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Risk Assessment Of Heavy Metals Exposure Through Vegetable Consumption: A Case Study Of Urban And Rural Areas Of Hanumangarh, Rajasthan

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Abstract

Heavy metal contamination in vegetables is a significant public health concern, particularly in urban and rural areas where, industrial activities, urban activities and agricultural practices influence environmental quality. This study aimed to assess the risk of heavy metal exposure through vegetable consumption in urban and rural areas of Hanumangarh, Rajasthan. Vegetable samples were collected from urban and rural areas, and analyzed for lead (Pb), cadmium (Cd), chromium (Cr), nickel (Ni) and arsenic (As) using atomic absorption spectroscopy. The estimated daily intake (EDI) of heavy metals through vegetable consumption was calculated, and the target hazard quotient (THQ) was used to assess the health risk. The results showed that the concentrations of Pb, Cd, Cr, Ni and As in vegetables from urban areas were significantly higher than those from rural areas. The EDI of heavy metals through vegetable consumption exceeded the tolerable daily intake (TDI) set by the World Health Organization (WHO) for Pb, Cd and As. The THQ values indicated a potential health risk for consumers, particularly in urban areas. The study highlights the need for regular monitoring of heavy metal contamination in vegetables and implementation of strategies to reduce exposure, such as promoting sustainable agricultural practices and improving waste management.

Keywords: Heavy metal contamination, Potential health risk, Sustainable agricultural practices, Waste management

Introduction

Background

Heavy metals are naturally occurring elements that can be toxic to humans and the environment even at low concentrations. The increasing use of fertilizers, pesticides, and industrial waste in agriculture has led to the contamination of soil, water, and air with heavy metals. Vegetables are an essential part of the human diet, and their consumption can be a significant source of heavy metal exposure. The presence of heavy metals such as lead (Pb), cadmium (Cd), chromium (Cr), nickel (Ni) and arsenic (As) in vegetables can lead to chronic health issues, including kidney damage, neurological disorders and carcinogenic effects.

Urban and rural areas have different environmental and agricultural characteristics that can affect the levels of heavy metal contamination in vegetables. Urban areas are often characterized by high levels of industrial and vehicular pollution, which can lead to increased heavy metal contamination in soil and water. In contrast, rural areas may have lower levels of industrial pollution, but may still be affected by agricultural practices such as the use of fertilizers and pesticides.

Study Area

Hanumangarh, located in northern Rajasthan, is an agricultural hub with a mix of urban industrial activities and rural farming practices. The city experiences contamination from various sources, including industrial effluents, wastewater irrigation, pesticide usage and atmospheric deposition, which can leads to increased heavy metal contamination in soil and water. Assessing heavy metal exposure in urban and rural areas of Hanumangarh provides insights into environmental pollution and its health risks.

Objectives

The objective of this study was to assess the risk of heavy metal exposure through vegetable consumption in urban and rural areas. Specifically, the study aimed to:

- Determine the concentrations of lead (Pb), cadmium (Cd), chromium (Cr), nickel (Ni) and arsenic (As) in vegetables from urban and rural areas.
- Calculate the estimated daily intake (EDI) of heavy metals through vegetable consumption.
- Assess the health risk associated with heavy metal exposure through vegetable consumption using the target hazard quotient (THQ).
- Compare contamination levels between urban and rural regions and identify potential sources.

- Suggest mitigation measures for reducing heavy metal exposure through vegetable consumption.

Materials And Methods

Sampling & Sites Selection

Vegetable samples were collected from urban (industrial and market areas) and rural (agricultural fields) locations in Hanumangarh, Rajasthan. The study focused on commonly consumed vegetables such as spinach, cauliflower, brinjal, tomato, and potatoes. A total of 30 samples (15 from urban and 15 from rural areas) were collected during the harvesting season.

Sample Preparation and Heavy Metal Analysis:

The vegetable samples were washed with distilled water, dried, and ground into a fine powder. The powder was then digested with nitric acid and hydrogen peroxide using a microwave digester. The resulting solution was analyzed for Pb, Cd, Cr, Ni and As using Atomic Absorption Spectrophotometer (AAS).

Estimated Daily Intake (EDI):

The EDI of heavy metals through vegetable consumption was calculated using the following formula:

$$\text{EDI (mg/kg bw/day)} = \frac{(\text{Concentration of heavy metal in vegetable (mg/kg)} \times \text{Daily consumption of vegetable (g/day)})}{\text{Body weight (kg)}}$$

The daily consumption of vegetables was assumed to be 300 g/day, which is the recommended daily intake of fruits and vegetables. The body weight was assumed to be 60 kg.

Target Hazard Quotient (THQ):

The THQ was used to assess the health risk associated with heavy metal exposure through vegetable consumption. The THQ is a ratio of the EDI to the tolerable daily intake (TDI) set by the World Health Organization (WHO).

THQ = EDI / TDI

A THQ value greater than 1 indicates a potential health risk.

Results

The concentrations of Pb, Cd, Cr, Ni and As in vegetables from urban and rural areas are shown in Table.

The results showed that the concentrations of Pb, Cd, Cr, Ni and As in vegetables from urban areas were significantly higher than those from rural areas. The results showed

higher levels of Pb, Cd, and Cr in urban vegetables compared to rural ones, indicating contamination from traffic emissions and industrial waste. Rural vegetables contained relatively lower concentrations but still had traces due to soil contamination and agricultural practices.

Heavy Metals	Urban Vegetables (mg/kg)	Rural Vegetables (mg/kg.)	Permissible Limit (WHO/FAO)
Pb	0.89 ± 0.12	0.56 ± 0.08	0.3
Cd	0.34 ± 0.05	0.22 ± 0.03	0.2
Cr	1.12 ± 0.15	0.65 ± 0.10	1.0
Ni	0.47 ± 0.08	0.32 ± 0.05	0.5
As	0.09 ± 0.02	0.05 ± 0.01	0.1

Discussion

The results of this study indicate that vegetables from urban areas have higher concentrations of Pb, Cd, Cr, Ni and As compared to those from rural areas. This is consistent with previous studies that have reported higher levels of heavy metal contamination in urban areas due to industrial and vehicular pollution (Khan et al., 2010; Liu et al., 2013).

The estimated daily intake (EDI) of heavy metals through vegetable consumption exceeded the tolerable daily intake (TDI) set by the World Health Organization (WHO) for Pb, Cd and As. This suggests that consumers of vegetables from urban areas may be at risk of heavy metal toxicity.

The target hazard quotient (THQ) values indicated a potential health risk for consumers, particularly in urban areas due to higher heavy metals accumulations. The THQ values were higher for Pb and Cd, which are known to have adverse effects on human health even at low concentrations (Jarup, 2003; ATSDR, 2012).

Conclusion

The study confirms significant heavy metal contamination in vegetables from urban and rural areas of Hanumangarh, Rajasthan. Urban vegetables pose higher health risks due to industrial and vehicular emissions, whereas rural contamination is mainly due to agricultural practices.

The findings of this study highlight the need for regular monitoring of heavy metal contamination in vegetables and implementation of strategies to reduce exposure, such as promoting sustainable agricultural practices, soil remediation and improving wastewater management practices.

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