ABSTRACT
The present study aims to determine the occurrence of some heavy metals in 70 samples of Yemeni green coffee (Coffea Arabica L.), which were collected by Yemen Standardization Metrology and Quality Control Organization from many local markets in some Yemeni Governorates in 2010/2011. The analysis carried out in Ibb University Laboratories by using Atomic Absorption Spectroscopy (AAS), and the results could be summarized as the following:
The concentrations of heavy metals in this investigation such as Cadmium (Cd), Copper (Cu), Iron (Fe), Lead (Pb) and Zinc (Zn) as averages were 0.67, 11.29, 25.33, 2.07 and11.24 ppm, respectively.

Keywords: Yemen coffee, chemical contamination, heavy metals

INTRODUCTION

Heavy metal contamination of the food items is one of the most important aspects of food quality assurance. International and national regulations on food quality have lowered the maximum permissible levels of toxic metals in food items due to an increased awareness of the risk these metals pose to food chain contamination **(Radwan and Salama, 2006).** Heavy metals are non-biodegradable and persistent environmental contaminants, which may be deposited on the surfaces and then absorbed into the tissues of vegetables. Plants take up heavy metals by absorbing them from deposits on the parts of the plants exposed to the air from polluted environments as well as from contaminated soils **(Jassir *et al.*, 2005 and Sharma *et al.*, 2009).**The occurrence of high metals content in edible plants, is of considerable importance, since they might constitute a possible toxicological hazard. Heavy metals, when concentrated in living organisms should be regarded as toxins towards mammals and particularly humans. Accumulation of specific elements results mainly from pollution, and might, in some cases, constitute useful environmental markers, **(Michelot *et al.*, 1998).** Food safety is a major public concern worldwide. During the last decades, the increasing demand for food safety has stimulated research regarding the risk associated with consumption of foodstuffs contaminated by pesticides, heavy metals and/or toxins (D'Mello, 2003). So, this study aims to determine some heavy metals such as Cadmium (Cd), Copper (Cu), Iron (Fe), Lead (Pb) and Zinc (Zn) in 70 samples of Yemeni green coffee beans, because until now there are few studies on this toxic metals in coffee. Even though there are many studies on heavy metals in other food commodities especially vegetables in the world.

MATERIALS AND METHODS

Samples:
A total of 70 samples of Yemeni green coffee (*Coffea Arabica* L.), were collected by Yemen Standardization Metrology and Quality Control Organization from many local markets in some Yemeni Governorates during 2010/2011.

Methods:
The heavy metals in this investigation were determined according to the standard method of **A.O.A.C. (2005),** by using Atomic Absorption Spectroscopy (AAS), NOVA 300 made by NOVA Company (USA).

Statistical analysis:
All the samples analyses in this study were carried out in triplicate and the results were reported as mean values. The obtained data were subjected to statistical analysis and the average, compared by Microsoft Excel statistical software (Microsoft Office Excel 2003, Microsoft Corp., Redmond, WA, USA).

RESULTS AND DISCUSSION

The soil is the primary recipient of these contaminants from where they enter the plants and then, the food chain. The most serious of these contaminants are the non-biodegradable heavy metals, with long biological half lives. They can accumulate over time within the body organs and constitute serious disruption to normal body function.

Table (1): Determination of Some Heavy metals in Yemeni Green Coffee Beans Samples*:

Samples	(Cd) ppm	(Cu) ppm	(Fe) ppm	(Pb) ppm	(Zn) ppm
1	0.026	10.38	46.49	1.62	15.16
2	0.052	3.71	59.99	1.29	10.09
3	0.057	21.55	52.18	1.57	14.79
4	0.067	17.41	25.83	1.41	46.89
5	0.083	14.61	22.85	1.24	12.39
6	0.103	18.46	64.08	1.69	10.47
7	0.104	13.11	51.48	1.77	41.36
8	0.174	14.21	32.15	1.73	10.18
9	0.171	22.74	53.64	1.58	37.55
10	0.155	6.97	45.33	1.64	7.52
11	0.227	13.66	36.91	1.74	19.75
12	0.239	10.82	32.64	1.32	9.41
13	0.194	13.24	25.22	1.39	8.17
14	0.194	13.76	42.74	1.05	6.97
15	0.075	96.24	82.73	1.63	9.24
16	0.211	7.66	69.86	1.48	10.45
17	0.113	16.61	76.77	1.38	7.31
18	0.182	30.06	68.43	1.81	12.61
19	0.174	13.83	33.11	1.68	7.79

20	0.058	18.43	30.11	1.36	7.65
21	0.061	9.05	27.18	1.31	7.51
22	0.309	51.74	87.71	1.66	8.52
23	0.068	27.59	48.74	1.46	13.28
24	0.108	85.42	54.99	1.51	9.16
25	0.071	6.41	42.57	1.36	8.49
26	0.079	9.02	33.06	1.46	7.11
27	0.290	9.65	15.34	1.74	8.45
28	0.181	8.85	23.64	1.33	7.73
29	0.512	10.46	22.35	1.12	6.91
30	0.610	9.89	21.12	1.87	9.42
31	0.443	9.59	19.47	1.99	10.53
32	0.212	9.52	20.17	1.66	8.19
33	0.920	9.61	20.11	1.15	9.67
34	0.881	10.24	22.91	1.31	7.39
35	0.643	10.32	24.36	1.55	6.88
36	0.96	4.894	7.86	1.5	11.73
37	1.43	5.324	9.22	2.38	12.32
38	1.09	4.93	1.33	1.557	11.88
39	1.64	5.013	5.93	2.415	11.9
40	1.66	1.981	15.37	2.437	4.9
41	1.65	1.873	3.33	3.267	4.871
42	1.23	3.559	3.43	1.799	9.9
43	1.52	2.998	7.65	6.779	8.99
44	1.05	3.012	6.58	7.989	8.87
45	0.01	3.019	5.76	1.25	8.91
46	0.88	5.288	5.58	1.765	11.95
47	0.59	5.013	5.26	2.216	11.87
48	1.35	5.031	12.01	2.178	11.72
49	1.2	5.039	12.64	6.109	11.63
50	1.26	4.19	12.85	1.97	12.18
51	0.35	4.819	13.46	1.657	11.25
52	1.2	8.217	6.96	1.5	15.34
53	1.1	3.93	10.03	2.46	10.53
54	1.54	3.664	8.16	4.125	9.07
55	0.88	3.891	13.39	0.599	9.98
56	1.47	4.922	8.38	1.478	11.06
57	0.77	3.989	6.49	1.439	9.39
58	1.07	5.34	28.01	1.859	11.81
59	0.84	1.329	7.82	5.694	6.57
60	1.5	1.382	18.04	1.884	6.78
61	0.84	3.71	4.22	2.049	3.82
62	1.24	5.9	4.36	1.987	3.74
63	0.64	1.93	13.71	4.21	5.67
64	1.38	2.839	24.47	1.152	10.02
65	1.34	2.453	17.25	5.79	9.9
66	0.44	3.104	8.29	2.028	9.32
67	1.37	3.089	13.65	0.83	11.94

68	**0.65**	**3.512**	**5.4**	**2.19**	**14.98**
69	**1.46**	**2.819**	**5.54**	**2.49**	**9.37**
70	**1.49**	**3.711**	**4.21**	**0.817**	**17.42**

*** Samples are 70 and the results were triplicates for each sample.**

Data in Table (1) represented the determination of some heavy metals in Yemeni green coffee beans samples, the result showed that, Zinc concentration (Zn) ranged between 3.74 to 46.89 ppm and the average was 11.24 ppm, meanwhile Copper concentration (Cu) ranged between 1.33 to 96.24 ppm and the average was 11.29 ppm. On the other hand Cadmium concentration (Cd) ranged between 0.01 to 1.66 ppm and the average was 0.67 ppm, whereas Lead Concentration (Pb) ranged between 0.60 to 7.99 ppm and the average was 2.07 ppm. Finally Iron concentration (Fe) ranged between 1.33 to 87.71 ppm and the average was 25.33 ppm. These heavy metals enter the soil through variety of sources which include urban, industrial aerosols created by combustion of fuels, metal smelting and other industrial activities, of significant in mechanic workshops are the wastes from overused engine oils, petrol, motor batteries, paints that are indiscriminately disposed therein. The major concern with the uptake of these contaminants by plants is their presence in plant produce consumed by humans.

US Environmental Protection Agency (US EPA), Joint FAO/WHO Expert Committee on Food Additives (JECFA) and Institute of Medicine of the National Academies (IOM) have provided guidelines on the intake of trace elements by humans. The IOM of the National Academies recommended the adequate intake (AI) and the tolerable upper intake level (UL) values for some essential elements, the JECFA recommended permissible tolerable weekly intakes (PTWIs) and acceptable daily intakes as guidelines for food additives and certain contaminants in foods. Also, the US EPA provided reference dose (RfDo) values in µg/kg body wt/day for some elements. The objective of these regulations were to protect human health and natural resources from toxicity of these heavy metals.

Human health risk assessment integrates information on environmental chemistry and toxicology of the metals of interest with estimates of product application rates and human exposures. Cadmium is reported as very dangerous causing kidney damage, cancer, diarrhea, and vomiting. Chromium can cause kidney and liver damage, alteration of genetic materials and lung cancer, skin rashes, stomach upset and ulcers, respiratory problems and weakening of the immune system. Lead is very harmful even at very low concentrations damaging the nervous system, bone, liver, pancreases, teeth, gum. Emissions of heavy metals from the industries and vehicles may be deposited on the vegetable surfaces during their production, transport and marketing. **Jassir *et al.,* (2005)** have reported elevated levels of heavy metals in vegetables sold in the markets at Riyadh city in Saudi Arabia due to atmospheric deposition. It is therefore suggested that regular monitoring of heavy metals in vegetables and other food items should be performed in order to prevent excessive buildup of these heavy metals in the human food chain. Appropriate precautions should also be taken at the time of transportation and marketing of vegetables, (**Sharma *et al.,* 2009**). Wastewater may contain various heavy metals including Zn, Cu, Pb, Mn, Ni, Cr and Cd depending upon the type of activities it is associated with. Industrial or municipal wastewater is mostly used for the irrigation of crops, mainly in peri-urban ecosystem, due to its easy availability, disposal problems and scarcity of fresh water. Heavy metals are generally not removed even after the treatment of wastewater at sewage treatment plants, and thus cause risk of heavy metal contamination of the soil and subsequently to the food chain (**Fytianos *et al.,* 2001**). In the individual metals exhibit specific signs of their toxicity, we can briefly summarize the environmental chemistry and toxicology of many heavy metals such as arsenic, cadmium, lead, mercury, and nickel. Short term responses to large doses (acute toxicity) are not relevant to the risk assessments of interest here, so discussion focuses on long-term exposure to low concentrations (chronic toxicity).

Cadmium tends to be more mobile in soil systems and therefore more available to plants than many other heavy metals. Chronic cadmium exposures result in kidney damage, bone deformities, and cardiovascular problems **(Goyer and Clarkson, 2001)**. A major human poisoning occurred in Japan during World War II due to industrial contamination of rice paddies. Chemical contamination from sources such as industries, vehicles and pesticides can affect the safety of food.

Heavy metals are one of a range of important types of contaminants that can be found on the surface and in the tissue of fresh vegetables. These metals are cofactor of large number of enzymes. For these essential metals there is a range of intake over which their supply is adequate to the body (Fe 8-18 mg/ day, Mn 1.8-2.3 mg/day, Cu 0.9 mg/day, Zn 8-11 mg/ day, Ni 0.5 mg/day). A high supplementation of Fe and Mn causes pathological events such as the iron oxides deposition in Parkinson's disease. Cu surplus had been associated with liver damage and Zn may produce adverse nutrient interactions with Cu. Also, Zn reduces immune function and the levels of high density lipoproteins. Other metals like Pb and Cd are toxic even at low concentration. Pb is known to induce renal tumours, reduce cognitive development, and increase blood pressure and cardiovascular diseases risk for adults and Cd may induce kidney dysfunctions, osteomalacia and reproductive deficiencies.

CONCLUSION

These results demonstrate clearly that, the heavy metals concentration in Yemeni neutral green coffee samples are very dangerous indicator for the consumers health.

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