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Research Article

Heavy Metal Contamination in Soil and Health Risk Assessment through Onion Consumption in Mojo and Koka, Ethiopia

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Abstract

The objective of this study was to determine the concentration of heavy metals in the soil and horticultural crops grown under irrigation in the Mojo and Koka sites in Oromia, Ethiopia, and to evaluate the potential health risks that these metals may cause to consumers. For this investigation, a total of 50 onion (*Allium porrum L.*) and 50 soil samples were gathered. The content of heavy metals was measured using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) after the samples were digested using microwave-assisted digestion. The mean concentrations of examined trace elements in onion (mg/kg) were found in the range of 0.80 to 0.95, for As 1.77 to 0.91 for Sn, 2.09 to 1.49 for Pb, 12.29 to 7.31 for B, 13.85 to 12.33 for Zn, 0.34 to 0.25 for Cd, 1.83 to 1.78 for Hg, 11.29 to 7.54 for Cu, 0.83 to 0.78 for Ni, 0.34 to 0.31 for Co, 78.39 to 42.19 for Fe, 17.03 to 11.56 for Mn, and 1.03to 1.02 for Cr. Given that the average levels of Pb, Hg, Cd, and As in onions at both irrigation sites surpassed the upper limit of allowable levels established by the joint FAO/WHO commission. These metals' concentrations in soil are found to be within acceptable bounds. As compared to other literatures, their concentration exceeded in both irrigation sites. According to the metal pollution load index, the overall pollution load of trace metals, including As, Pb, Cd, and Hg, was found to be moderately higher in both irrigation locations for the majority of the onions under study. The results, which were computed using an adult consumer's food intake, indicated that the Pb and Hg dietary exposure levels were much higher than the daily intake amounts that were considered tentatively tolerated. The soil-to-onion transfer factor showed that whereas Fe has a strong sorption to the soil colloids, metal Cu is comparatively poorly maintained in the soil. The degree of metal enrichment in soils and sediments is higher than in other literature, according to the soil pollution indices. Thus, swift action is needed to stop the issue and guarantee public safety along the food system's supply chain.

Introduction

The global concern over heavy metal pollution of the environment has been exacerbated by urbanization, industry, greater population density, improved living conditions, and economic development [1]. Numerous organic and inorganic pollutants, primarily toxic heavy metals, are released into the environment either directly or indirectly as a result of human or natural activity. These pollutants are extremely harmful to human health and other living things, even at low concentrations, because there is no reliable method of removal [1,2].

Vegetables poisoned by heavy metals may have been irrigated with tainted soil and water. Due to their high vitamin and mineral content as well as their consistent antioxidant properties, vegetables are an essential part of the human diet. Vegetable consumption is progressively rising as a result of increased knowledge of their nutritional value, and one of the most important features of food quality is trace metal contamination [3]. Potentially harmful metals like lead, mercury, and cadmium, as well as probably essential metals like cobalt, nickel, and vanadium, and essential metals like zinc, selenium, and iron, can all be categorized as trace metals.

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Even at low concentrations, consuming those harmful metals over an extended period can be very deadly [4,5]. In addition to contaminating the land, contaminated water irrigation can have an impact on the safety and quality of food [6]. In Ethiopia's Central Rift Valley, residents use wastewater from various industrial sources to irrigate horticulture crops during the dry season. Consuming vegetables grown in contaminated soil and water could put a large number of people at risk for health problems. The Rift Valley region of Ethiopia (Modjo and Koka regions) has very little and insufficient data on trace metals in soil and vegetable samples grown under irrigation by potentially polluted rivers.

Furthermore, the sample preparation and analysis in those few works did not make use of microwave digestion or Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Because there are so many companies in this area of the country, the ecology there is quite vulnerable to contamination. Thus, the goal of this study is to ascertain the concentration of harmful metals in regularly consumed onion vegetables that are grown with irrigation and in the soil in which they are planted, as well as the potential health effects of those metals on the consumer based on dietary consumption.

Materials and methods

Reagents and chemicals

Hydrogen peroxide (H_2O_2, 30%), hydrofluoric acid (HF, 70%) (Dong Woo Fine-Chem Iksan, Korea), concentrated hydrochloric acid (HCl) 37% (Fluka, Germany), nitric acid (HNO_3, 69%) (Fluka), and ultrapure deionized water (18.2 M.cm) (Millipore, Bedford, MA, USA) were the chemicals used. A 10 mg/L multi-elemental standard solution from Ana pure Krait, Daejeon, Korea was used for preparing standards for calibration curves.

Instrumentation

The Multiwave 3000 microwave system (Anton Paar, Graz, Austria) was used for the digestion of the samples. It was programmable for time and power between 600 and 1400 W and came with 16 high-pressure polytetrafluoroethylene vessels (MF 100). The examined elements were analyzed using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The device was running at 1.0 kW of forward plasma power, 99.95% spectral quality nitrogen gas, 16.0 L/min of plasma flow rate, and 1.2 L/min of auxiliary and 1.0 L/min (nebulizer) flow rate [7,8].

Study area

The study regions include the Koka Town area (Ejersa Joro Kebele) and Mojo (Lome woreda). Modjo is located 73 kilometers to the east of Addis Ababa, Ethiopia as shown in Figure 1. Its elevation is between 1788 and 1825 meters above sea level, and its latitude and longitude are 8°39′N 39°5′E. With a grid reference of 8°27.154′ latitude and 39°03.894′ longitude, Koka (Ejersa Joro Kebele) is situated 85 kilometers southeast of Addis Ababa.

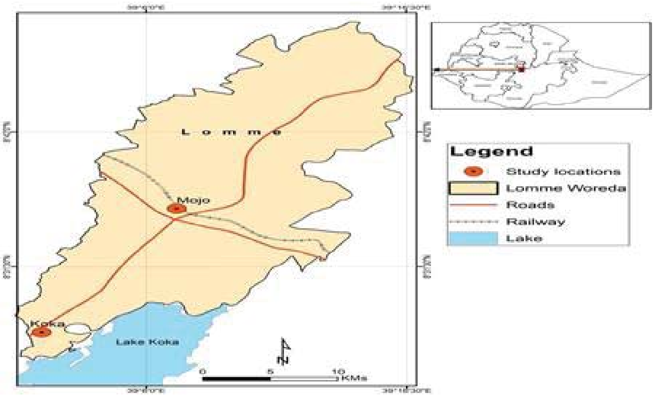

Figure 1: Study areas from Koka and Mojo, Oromia, Ethiopia.

Sample collection: A total of 25 vegetable (onion) and 25 soil samples at (depth of 25 cm) were collected in polyethylene bags from the irrigation sites (Koka and Mojo) in the dry season.

Sample preparation and microwave digestion: The collected onion samples were cleaned with deionized water, dried between layers of sterile scientific tissue paper, and cut with a stainless steel knife. Homogenized onion and soil samples were grounded using titanium blades and stored for further analysis. Total, 0.5 grams of each onion and soil sample, were accurately weighed directly into separate digestion vessels in microwave digestion, and 7.0 mL of concentrated HNO_3 and 2.0 mL of H_2O_2 were added to onion samples [9], and 10 mL of HNO_3 and 3.0 mL of HF were added for soil samples [10,11]. To assess instrumental drift, many analytical blanks that underwent the identical digestion and dissolving process were also included and examined [7,8]. The combustion process consisted of 1000 W for five minutes at 80 °C, 1000 W for five minutes at 50 °C, 1000 W for twenty minutes at 190 °C, and 0 W for thirty minutes to cool. The tubes' contents were diluted once they had cooled. using ultrapure deionized water up to 50 mL. Spinach leaves (NIST-1570a) for vegetables and GBM399–5 for soil were used as certified reference materials for repeated analyses. These materials were also included as samples during digestion and went through the same dissolution process. To define instrumental drift, several analytical blanks that underwent the identical digestion and dissolving process were also included and examined.

Soil pollution indices

Indexes such as the integrated pollution load index, enrichment factors, and pollution load index were taken into consideration to measure the extent of metal pollution or enrichment in the soils of the two sites.

Pollution load index (PI): The pollution load of trace metals in the soil samples was calculated [12].

$$PI = Ci / Si \quad (1)$$

Where Ci is the measured concentration of the metals under examination in the soils, Si is the metals' geochemical background concentration, and PI is the evaluation score

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assigned to each sample. Each metal is categorized according to its PI value as low (PI ≤ 1.0), moderate (1.0 < PI ≤ 3.0), or high (PI > 3.0) contamination.

Integrated pollution load index (IPI): The pollution load index values for all the metals under consideration were determined [13,14]. IPI is categorized as having four levels of contamination: low (IPI ≤ 1.0), moderate (1.0 < IPI ≤ 2.0), high (2.0 < IPI ≤ 5), and extremely high (IPI > 5).

Soil-vegetable Transfer Coefficient (TF)

The kinds of plants, the quantity and kinds of heavy metals, soil type, and other factors all affect how quickly heavy metals are transferred to and accumulated by plants [15]. The transfer factor which quantifies the relative differences in bioavailability of metals to plants was analyzed by [16].

$$TF = C_{Plant} / C_{Soil} \quad (2)$$

Where; C_{plant} is the metal concentration in vegetables and C_{soil} stands for the metal concentration in soil. A low coefficient demonstrates the strong sorption of metals to the soil colloids [17].

Health risk assessment

The target hazard quotient and hazard index, the metal pollution load index, and the projected dietary exposure were used to evaluate the health risks of trace elements associated with the consumption of onions.

Estimated dietary exposure (EDI): The estimated daily intake of the metals considered in this study was determined based on their mean concentration in onion and the estimated daily consumption of the vegetables in gram [18].

$$EDI = \frac{C * D \ food\ intake}{BWaverage} \quad (3)$$

Where; C is the concentration (mg/kg) of the trace metals present in the onion vegetables, D is the daily intake of food in kg per person (0.100 kg) and BW represents the average body weight in kg of a consumer, an adult (70 kg) [19].

Target hazard quotient (THQ): Equation (4) was used to determine the THQ. It is assumed that THQ values < 1 carry no non-carcinogenic hazards. On the other hand, significant health risks are thought to be possible if the THQ >1.

$$THQ = \frac{Ef * ED * EIF * CM * Cf * 0.001}{BW * TA} \quad (4)$$

Where; BW is the average body weight for an adult (70 kg) of a consumer, CM is the metal concentration (mg/kg) present in the onion, Ef is exposure frequency (365 days/year), and ED is the daily food consumption in (65 years), FIR is the average food (vegetable) consumption (240 g/person/ day) and TA is the average exposure time (65 yrs x 365 days), 0.001 is unit conversion factor and Cf is the concentration conversion factor for fresh vegetable weight to dry weight (which is 0.085) [20].

Health risk index (HRI): The specific health risks associated with each of the heavy metals that were tested in the same vegetable have been shown to accumulate; this is represented by the health risk index (HRI) [21].

$$HRI = \sum THQ \quad (5)$$

Results and discussion

Table 1 shows the average concentration and standard deviation (SD) of the following heavy metals in soil taken from the two irrigation sites: As, Sn, Pb, B, Zn, Cd, Hg, Cu, Ni, Co, Fe, Mn, and Cr. While the mean concentrations Zn, Hg, Cu, Sn, and Mn were found in higher quantities in Mojo than in Koka, the average metal concentration in the soil sample collected from the two sites (Koka and Mojo) revealed that almost all metals were found in higher concentrations in Koka than in Mojo. The accumulation of metal concentrations (mg/kg) in the soil from higher to lower Fe > Mn > Zn > Sn > Pb > Cr > Ni > B > Cu > As > Co > Hg > Cd, and Fe > Mn > Zn > Sn > Cr > Pb > As > B > Ni > Cu > Co > Hg > Cd in Mojo and Koka sites, respectively. The Mojo and Koka sites had an average Fe concentration of 78.39 mg/kg and 42.19 mg/kg, respectively, in the onion sample. The mean concentrations of several metals are shown in Table 2 for samples of vegetables and onions. The average concentrations of As, Sn, Pb, B, Zn, Cd, Hg, Cu, Ni, Co, Fe, Mn, and Cr in onion were 0.95, 1.77, 2.09, 12.29, 12.33, 0.34, 1.78, 11.29, 0.83, 0.34, 78.39, 17.03, and 1.03, correspondingly, in the Mojo site and 0.80, 0.91, 1.49, 7.31, 13.85, 0.25, 1.83, 7.54, 0.78, 0.31, 42.19, 11.56, and 1.02, respectively, in the Koka site. The Mojo irrigation site had greater amounts of practically all metal concentrations than the Koka location, except zinc (Zn) and mercury (Hg). This suggests that the Mojo irrigation site is more contaminated with heavy metals than the Koka irrigation site. The maximum allowable level established by the joint FAO/WHO commission Table 2 was exceeded by the mean concentration values of As, Pb, and Cd (mg/kg) in the onions in both irrigation sites. In the literature, the maximum amount of Pb, Ni, Co, Fe, Mn, and Cr in onions were found 0.67, 0.25, 0.14, 3.6, 0.16, and 0.44, respectively [27] but in this study, the concentrations of these elements were found to be higher amount. According to [7], the metal concentrations of Zn, Cu, Ni, Pb, Mn, and Fe in onions were found 44.2, 9.2, 0.2, 7.7, 659.6, and 1034.3, respectively, which indicates, the concentration of Zn, Pb, Mn, and Fe were found to be in higher amount compared within this study but metals Cu and Ni were also found in lower amount compared to in this study.

As shown in Table 3 the overall load of metals in onion growing at each irrigation site, Mojo and Koka were computed and assessed. It is observed that in most of the onions studied the overall pollution load of trace metals such as As, Pb, Cd, and Hg were moderately higher in both irrigation sites. And the reasons could be the number of industries that damp their unregulated wastes to the nearby streams which ultimately end up for irrigation use.

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Table 1: Concentration (mg/kg) of trace metals (mean and SD) in soil (N = 25) from Mojo (M), and (N = 25) from Koka irrigation sites.

Sampling Sites	Conc.	As	Sn	Pb	B	Zn	Cd	Hg	Cu	Ni	Co	Fe	Mn	Cr
MS 1	Mean	15.28	35.52	24.35	23.12	68.08	3.33	3.87	14.47	21.38	8.45	26943.33	726.67	25.43
	SD	0.06	0.64	0.17	0.85	0.12	0.03	0.06	0.03	0.03	0.00	15.28	15.28	0.06
MS 2	Mean	13.83	31.62	21.97	21.77	54.68	3.02	3.48	13.18	17.55	6.77	23241.67	606.67	20.68
	SD	0.03	0.13	0.06	0.51	0.20	0.03	0.03	0.03	0.09	0.03	11.55	5.77	0.06
MS 3	Mean	11.93	55.15	20.13	12.97	50.37	1.25	4.47	13.35	15.13	7.12	21560.00	1016.67	17.20
	SD	0.06	0.87	0.40	0.33	0.46	0.00	0.03	0.05	0.16	0.03	34.64	23.09	0.09
MS 4	Mean	13.52	59.50	22.32	11.12	55.27	3.10	4.65	14.22	16.97	7.07	21898.33	1110.00	19.53
	SD	0.03	0.31	0.03	0.36	0.28	0.09	0.09	0.03	0.03	0.03	11.55	5.00	0.20
MS 5	Mean	12.42	28.73	18.97	18.67	49.93	2.62	3.82	13.07	18.08	7.55	23690.00	893.33	18.28
	SD	0.03	0.14	0.03	0.63	0.24	0.12	0.12	0.03	0.25	0.09	128.55	5.77	0.16
KS1	Mean	32.52	40.23	26.62	26.20	67.92	3.65	4.20	14.85	24.33	7.57	30853.33	868.33	29.15
	SD	0.12	0.32	0.03	1.17	3.00	0.00	0.00	0.35	0.03	2.87	54.85	5.77	0.17
KS2	Mean	29.67	29.73	27.72	22.67	65.40	2.78	3.37	14.48	20.08	7.88	26430.00	691.67	24.38
	SD	0.35	6.71	0.06	0.58	1.56	0.55	0.45	0.03	0.51	0.23	13.23	2.89	0.03
KS3	Mean	23.15	24.70	24.23	20.12	46.88	2.78	3.33	11.52	24.68	11.13	28235.00	921.67	28.80
	SD	0.09	6.12	0.03	0.72	0.23	0.06	0.12	0.08	0.32	0.06	111.69	2.89	0.26
KS4	Mean	18.70	35.52	24.35	23.12	67.83	3.32	3.87	14.47	21.37	7.95	26953.33	733.33	25.43
	SD	0.09	0.64	0.17	0.85	0.06	0.03	0.06	0.03	0.03	0.00	32.15	5.77	0.06
KS5	Mean	14.33	26.85	28.98	21.08	59.18	2.90	3.53	11.38	26.02	11.50	24408.33	940.00	29.98
	SD	0.14	8.41	5.74	0.56	0.21	0.09	0.03	0.06	0.06	0.05	40.41	8.66	0.06
[22]				200		110			270	72		N/A	N/A	
[7]				133.2		236.8			36.9	1.1		54015.8	3597.1	
[23]				34.6		90.7			83.7	249.2		43317.8	1446.8	
*Maximum permissible limits (mg/kg)		32	-	750	-	400	350	-	200	150	50	50,000	2000	50

*Represents references for maximum permissible limit for agricultural soil: UNEP (United Nations Environment Program, 2013).

Table 2: Concentration (mg/kg) of trace metals (mean and SD) in cultivated vegetable (onion) (N = 25) in Mojo (M), and (N = 25) from Koka irrigation sites.

S. Sites	Conc.	As	Sn	Pb	B	Zn	Cd	Hg	Cu	Ni	Co	Fe	Mn	Cr
MO1	Mean	1.03	1.52	2.40	6.90	14.52	0.32	1.82	6.90	0.93	0.38	41.10	14.55	0.75
	SD	0.03	0.13	0.00	0.17	0.12	0.03	0.03	0.09	0.03	0.03	0.25	0.31	0.17
MO2	Mean	0.97	1.70	1.83	5.63	12.33	0.28	1.72	8.12	0.93	0.32	42.55	13.60	0.75
	SD	0.03	0.48	0.03	1.24	0.12	0.03	0.03	0.23	0.03	0.03	0.09	0.17	0.01
MO3	Mean	1.73	4.58	3.78	35.80	12.72	0.48	2.15	3.32	1.47	0.63	245.62	39.72	2.35
	SD	0.03	0.44	0.06	0.54	2.45	0.03	0.09	0.06	0.03	0.12	4.94	0.89	0.65
MO4	Mean	0.57	0.30	1.08	6.58	10.78	0.43	1.58	31.38	0.35	0.13	31.10	8.47	0.62
	SD	0.03	0.00	0.06	1.20	0.03	0.03	0.03	0.03	0.00	0.06	0.67	0.15	0.03
MO5	Mean	0.43	0.75	1.37	6.55	11.32	0.20	1.62	6.72	0.47	0.22	31.60	8.82	0.68
	SD	0.03	0.05	0.06	1.39	0.06	0.00	0.03	0.03	0.03	0.03	0.10	0.19	0.03
KO1	Mean	0.75	0.20	1.45	7.52	18.37	0.18	1.85	6.13	0.40	0.27	44.58	10.08	1.80
	SD	0.00	0.05	0.09	0.51	0.51	0.03	0.13	0.65	0.05	0.03	1.08	0.12	0.05
KO2	Mean	0.70	0.80	1.72	8.30	14.22	0.27	1.85	8.33	0.83	0.25	40.27	15.20	0.88
	SD	0.00	0.17	0.12	0.61	0.28	0.03	0.00	0.29	0.03	0.00	1.15	0.00	0.03
KO3	Mean	0.78	0.92	1.38	7.55	14.08	0.25	2.13	7.47	0.92	0.40	43.17	9.28	0.95
	SD	0.06	0.12	0.03	0.36	0.13	0.00	0.03	0.06	0.03	0.00	2.11	2.89	0.05
KO4	Mean	0.80	0.92	1.32	7.55	9.08	0.27	1.63	7.45	0.80	0.27	40.33	9.52	0.70
	SD	0.00	0.12	0.06	0.36	0.13	0.03	0.03	0.13	0.00	0.03	1.49	0.06	0.00
KO5	Mean	0.98	1.70	1.60	5.63	13.50	0.28	1.70	8.30	0.93	0.35	42.60	13.70	0.75
	SD	0.03	0.48	0.00	1.24	0.00	0.03	0.00	0.09	0.03	0.00	0.00	0.00	0.00
[22]				0.67						0.25	0.14	3.6	0.16	0.44
[7]				7.7		44.2			9.2	0.2		1034.3	659.6	
Maximum permissible limits (mg/kg)		0.1[a] 0.1[b]		0.3[a] 5[b]		60[a] 60[b]	0.02[a] 0.2[b]	0.01[c] 0.2[a]	40[a]	1.5[a]	0.1[a]	450[a] 425[c]	500[a]	5[a] 5[b]

[a]WHO/FAO (codex alimentarius commission. [24].
[b]FAO/WHO (codex alimentarius commission. [25].
[c]WHO/FAO (Codex Alimentarius Commission, [26].

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Soil-vegetable transfer coefficient

The term "transfer factor," also known as "plant concentration factor" (PCF), refers to a metric that describes how trace hazardous chemicals are transferred from the soil to the plant body. It depends on the characteristics of the soil and the vegetable. The transfer coefficient, which measures the proportional variations in the metals' bioavailability to the onion under study, is presented in Table 4. In vegetable (onion) samples, the trace metal trend according to TF was as follows: Cu > B > Hg > Zn > Pb > Cd > As > Cr > Sn > Ni > Co > Mn > Fe. This indicates that while Fe has considerable sorption to the soil colloids, Cu is either kept in the soil comparatively poorly or is absorbed by plants more effectively. The pattern aligns with research conducted by [31].

Estimated Daily Intake (EDI)

Based on the mean concentration of each metal in each meal and the corresponding consumption rate of the onion, the estimated daily intake (EDI) of the metals considered in this study by the adult population was calculated. The most popular method for assessing the health risks associated with metals in food is to calculate the anticipated dietary intake values and compare them to the prescribed dietary standards and acceptable upper intake values. The Food and Nutrition Board of the United States [32] for adults and the Joint World Health Organization and Food and Agriculture Organization Expert Committee on Food Additives [33-35] have set those values. The estimated daily intake (EDI) of individual metals as a result of the consumption of onion has followed the increasing order of Co = Cd < Ni < As < Cr < Sn < Hg < Pb < Cu < B < Zn < Mn < Fe as shown in Table 5. The EDI of Pb, As, and Cd obtained in this study were greater than the data reported, although the EDI of metals analyzed in this study due to the consumption of onion were found to be less than the corresponding recommended dietary intakes (RDI) and provisionally tolerable daily intake (PTDI) values [35,36].

Target hazard quotient and hazard index

The upper acceptable intake (or standard reference dosage) and the amount of a contaminant consumed are compared in the target hazard quotient, an integrated risk index. The target hazard quotients of each examined constituent add up to the hazard index. When several metal exposures are added together, the amount of harmful effects that hazardous metals have on a sample is linear. Based on the findings presented in Table 5, it is clear that there is no potential health risk associated with onion eating. All metal THQs in the onion studied in this study were found to be less than 1.

Conclusion

This study shows the level of heavy metal concentrations in soil and onion samples collected from the Mojo and Koka sites. There has been no discernible variation in the irrigated soil in these study regions, according to the results of some metals in the irrigated lands. Heavy metal contamination was present in the irrigated onions in the research locations. The results indicated that the dietary exposure level of Pb and Hg was found to be well above the provisionally tolerable daily intake values. The levels of heavy metal concentrations, such as As, Pb, Cd, and Hg, exceeded the permissible limits set by the joint FAO/WHO guideline, and their health significance was calculated based on the dietary intake of an adult consumer. It was discovered that metals including Sn, B, Zn, Cu, Ni, Co, Fe, Mn, and Cr were within allowable bounds. In the sample sites, onions had a high bio-concentration factor, also known

Table 3: Pollution load index (PI) of the soil samples.

Heavy metals	Background soil (mg/kg) [7,28-30]	Mean Con. (mg/kg)		IP	
		Mojo	Koka	Mojo	Koka
As	18.4	13.61	23.43	0.74	1.27
Sn	52.3	44.12	32.47	0.84	0.62
Pb	21.4	21.66	26.61	1.01	1.24
B	23.2	17.12	23.16	0.74	1.00
Zn	95	59.01	57.40	0.62	0.60
Cd	2.1	2.29	3.22	1.09	1.53
Hg	2.81	4.07	3.77	1.45	1.34
Cu	20	13.77	13.12	0.31	0.29
Ni	68	18.26	23.05	0.27	0.34
Co	14.91	7.61	9.53	0.51	0.64
Fe	47200	24251.67	27630.83	0.51	0.59
Mn	860	858.33	815.83	1.00	0.95
Cr	8.2	21.32	27.18	2.60	3.31

Table 4: Transfer factors of trace metals from the soil into the vegetable (onion) samples.

Heavy metals (mg/kg)	For soil samples				For onion samples				Soil to onion transfer factors (TF)	
	Mojo		Koka		Mojo		Koka			
	Min	Max	Min	Max	Min	Max	Min	Max	TF of Mojo sites	TF of Koka sites
As	11.93	15.28	14.33	32.52	0.43	1.73	0.70	0.98	0.11	0.03
Sn	28.73	59.50	24.70	40.23	0.30	4.58	0.20	1.70	0.08	0.04
Pb	18.97	24.35	24.23	28.98	1.08	3.78	1.32	1.72	0.16	0.06
B	11.12	23.12	20.12	26.20	5.63	35.80	5.63	8.30	1.55	0.32
Zn	49.93	68.08	46.88	67.92	10.78	14.52	9.08	18.37	0.21	0.27
Cd	1.25	3.33	2.78	3.65	0.20	0.48	0.18	0.28	0.15	0.08
Hg	3.48	4.65	3.33	4.20	1.58	2.15	1.63	2.13	0.46	0.51
Cu	13.07	14.47	11.38	14.85	3.32	31.38	6.13	8.33	2.17	0.56
Ni	15.13	21.38	20.08	26.02	0.35	1.47	0.40	0.93	0.07	0.04
Co	6.77	8.45	7.57	11.50	0.13	0.63	0.25	0.40	0.07	0.03
Fe	21560.00	26943.33	24408.33	30853.33	31.10	245.62	40.27	44.58	0.01	0.00
Mn	606.67	1110.00	691.67	940.00	8.47	39.72	9.28	15.20	0.04	0.02
Cr	17.20	25.43	24.38	29.98	0.62	2.35	0.70	1.80	0.09	0.06

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Table 5: Estimated Daily Intake (EDI), Target Hazard Quotient (THQ), and Health Risk Index (HRI) of heavy metals.

Elements	Mojo site		Koka site	
	EDI	THQ	EDI	THQ
As	0.0014	0.0003	0.0011	0.0002
Sn	0.0025	0.0005	0.0013	0.0003
Pb	0.0030	0.0006	0.0021	0.0004
B	0.0176	0.0036	0.0104	0.0021
Zn	0.0176	0.0036	0.0198	0.0040
Cd	0.0005	0.0001	0.0004	0.0001
Hg	0.0025	0.0005	0.0026	0.0005
Cu	0.0161	0.0033	0.0108	0.0022
Ni	0.0012	0.0002	0.0011	0.0002
Co	0.0005	0.0001	0.0004	0.0001
Fe	0.1120	0.0228	0.0603	0.0123
Mn	0.0243	0.0050	0.0165	0.0034
Cr	0.0015	0.0003	0.0015	0.0003
HRI	0.0409		0.0262	

as a transfer factor. It is noted that in both irrigation sites, the overall pollution load of trace metals, including As, Pb, Cd, and Hg, was somewhat higher in the majority of the onion study. Fe has significant sorption to the soil colloids, while Cu is comparatively poorly maintained in the soil or more effectively absorbed by plants. Therefore, to reduce the direct impact of these dangerous heavy metals on human-ecological systems, management, and proper treatment are important before releasing industrial wastes into the environment.

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The data used to support the findings of this study are included in the article. The used materials are available in the Ethiopian Institute of Agricultural Research Laboratory.

Data availability

The data that has been used is confidential.

Authors contribution

Conceptualization: Leta Danno Bayissa; Data curation: Hailu Reta Gebeyehu; Formal analysis: Hailu Reta Gebeyehu; Investigation: Hailu Reta Gebeyehu; Methodology: Nibret Mekonen and Hailu Reta; Supervision: Leta Danno Bayissa; Validation: Leta Danno Bayissa; Data analysis and interpretation: Nibret Mekonen; Writing – manuscript: Nibret Mekonen; Writing – review & editing: Nibret Mekonen.

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