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Heavy metal contamination in wheat and rice grains of Ranchi, Jharkhand

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Abstract- The detection of heavy metals in cereals is of vital significance, due to their toxicity and adverse effect on human health. Industrial effluents, municipal sewage water, and agricultural runoff all have a substantial short- and long-term impact on the water quality, which is used for irrigation. A study was conducted to ascertain the amounts of several trace heavy metals contained in regularly consumed grains like wheat and rice of two villages of Ratu and Mandar in Ranchi, Jharkhand in order to examine the heavy metals like Lead, Cadmium, Mercury, Copper quantities and impact of those metals on human health. All the samples were analysed using atomic absorption spectrophotometer. The concentration of heavy metals in analysed samples were found within permissible limit suggested by Food Safety and Standards Authority of India (FSSAI). The average concentration of heavy metals in Wheat grains found to be in order of Cu>Cd>Hg>Pb. The average concentration of Rice grains in order of Hg>Cu>Pb>Cd.

Key words: Heavy metals, Cereals, Atomic Absorption Spectrophotometer, Food Safety and Standards Authority of India

INTRODUCTION

Cereals are the most widely consumed foods and a major source of nutrients in India.[1] Cereals are grown and sold throughout the nation through retail outlets, serving as a dependable source of energy and minerals for people in particular. They are a good source of carbohydrates, protein, oil, vitamins, and trace minerals. However, cereal protein has little lysine. Lysine is an essential amino acid. Food safety is simply the lack of or presence of safe levels of pollutants, adulterants, naturally occurring toxins, or any other substance that could cause food to be harmful to health on an acute or ongoing basis. Food quality is a complicated aspect of food that affects its worth or acceptability to consumers. Plant species, genetics, types of soil and metal, soil conditions, weather, environment, maturation stage, and supply route to market significantly affect the amount that heavy metal accumulates in plants.[2]

Heavy metals are environmental pollutants that can harm humans if an excessive quantity is consumed by food because they are persistent, non-biodegradable, have a long biological half-life, and may bio-accumulate through biological chains. Heavy metal toxicity can be carried on by industrial emissions, contaminated irrigation water, the use of fertilisers and metal-based herbicides, harvesting processes, transportation, storage, or sale. The main aim of the experiment was to evaluate the concentration of Pb, Cd, Cu and Hg in two common cereals rice and wheat in the local area of Ranchi city.

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Toxic Effects of Heavy Metals

Toxicity of heavy metals such as Lead, Cadmium, Mercury and Copper in paddy and wheat under taken for the study are listed below:

Lead toxicity in the body can affect the immune system, the nervous system, the reproductive system, the musculoskeletal system, and the renal system.[3]

Consuming cadmium has been linked to a number of health problems, including cancer, bone fractures, stomach discomfort, severe vomiting, infertility, and central nervous system damage.

Mercury is more toxic than lead and cadmium.[4] Its adverse effects are loss of vision, mental disorder and hearing loss and death occurs due to high accumulation of mercury.[5]

In addition to iron, copper is a vital micronutrient needed for body pigmentation that acts as a biocatalyst.[6] If the concentration is within the acceptable range, it supports a healthy nervous system and avoids anaemia, while higher amounts can cause acute stomach, intestinal, and liver damage.[7]

The toxicity of heavy metals is also defined by the CAS (Chemical Abstracts Service) number across the world. CAS of a few heavy metals is listed here in table 1.[8]

Table 1- CAS number of heavy metal

S.N.	Name of Heavy Metals	CAS Number
1	Lead	7439-92-1
2	Cadmium	7440-43-9
3	Mercury	7439-97-6
4	Copper	7440-50-8

Table 2- Permissible limit of heavy metas in cereals

S.N.	Name of Heavy metal	Name of cereals	Permissible limit
1	Lead	Rice	2.5
		Wheat	2.5
2	Cadmium	Rice	0.4
		Wheat	0.2
3	Mercury	Rice	1.0
		Wheat	1.0
4	Copper	Rice	30
		Wheat	30

Units- mg/kg

MATERIAL & METHODS

Study area

The total cultivable land of Jharkhand is 38 lakh hectares which constitutes 48% of the total geographical area of the state. Agriculture is the employment and primary income generating activity for the 80% of rural population. Major crops of Jharkhand is Paddy, Wheat, Maize, Pulse, Oilseeds and Horticultural crops.[9] The study has conducted on food grains from Ratu (Sample 1 Wheat and Sample 1 Rice) and Mander (Sample 2 Wheat and Sample 2 Rice) area in Ranchi, Jharkhand, shown in figure 1 and figure 2.

Figure 1- Sample 1 Wheat and Sample 1 Rice (Bajpur, Ratu)

Figure 2- Sample 2 Wheat and Sample 2 Rice (Bansjari, Mandar)

Sample collection

The cereals namely wheat (*Triticum aestivum* L) and paddy (*Oryza sativa*) of Poaceae family were collected in the months of September 2022 and January 2023 respectively directly from the farmers. 250 grams of wheat and 250 grams of paddy were collected from Bajpur village in Ratu block, and again, the same quantity was collected from Bansjari-Mandar village located in Ranchi, Jharkhand.

Methods

For dilution and preparation of reagents and working standards, all reagents used for analysis were highly purified by de-ionised double-distilled water (DDW). All equipments were thoroughly washed.

Sample preparation

Digestion of the sample- Cereals were dried at temperature 105°C for 2 days in the oven. Dried samples were grinded and made into fine powder. The cereals were digested using TKN (Total Kjeldahl Nitrogen) digester with concentrated Nitric Acid (Conc. HNO_3) and Sulphuric Acid (H_2SO_4) at 80°C. The total time taken for the sample digestion is 3 to 4 hours.

Procedure- Mixing of 0.5 gm of the powdered sample with 50 ml of distilled water was carried out and added to a total of 15 ml Conc. HNO_3 and 10 ml H_2SO_4 in the mixture to the solution. The solution was heated to make the digestion of the sample up to a volume of 40 ml. In a volumetric flask, the solution was made up to 50 ml by adding distilled water and then filtered. The digested solution of the sample used to test the Lead (Pb), Cadmium (Cd), Mercury (Hg) and copper (Cu) were aspirated into the instrument "atomic absorption spectrophotometer" after all necessary set up and standardization procedures in the laboratory.

RESULTS & DISCUSSION

Plant can absorb heavy metals from soil and build up in higher concentrations in them. Heavy metal pollution in the soil is the main contributing factor to bioaccumulation of metals in plants. Anthropogenic activities determine heavy metal contamination in the soil surface but geological background also play an important role. Rock is the basic primary material of soil, weathering of rocks generates parent material of loose debris soil. Researches have shown that the soil parent material is a significant natural source of heavy metal, determining the soil initial heavy metal corporation.[10]

To support the expansion and diversity of farming systems, increase earnings for farm families, and act as a buffer against climatic variations, sustainable access to clean, freash water resources is a crucial problem. The monsoon is a major supply of water for agriculture of many agro-ecologies in Jharkhand. When it fails there is a water deficit and below average crop yields.[11] In tested cereals, farmers of Ratu and Mandar used well water and monsoon or rain water for irrigation purposes. They also used animal`s manure as fertilizer, which contains nutrients such as nitrogen, phosphorus and potassium that facilitate plant growth.

Heavy metal-containing grains may be detrimental to consumers in addition to reducing the nutritional value of the grains. The maximum permissible amounts of harmful metals in human food have been lowered as a result of regulations on food quality, and this necessitates good and rigorous food quality control on the concentration of metals in food.[12]

Table 3- Concentrations of heavy metals in cereals

SN	Parameters	Cereals							
		Sample 1 wheat		Sample 1 rice		Sample 2 wheat		Sample 2 rice	
		Permissible limit	Result	Permissible limit	Result	Permissible limit	Result	Permissible limit	Result
1	Lead	2.5	BDL	2.5	0.09	2.5	BDL	2.5	BDL
2	Cadmium	0.2	0.19	0.4	BDL	0.2	0.12	0.4	BDL
3	Mercury	1.0	0.028	1.0	0.019	1.0	0.016	1.0	0.19
4	Copper	30	0.29	30	0.15	30	0.25	30	BDL

Units- mg/kg

Sample 1- Bajpur, Ratu; Sample 2- Bansjari, Mandar; BDL- Below detection limit

Table 2, displays the findings of the study of heavy metals in the crops taken for study. These outcomes demonstrated a variation in the metal concentrations that were examined across all the samples. Levels of Pb, Cd, Hg, Cu were observed to be in range suggested by Food Safety and Standards Authority of India (FSSAI)[8] in selected cereals samples.

Lead- The result of cereals analysis showed that the range of Pb in all samples was in order of

Sample 1 Rice > Sample 1 Wheat = Sample 2 Rice = Sample 2 Wheat.

Cadmium- Cd is a non-essential element. Cd has the greatest potential for transmission through the food chain since it is more mobile in soil and plant than any other heavy metal.[10] its level in wheat varies between 0.12mg/kg-0.19mg/kg but it is not found in rice after analysis. Range of cadmium in all samples was in order of-

Sample 1 Wheat > Sample 2 Wheat > Sample 1 Rice > Sample 2 Rice.

Mercury- The result reveals that concentration of Hg is ranges from 0.016mg/kg-0.19mg/kg. Maximum concentration of mercury is found in sample 2 rice followed by sample1 wheat, sample1 rice and sample 2 wheat.

Copper- Cu is one of the important micro nutrient acts as a biocatalyst and in addition to iron it gives body pigmentation.[6] With in permissible limit it provides a healthy nervous system and also prevents from anemia.[7] In current study the concentration of Cu in all cereals varied between 0.15 mg/kg-0.29 mg/kg. Cu level observed in all samples in the order of-

Sample 1 Wheat > Sample 2 Wheat > Sample 1 Rice > Sample 2 Rice

Chart 1- Heavy metals in sample 1 cereals

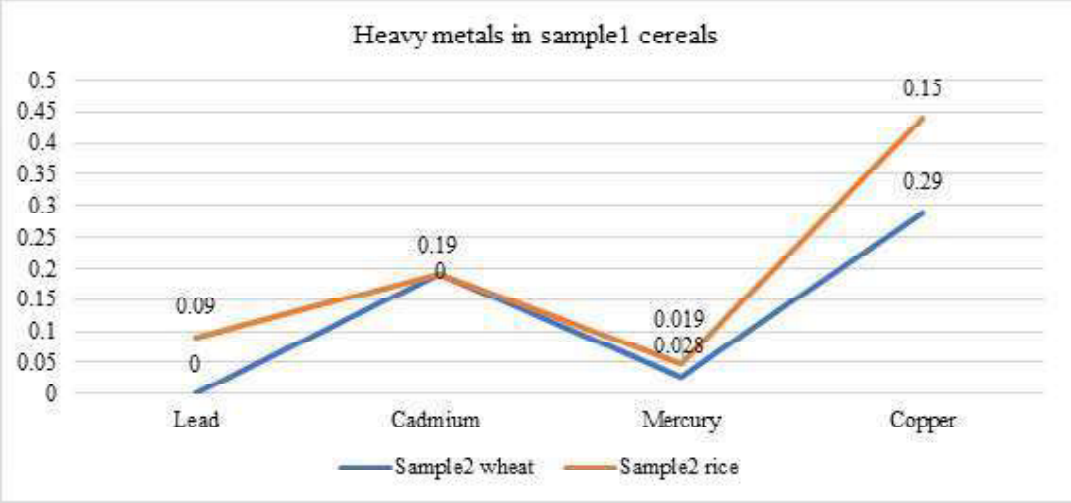
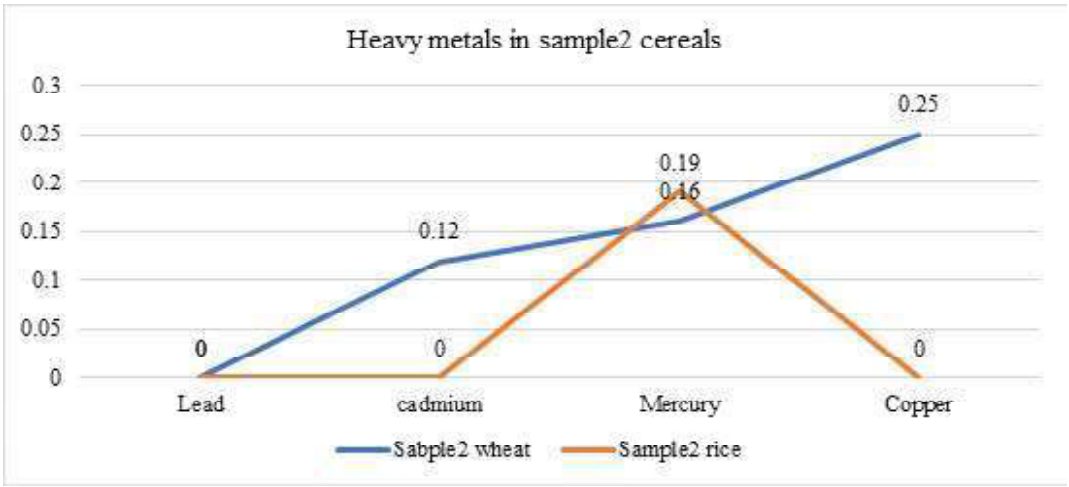


Chart 2- Heavy metals in sample 2 cereals



CONCLUSION

Heavy metal contamination in cereals can be attributed to the excess application of heavy metal containing fertilizers, pesticides, runoff from other agricultural fields, contaminated irrigation etc. It is important to educate the farming communities and get ideas on the qualities of the soil and appropriate applications of pesticides and fertilisers. Before discharging municipal sewage water into a water stream, the municipal authority informed to go for sewage water treatment before dumping into the water stream. Formers were urged to limit the use of fertilizers and pesticides in order to reduce soil contamination.

The study showed that the content of samples wheat and rice of Ratu (sample 1) and Mandar (sample 2) can be risk free after consumption because all the heavy metals tested are in permissible limit.

REFERENCES

1. **Laskowski W., Warsewicz H. N., Rejman K., Czeczotko M., Zwolinska J. 2019.** How important are cereals and cereal products in the Average Polish Diet?, *Nutrients*, **11(3):** 679.
2. **Abdulrazak S, Oniwapele Y, Sulyman Y, Abdulrazak S, Oniwapele Y, Ahmad A. 2015.** Concentration of heavy metals in some selected cereals sourced within Kaduna state, Nigeria. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)e-ISSN:* 2319-2402,p-ISSN: 2319-2399. **9(10):** Ver. II 17-19.
3. **Lisa H. Mason, Jordan P. Harp and Dong Y. Han. 2014.** Pb Neurotoxicity: Neuropsychological Effects of Lead Toxicity. *BioMed Research International.* Volume **2014**, Article ID 840547, 8 pages. http://dx.doi.org/10.1155/2014/840547.
4. **Abbas M., Parveen Z., Iqbal M., Iqbal R. S., Ahmed M. and Bhutto R. 2010.** Monitoring of Toxic Metals (Cadmium, Lead, Arsenic and Mercury) in Vegetables of Sindh, Pakistan. *Kathmandu University Journal of Science, Engineering and Technology,* **6(II):**60-65.
5. **Reilly S. B., McCarty K. M., Steckling N. and Lettmeier B. 2010.** Mercury Exposure and Children's Health. *Curr Probl Pediatr Adolesc Health Care,* **40(8):**186–215, doi:10.1016/j.cppeds.
6. **Elbagarmi M. A., Edwards H. G. M. and Alajtal A. I. 2012.** Monitoring of Heavy metal Content in Fruits and Vegetables Collected from Production and Market Sites in Misurata Area of Lybya. *International Scholarly Research Network ISRN Analytical Chemistry,* Volume **2012**: Article ID 827645, 5 pages, 2012.
7. **Shobha N. and Kalshetty B. M. 2017.** Assessment of heavy metals in green vegetables and cereals collected from Jamkhandi local market, Bagalkot, India. *Rasayan J. Chem.* **10(10):**124-135.
8. **Food Safety and Standards (Contaminants, Toxins and Residues) Regulations. 2011.** Version-V19. 08.2020.
9. **Birju Prasad Dangi. 2023.** Trends in Vegetables and Fruits Production in Jharkhand, *TIJER*. ISSN 2349-9249. **10(3).**
10. **Mawari G., Kumar N., Sarkar S., Daga M. K., Singh M. M., Joshi T. K. and Khan N. A., 2022.** Heavy Metal Accumulation in Fruits and Vegetables and Human Health Risk Assessment: Findings from Maharashtra, India, *Environmental Health Insights,* **16:** 1-10.
11. **S. S. Mali, B. K. Jha, S. K. Naik, S. Kumar. 2020.** Agricultural Water Management in Jharkhand: Issues and Strategies. *Agriculture and Food.* **2(8).**
12. **E. B. Mubofu. 2012.** Heavy Metal Content in some commonly consumed vegetables from Kariakoo Market, Dar Es Salaam, Tanzania, *Tanz. J. Sci.* **38(3).**

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