International Journal of Biological Innovations

Available online: http://ijbi.org.in | http://www.gesa.org.in/journals.php

DOI: https://doi.org/10.46505/IJBI.2020.2222

Research Article

E-ISSN: 2582-1032

HEALTH RISK ASSESSMENT OF HEAVY METALS FOR POPULATION VIA CONSUMPTION OF PULSES AND CEREALS

Muzaffar Ahmad Mir[1], Sandeep Arya[1*] and A. M. Kak[2]

[1]Institute of Environment and Development Studies,
Bundelkhand University, Jhansi (U.P.), India
[2]Islamic Colleges of Science and Commerce, Srinagar (J & K), India
**Corresponding author*: drsanarya@rediffmail.com

Received: 25.08.2020 **Accepted:** 30.09.2020 **Published:** 07.10.2020

Abstract: Plants absorb a number of elements from the soil, some of which have no biological significance while some are biologically toxic even at low concentration. The objective of present study was to assess the concentration of heavy metals (Fe, Cu, Zn, Cd, Hg, Ni and Pb) in edible cereals like multi colored rajma, white rajma, red rajma, red moong, white beans, black beans, local rice, mustard (oil yielding crop), white moong and wheat grown in the farmlands of Ganderbal and Srinagar district of Kashmir. The maximum concentration of heavy metals *i.e.* iron 4.73±0.02 ppm in red moong, copper 0.86±0.02 ppm in white beans, zinc 0.092±0.02 ppm in black beans, cadmium 0.03±0.01 ppm white rajma and black beans, mercury 0.32±0.01 ppm in white beans, nickel 1.33±0.02 ppm in multi colored rajma and lead 0.16±0.06 ppm in local rice were recorded. The results revealed that heavy metal concentrations were under the acceptable limits of WHO and FAO standards, hence it can be concluded that edible pulses and cereals that are growing in Ganderbal and Srinagar are not dangerous for human consumption.

Keywords: Heavy metals, Kashmir, Pulses, Rice, Soil, Wheat.

INTRODUCTION

Contamination of heavy metals is a major problem in an environment, which is also chief contaminating agents of our food supply (Khairy, 2009). The biological and geochemical cycles are also concerned with heavy metal concentrations in soil which are inclined by anthropogenic activities *i.e.* agricultural practices, industrial activities and waste disposal methods (Eja *et al.*, 2003). Waste water irrigation is known to contribute significantly to the heavy metal contents of soil (Mapanda *et al.*, 2005). Although problems occur in water ways when pollutants are leached out of the soil. If the plant dies and decay, heavy metals reabsorbed by other plants consequently the soil is enriched with the pollutants. The heavy elements are absorbed from the soil and accumulated in plants by roots and foliar surface (Sawidis *et al.*, 2001). The assimilation of metals in the soil depends upon different factors such as soil pH, types of species, plants growth stages, fertilizers and soil and their soluble content in soil (Sharma *et al*., 2006) but metal toxicity mostly depends on plant species as they show significant genetic variations in ability to tolerate amounts and the concentration of specific heavy metals (Vojtechova and Leblova, 1991). The level of accumulation of elements differs between and within species (McGrath *et al*., 2002). The solid wastes have a negative impact on environment and public health (Verma and Prakash, 2020).

Some heavy metals are essential micro nutrients for plants (Claire *et al*., 1991) but when their accumulation exceed the permissible limit it exerts toxic hazards and may produce variety of diseases in human, plants and animals (Irshad and Jan, 1997). Heavy metals are enormously persistent in the environment which is non-biodegradable and non thermo degradable and thus their accumulation readily influences to toxic levels. The biotoxic effects of heavy metals depend upon the concentration and oxidation state of heavy metals, kind of sources and mode of deposition (Bohn *et al.*, 1985). The increasing rate of heavy metal toxicity as well as food safety demand has drawn the attention to the risk associated with consumption of contaminated food stuffs. The present work deals with the quantification of heavy metal concentration in some selected species of pulses and cereals grown in agricultural fields of Srinagar and Ganderbal district of J & K, India.

MATERIALS AND METHODS

Study Area

Agricultural fields of Ganderbal and Srinagar districts were selected as sampling sites in present study. District Ganderbal is located at an elevation of $34^0$14'N- $74^0$47'E and Srinagar at $34^0$5'N-$74^0$47'E elevation. In this area, canal water is used for irrigation purpose in which municipal waste is also dumped at some points.

Sample Collection

A total of thirty samples (10 samples of seeds and grains with its three replicates) from cereal crops like Rajma multi colored, White Rajma, Red Rajma, Red Moong, White Beans, Black Beans, Local Rice, Mustard, White Moong and wheat of given area were collected randomly to estimate the heavy metals (Fe, Cu, Zn, Cd, Hg, Ni and Pb) concentration. Samples were collected during the year 2010-2011.

Sample Preparation

The known weight of each sample was dried up to 105^0C temperature, followed by crushed into powder form. The resultant powder is mixed with boric acid forming base while sample remains on upper side the amalgam is then pressed under 5 tons pressure for 30 seconds using in smart system machine this whole process is called Plating.

Analysis through XRF Spectrometer

Fluorescence Spectrometers are designed to measure samples that are circular disks with a radius between 5 and 50 mm. The sample is placed in a cup, and the cup is placed in the spectrometer.

RESULTS AND DISCUSSION

The determination of trace elements in cereal samples is of interest because of nutritional and toxicological reasons. In this study the concentration of iron, copper, zinc, cadmium, mercury, nickel and lead were measured in the selected cereal crops and results are presented in table-1 and figure-1.

Iron is an essential element for living organisms, because of its importance in major biological mechanisms such as electron transport, nitrogen fixation and DNA synthesis. In plants, iron deficiency causes a series of biochemical lesions which mainly affect the photosynthetic apparatus, leading to the syndrome of chlorosis (Laulhere and Briat, 1993). The present study reports the iron concentration in red rajmais1.69$\pm$0.06 ppm, in white rajma 2.51$\pm$0.03 ppm, in red rajma 4.08$\pm$0.05 ppm, in red moong 4.73$\pm$0.02 ppm, in white beans 3.17$\pm$0.02 ppm, in black beans 2.08$\pm$0.01, in local rice 1.34$\pm$0.02 ppm, in mustard 1.13$\pm$0.02 ppm, in white moong 1.06$\pm$0.01 ppm and in wheat 3.74$\pm$0.02 ppm.

Copper is an essential element because it is involved in a number of physiological processes such as the photosynthetic and respiratory electron transport chains and as a cofactor or as a

Table 1: Exposure of heavy metals accumulation in different edible pulses and cereals.

Sr. No.	Local Name	Fe (ppm)	Cu (ppm)	Zn (ppm)	Cd (ppm)	Hg (ppm)	Ni (ppm)	Pb (ppm)
1	Rajma Multicoloured	1.69+0.06	0.43+0.01	0.31+0.04	0.02+0.01	0.23+0.02	1.33+0.02	Nil
2	White Rajma	2.51+0.03	0.23+0.02	0.32+0.02	0.03+0.01	Nil	1.20+0.02	Nil
3	Red Rajma	4.08+0.05	0.51+0.02	0.27+0.02	Nil	0.18+0.02	1.07+0.06	Nil
4	Red Moong	4.73+0.02	0.73+0.02	0.32+0.02	Nil	Nil	0.14+0.02	Nil
5	White Beans	3.17+0.02	0.86+0.02	0.13+0.02	Nil	0.32+0.01	0.18+0.02	Nil
6	Black Beans	2.08+0.01	0.85+0.02	0.92+0.02	0.03+0.01	0.25+0.03	0.27+0.02	Nil
7	Local Rice	1.34+0.02	0.08+0.01	0.18+0.02	Nil	Nil	Nil	0.16+0.06
8	Mustard	1.13+0.02	0.57+0.03	0.13+0.02	Nil	0.23+0.03	Nil	0.12+0.01
9	White Moong	1.06+0.01	0.30+0.44	0.15+0.04	Nil	0.17+0.02	0.94+0.02	Nil
10	Wheat	3.74+0.02	0.21+0.01	0.14+0.02	Nil	Nil	Nil	Nil

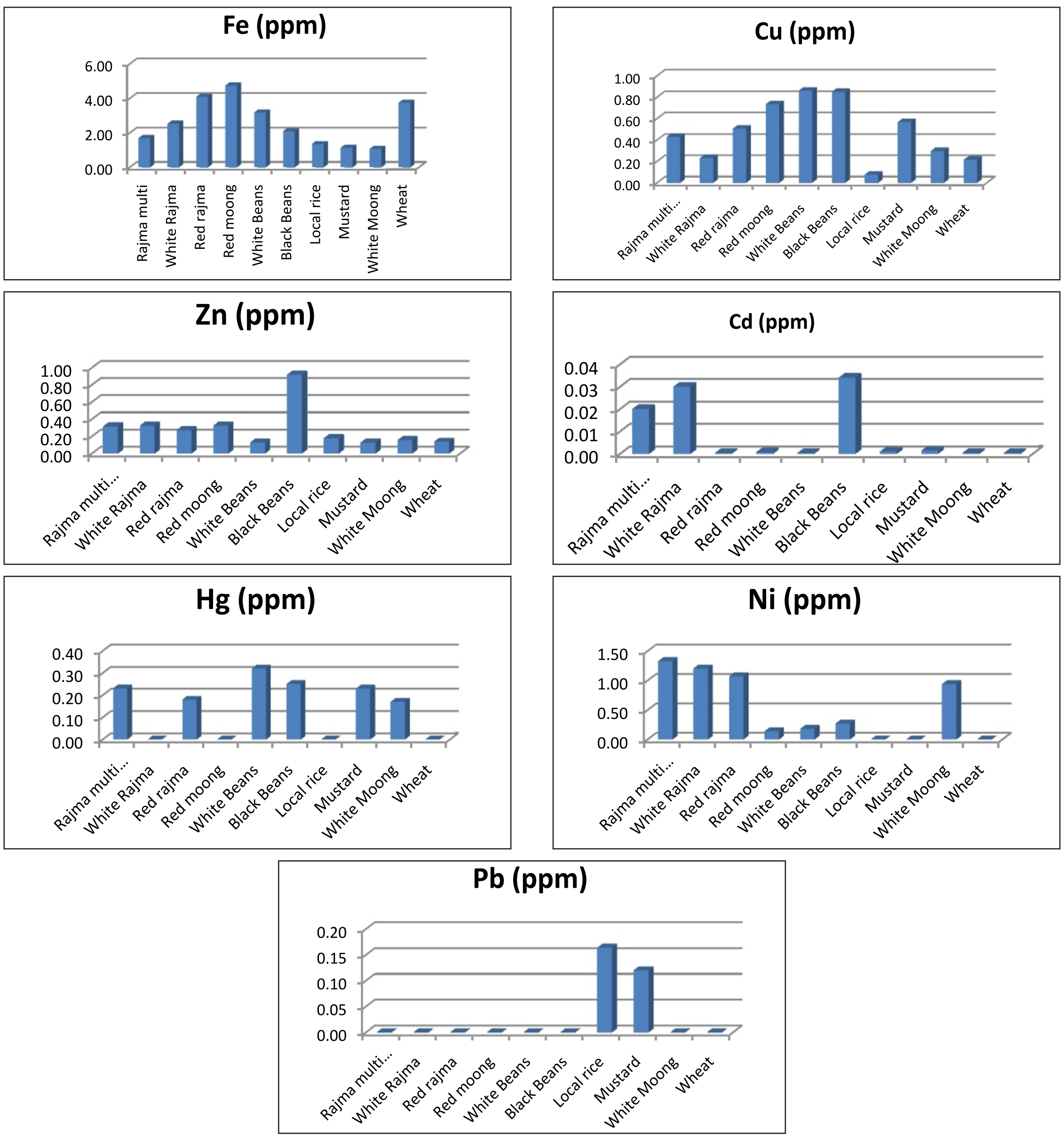

Fig 1: Concentrations of different heavy metals in different edible pulses and cereals.

part of the prosthetic group of many key enzymes involved in different metabolic pathways, including ATP synthesis (Harrison *et al*., 1999).The concentration of copper is found as 0.43±0.01 ppm in rajma multi colored, 0.23±0.02 ppm in white rajma, 0.51±0.02 ppm in red rajma, 0.73±0.02 ppm in red moong, 0.860±.02 ppm in white beans, 0.85±0.02 ppm in black beans, 0.080±0.01 ppm in local rice, 0.57±0.03 ppm in mustard, 0.30±0.44 ppm in white moong and 0.210±0.01 ppm in wheat.

Zinc is an important limiting factor in sustainable crop production in deficit soils (Rengel and Graham, 1995) and important element for some biochemical processes *i.e.* cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation and membrane integrity (Bennett, 1993). In present study, Zn concentration is reported as 0.31±0.04 ppm in multi colored rajma, 0.32±0.02 ppm in white rajma, 0.27±0.02 ppm in red rajma, 0.32±0.02 ppm in red moong, 0.13±0.02 ppm in white beans, 0.92±0.02 ppm in black beans, 0.18±0.02 in local rice, 0.13±0.02 in mustard, 0.15±0.04 in white moong and 0.14±0.02 in wheat.

Harmful effects caused by cadmium might be explained by its ability to inactivate enzymes possibly through reaction with the SH-groups of protein (Furher, 1982). Detrimental effects are manifested in inhibition of photosynthesis and in oxidative stress leading to membrane damage (Prasad, 1995).Concentration of cadmium in selected crops was found 0.02±0.01 in rajma multicolored, 0.03±0.01 in white rajma and black beans. Red rajma, red moong, white beans, local rice, mustard, white moong and wheat shows absence of cadmium.

Mercury contamination has been one of major current interest because of environmental pollution on world level. Mercury is strong phytotoxic as well as genotoxic metal (Suszeynsky and Shann, 1995). Abscission of older leaves, growth reduction and deceased vigor inhibition of roots and leaf development, decreased chlorophyll content and nitrate reductase activity can be traced as toxic effect of mercury in plants (Vyas and Puranik, 1993). Other adverse effect caused by excessive mercury includes membrane structure integrity disruption (Cho and Park, 2000). The concentration of mercury was found as 0.23±0.02 (rajma multi colored), 0.18±0.02 (red rajma), 0.32±0.01 (white beans), 0.25±0.03 (black beans), 0.23±0.03 (mustard) and 0.17±0.02(white moong) and it was absent in white rajma, red moong, local rice and wheat.

Phyto toxicity varies with the concentration of nickel in soil solution as well as with the plant species (Mizuno, 1968). Nickel when applied in excess is believed to interfere with iron uptake and metabolism causing chlorosis and necrosis (Abdel *et al*., 1988).The concentration of nickel was recorded 1.33±0.02 in rajma multi colored, 1.20±0.02 in white rajma, 1.07±0.06 in red rajma, 0.14±0.02 in red moong, 0.18±0.02 in white beans, 0.27±0.02 in black beans and 0.94±0.02 in white moong. The nickel was not found in local rice, mustard and wheat.

This has been also observed in some cases that lead is not counted as crucial nutrient for plants, majority of lead is easily absorbed by plants from the soil and deposited in roots while only a small segment was translocated upward to the shoots (Patra *et al*., 2004). In selected cereal crops lead is reported absent except in local rice and mustard. Local rice has the concentration of lead is 0.16±0.06 ppm and mustard have 0.12±0.01 ppm. The effect of lead depends on concentration, type of soil, soil properties and plant species. Lead toxicity leads to decreases germination percent, length and dry mass of root and shoots (Munzuroglu and Geckil, 2002) disturbed mineral nutrition (Paivoke, 2002) reduction in cell division.

The highest concentration of iron was observed in red moong (4.73±0.02ppm) and lowest in white moong (1.06±0.01 ppm), In case of copper, maximum concentration of copper was found (Eun *et al*., 2000) in white beans (0.86±0.02 ppm) and minimum in local rice (0.08±0.01 ppm), across the result, zinc was found to be maximum in black beans (0.92±0.02 ppm) and minimum in white beans (0.13±0.02 ppm), meanwhile in case of cadmium, it was found highest in white rajma and black beans i.e. (0.03±0.01 ppm) and lowest in rajma multi colored (0.02±0.01 ppm), however, mercury was maximum in white beans (0.32±0.01 ppm) and minimum in white moong (0.17±0.02 ppm) meanwhile in case of nickel highest concentration was found in multi colored rajma (1.33±0.02 ppm) and minimum in red moong (0.14±0.02 ppm) lastly, In case of lead maximum was found in local rice (0.16±0.06 ppm) and nil in multi colored rajma, white rajma, red rajma, red moong, white beans, black beans, white moong and mustard.

CONCLUSION

The entire observations of the study might be concluded as the foods growing in the study area are not dangerous for human consumption because of low concentration of heavy metals. Present study reveals that heavy metals concentration is within acceptable limits of WHO/FAO standards. The results from this study also reveals that significant difference exist in elemental concentration among the edible foods analyzed that might be in due part to the geological status of the area under investigation and the ability of plants and their specific parts to accumulate metal as well. Further research is needed to find out variation in metal uptake by different edible species and the site-specific risk assessment guidelines to highlight and to minimize the potential health risks of ingesting edible food crops, containing high levels of heavy metals. Lastly, it is recommended that consistent survey of heavy metals should be made on all food commodities in directive to eradicate any health risk from heavy metal exposure to assure food safety and to protect the end user from food that might ignore their health.

ACKNOWLEDGEMENTS

The authors are thankful to Institute of Environment and Development Studies, Bundelkhand University Jhansi (UP) and Department of Botany, Islamic College of Science and Commerce, Srinagar (Jammu and Kashmir), India for providing the laboratory facilities.

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