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Levels of Heavy Metals in Some Vegetables and Human Health Risk Assessment in Loumbila Area, Burkina Faso

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Abstract

Contamination by heavy metals of soil, water and agricultural products is currently a major problem of environmental pollution in the world. The consumption of plants contaminated with heavy metals can be the cause of diseases such as cancers, the number of cases of which is only growing. The objective of this study was to determine the concentration of copper (Cu), chromium (Cr), zinc (Zn), lead (Pb), nickel (Ni), and cadmium (Cd) in plants from the vegetable farm of LOUMBILA and the assessment of health risks linked to the consumption of plants. In this paper, the concentration of heavy metal in vegetable was measured using the model AANALYST 200 flame atomic absorption spectrometer from PERKIN ELMER. The level of Zn in the vegetables from Loumbila vegetable farms ranged between 42.95 mg/kg and 78 mg/kg. The concentrations of Zn in the studies vegetables were higher than the permissible levels set by FAO/WHO (20 mg/kg). The concentration Pb in vegetables varied from 1.73 mg/kg to 27.02 mg/kg. All concentrations of Pb in vegetable were higher than the permissible levels set by FAO/WHO (0.3 mg/kg). Daily intake of Ni, Cr and Pb was higher than the MTDI, so consumption of vegetables from Loumbila vegetable farms can lead to health problems related to Ni, Cr and Pb. In vegetables from LOUMBILA, the estimated daily intake decreased in the following order: Zn > Cu > Pb > Ni > Cr. The Hazard index values for carrot, onion, lettuce, green bean and onion leaves were greater than (>) one (1) which indicates that there might be a potential health risk to those consuming these vegetables. The Target Cancer Risk (TCR) analysis also revealed the potential cancer risk induced by Cu, Ni, Zn, Cr and Pb due to the consumption of carrot, onion leaves, onion, lettuce, green bean, and bell pepper because their TCR values were above the threshold.

Keywords

Heavy Metal, Concentration, Vegetables, Daily Intake, Hazard Index

1. Introduction

The subject of environmental contamination by toxic substances such as heavy metals is a very important focus in recent and current environmental research activities. Heavy metals accumulate in the environment through the processes of weathering and artificial dissolution; they can be introduced into soils and waters during mining, agricultural and industrial activities. Once present in soil and water, many of these metals can contaminate water, soil and plants [1] [2].

The plants heavy metals concentrations depend on the soil concentration and the accumulation of heavy metals in the soil can be caused by waste water irrigation. Also, the use of waste water can increase the contamination of heavy metals (Pb, Ni, Cd, Cu, Zn, Mn, Cr…) in the plants [3] [4]. The vegetable from the contaminated soil can accumulate some high concentration of heavy metal and cause some serious risk to human health [5]. As an example, John *et al.*, (2012) show that the vegetable and the soil from Kaduna city are polluted by Pb, Cd and Cr [6].

Pb concentrations in cabbage (10.51 mg/kg), lettuce (10.19 mg/kg), green pepper (9.44 mg/kg), hot pepper (7.61 mg/kg) and ayoyo (9.05 mg/kg) from Accra vegetables crops sites were above the FAO/WHO recommended maximum limit of 0.30 mg/kg for Pb. Health risk assessments have showed that the hazard indices for vegetables analyzed from Accra vegetables crops sites were less than 1 (USEPA), indicating no risk of heavy metal toxicity [7].

The study of certain plants from BAUCHI has shown the presence of heavy metals (Pb, As, Cd, Cr and Zn) in different parts of the plants and at various concentrations, with some concentrations exceeding the limits authorized by the WHO/FAO. The highest average concentration was recorded in the roots. Pepper (*Capsicum annuum*), Tomato (*Solanum lycopersicum*) and Onion (*Allium cepa*) have been shown to be Cd and Cr hyperaccumulators. The Hazard Index (HI) of heavy metal contamination in Pepper, Tomato and Onion was greater than one, indicating a potential risk to human health [8].

Burkina is a landlocked country with weak waters resources. The development of agriculture is becoming very important with the used of wastewater, dam water, drilling water and well water. The used of water in agriculture without knowing the quality of the water can be the cause of environment and vegetable pollution.

The present work deals with the determination of copper (Cu), chromium (Cr), zinc (Zn), lead (Pb), nickel (Ni), and cadmium (Cd) concentrations in some vegetables from Loumbila vegetable farms and Human Health Risk Assessment. The specific objectives of this study were: to determine the concentrations of the heavy metal in the plants; to calculate the daily intakes from the concentrations; to calculate the Target Risk Quotient; to calculate the Hazard Indices (HI) and to estimate the Target Cancer Risks.

2. Material and Method

2.1. Study Area

In this study, the vegetables samples were collected in different agricultural areas at Loumbila market garden. Distance of eighteen (18) kilometers from Ouagadougou capital city of Burkina, Loumbila market garden is expanding around the dam. The dam is located at a longitude of 01˚24'07.4 West and a latitude of 12˚29'35.8 North with the water capacity of 42.2 million cubic meter. It is used by market gardeners to irrigate the plants [9].

Loumbila's market gardening areas have a much-diversified production of vegetables, namely onion, tomato, okra, zucchini, African eggplant, eggplant, pepper, bell pepper, lettuce, cabbage, carrot, green bean, and potato. Market garden products from Loumbila can be found in most markets in the city of Ouagadougou or exported to neighboring countries. These reasons led to the choice of the Loumbila market gardening areas to carry out this study, by choosing the most consumed vegetables in the city of Ouagadougou.

2.2. Sample Collection

During this study, a vegetables samples collection campaign was carried out in the Loumbila market gardening area located downstream from the dam. The following materials were used for sample collection:

- A pickaxe to dig up the chosen plant species;
- A ceramic knife to separate leaves and fruits lengthwise to ensure consistency in analyzes. The ceramic knife prevents any external contamination;
- The plastic seals to wash the samples of the plants taken;
- Distilled water for rinsing the leaves and fruits;
- A cooler containing ice for storing samples.

Sampling was carried out at regular intervals and over the entire plot for each type of sample. The different plants were sampled by separating the different plant tissues (roots, leaves, stems and fruits) of each plant using a ceramic knife to avoid contamination. To measure an average concentration, at the plot level, the samples were mixed by family and constitute an aliquot. Plant samples for analysis of heavy metal were placed in plastic bags. These samples were then stored at −20˚C in the BUMIGEB Analysis Laboratory. African eggplant, cabbage, okra, eggplant, corchorus olitorius leaf, amaranthus hybridus leaf, lettuce, spinach, tomato and chili were collected during the campaign.

2.3. Sample Preparation

The vegetables were washed up with tap water thoroughly to remove the attached dust particles, soil, unicellular algae, etc. Then they were washed with distilled water and finally with deionized water. The washed vegetables were dried at room temperature to remove surface water. The vegetables were immediately kept in desiccators to avoid further evaporation of moisture from the materials. After that the vegetables were chopped into small pieces and were oven dried. Then the vegetables were crushed into fine powder using a porcelain mortar and pestle. The resulting powder was kept in air tight polythene packet at room temperature before being taken to the laboratory for digestion and metals analysis.

2.4. Digestion and Metal Analysis

The vegetable sample (1 g) was weighed into a 100 ml volumetric flask and concentrated acids of 10.0 mL of concentrated sulfuric acid were added to each sample. The samples obtained after adding concentrated acid were gently on a hot plate, stirring occasionally until the powder completely dissolved in the solution (about 10 to 15 minutes). Then 10 ml of distilled water was added and the whole was heated gently for a few minutes (5 to 10 mins). Finally, the solution was left to stand for it to settle well and the filtrate was taken for analysis.

A model AANALYST 200 flame atomic absorption spectrometer from PERKIN ELMER was used for copper (Cu), chromium (Cr), zinc (Zn), lead (Pb), nickel (Ni), and cadmium (Cd) analysis.

The final concentration of each metal in the plant was calculated using the following formula:

$$C\ \text{final}\left(\text{mg/kg}\right)=\frac{\text{Cmetal} * \text{dilution factor} * \text{nominal volume}}{\text{sample weight}\left(\text{g}\right)} \tag{1}$$

2.5. Health Risk Assessments

To assess the health risks associated with the consumption of the plants studied, the estimated daily intake, target hazard quotient and the hazard index were calculated from the concentrations obtained.

2.5.1. Estimated Daily Intake (EDI)

The estimated daily intake of each metal studied was determined from the concentration of the metal in plants using Equation (2):

$$\text{EDI}=\frac{E_f \times E_D \times F_{IR} \times C_M \times C_f}{B_W \times T_A} \times 0.001 \tag{2}$$

where E_f is exposure frequency (365 day/year); E_D is the exposure duration (65 years), equivalent to average life time; F_{IR} is the average food (vegetable) consumption (240 g/person/day); C_M is metal concentration (mg/kg dry weight); C_f = 0.085 is concentration conversion factor; B_W is reference body weight for an adult (70 kg); T_A is the average exposure time in 65 yrs (23,725 days) and 0.001 is unit conversion factor [10] [11] [12].

2.5.2. Target Hazard Quotient (THQ)

The Target hazard quotient (THQ) assesses the non-carcinogenic health risk (non-carcinogenic human toxicity) to humans who consume vegetables contaminated with heavy metals. The THQ reflects the potential harm to human health from heavy metals in agricultural products. In this study, target hazard quotients were estimated. THQ values for the population consuming vegetables from irrigated perimeters were calculated using Equation (3):

$$\text{THQ} = \frac{\text{EDI}}{\text{RfD}} \quad (3)$$

where EDI is the estimated daily metal intake of the population in mg/day/kg of body weight and RfD is the values of the oral reference dose (mg/kg/day) for each metal of interest and as indicated in **Table 1**.

If the calculated THQ value is <1, indicates that consumption of the vegetables is presumed safe and if THQ value is >1, indicates the potential health risk due to the consumption of the products with increasing probability as the consumption increases [10] [13] [14] [15] [16].

2.5.3. Hazard Index (HI)

The hazard index characterizes the risks to the health of individuals linked to the accumulation of heavy metals analysed in the same vegetable.

The hazard indices (HI) of the studied metals were calculated using Equation (4) [10] [17] [18] [19]:

$$\text{HI} = \sum_{n=1}^{i} \text{THQ}_n ; \text{avec } i = 1, 2, 3, \cdots, n \quad (4)$$

2.5.4. Target Cancer Risk (TCR)

The cancer risk (CR) in humans due to ingestion of potentially carcinogenic heavy metals was estimated using Equation (5). Then, the target cancer risk (TCR) resulting from the ingestion of heavy metals, which can cause cancer depending on the exposure dose, is from Equation (6) [10]:

$$\text{CR} = \text{EDI} * \text{CPS}_0 \quad (5)$$

$$\text{TCR} = \sum_{i=1}^{n} \text{CR}_i ; i = 1, 2, 3, \cdots, n \quad (6)$$

where EDI is the estimated daily metal intake of the population in mg/day/kg body weight, CPS_0 is the oral cancer slope factor in $(mg/kg/day)^{-1}$ and n is the number of heavy metals considered for cancer risk calculation. The CPS_0 values for As, Pb, Cd, Cr and Ni are given in **Table 2** [10] [20].

3. Results and Discussions

3.1. Concentration of Heavy Metals in Vegetable

Table 3 shows the concentrations of heavy metals in carrot, onion leaves, onion, lettuce, green bean, and bell pepper from LOUMBILA's market gardening areas.

Table 1. Values of the oral reference dose (mg/kg/day).

	Cu	Ni	Zn	Cd	Cr	Pb
RfD (mg/kg/day)	0.04	0.02	0.3	0.001	0.0003	0.0035

Table 2. Values of Oral Cancer Slope Factor (CPS_0) $(mg/kg/day)^{-1}$ for each metal.

Metal	Cu	Ni	Zn	Cr	Pb
Oral cancer slope factor (CPS_0) $(mg/kg/day)^{-1}$	0.3	1.7	0.3	0.5	0.0085

Table 3. Average concentrations of heavy metals in plants.

	Cu	**Ni**	**Zn**	**Cr**	**Pb**
Carrot	17.6	11	42.95	1.3	27.02
Onion leaves	16.4	11.16	57.72	3.72	10.48
Onion	19.81	10.05	73.37	4.65	11.52
Lettuce	16.9	5.09	70.1	4.89	15.44
Green bean	16.06	8.58	78	5.89	4.09
Bell Pepper	19.65	7.01	70.39	3.56	1.73
Average concentration	**17.74**	**8.82**	**65.42**	**4.00**	**11.71**
FAO/WHO safe limit in vegetables	**40**	**80**	**20**	**2.3**	**0.3**

Copper is an essential micronutrient which functions as a biocatalyst required for body pigmentation in addition to iron, maintain a healthy central nervous system, prevents anaemia and interrelated with the functions of zinc and iron in the body [21]. In excess in the body copper can be the origin of organic diseases such as gastroenteritis with nausea and intestinal irritations [22]. The Cu level in studies vegetables from Loumbila market garden ranged between 16.06 mg/kg in *green bean* and 19.81 mg/kg in Onion. The Cu levels in the vegetables presented in this study were lower than WHO/FAO suggested safe limits of 40 mg/kg.

Nickel is essential for growth and reproduction in livestock and man, but could be carcinogenic (nose, lung) in high amount in the body. Nickel can also cause diseases such as allergies, dermatitis, eczema, asthma, congenital malformations, headaches, dizziness, and lack of sleep [22] [23] [24]. In this study, the concentrations of nickel in the vegetables from the Loumbila market garden ranged between 5.09 mg/kg in lettuce and 11.16 mg/kg in Onion leaves.

Nickel content in vegetables was found to be lower than the estimated maximum guideline set by United State Food and Drug Administration of 70 - 80 mg/g. These variations of Ni concentration in various vegetables might be due to the pollutants in soil, air, water, factory wastages, sewerages etc. Nickel is reported to be a common cause of allergic contact dermatitis [21].

In human body, Zn is essential for normal growth, mental ability, immune system, reproduction and healthy function of the heart [21]. The level of Zn in the studies vegetables from Loumbila market garden ranged between 42.95

mg/kg and 73.37 mg/kg with the highest recorded in onion and the least in carrot. All concentrations of Zn obtained in this study, were higher than the permissible levels by FAO/WHO in vegetables of 20 mg/kg. In the study done by Bambara *et al.* (2015), the concentration of Zn in the vegetables from Loumbila market garden ranged between 0.26 mg/kg and 4.52 mg/kg with the highest recorded in *tomato [25].* Consumption of vegetables from Loumbila market garden could cause nausea, vomiting, loss of appetite, abdominal cramps, diarrhea, headaches and inhibition of copper absorption which sometimes produce copper deficiency and associated anemia [21].

The concentrations of Cr in the studies vegetables from Loumbila market garden ranged between 1.3 mg/kg in carrot to 5.89 mg/kg in *green bean*. Chromium levels in onion leaves, onion, lettuce, green bean and bell pepper was higher than the safe limits (2.3 mg/kg). In a study done by Bambara *et al*., (2015), the concentration of tomato from Loumbila market garden was higher than the safe limits [25]. These high concentrations of Cr might be accumulated in the vegetables due to the contamination of soil, wastewater or fertilizer [3] [4] [26]. Cr is a trace element necessary for carbohydrate, fat and cholesterol metabolism and important for many hormones and enzyme activity in a certain concentration (up to 200 mg/day) but chronic exposure to Cr may damage liver and kidney and causes organic diseases such as cancers (lungs, nose, stomach, intestine) and dermatitis [21] [22].

The highest Pb concentration in vegetables obtained from Loumbila market garden was recorded in carrot (27.02 mg/kg) and the least in bell pepper (1.73 mg/kg). All concentrations of Pb obtained in this study, were higher than the permissible levels by FAO/WHO in vegetables of 0.3 mg/kg. The values have been previously reported in leafy vegetables which include 8.194 mg/kg from Baskuy and 5.307 mg/kg from Boulbi by Derra *et al.* (2018) for lettuce [27]. The high levels of lead in all vegetable's samples may probably be attributed to pollutants in irrigation water, farm soil, fertilizer or due to pollution from the highways traffic and industrial sites located around the sampled locations [3] [4] [26]. Pb is highly toxic heavy element and its intake via vegetable consumption can cause effect on liver, kidney, vascular and immune system [21]. The consumption of vegetable from Loumbila market garden can cause also neurological and psychiatric effects such as depressions leading to suicide, lack of attention, impairment of visual intelligence and motor functions, memory impairment, learning difficulties, states of fatigue, restlessness, aggressiveness, psychoses, hallucinations, peripheral polyneuropathy, encephalopathy, and lead poisoning [23].

Figure 1 presents the histograms of the concentrations of copper, nickel, zinc, chromium and lead in carrot, onion leaves, onion, lettuce, green bean and pepper.

The results of this study show that carrot, onion leaves, onion, lettuce, green bean and bell pepper accumulated more zinc.

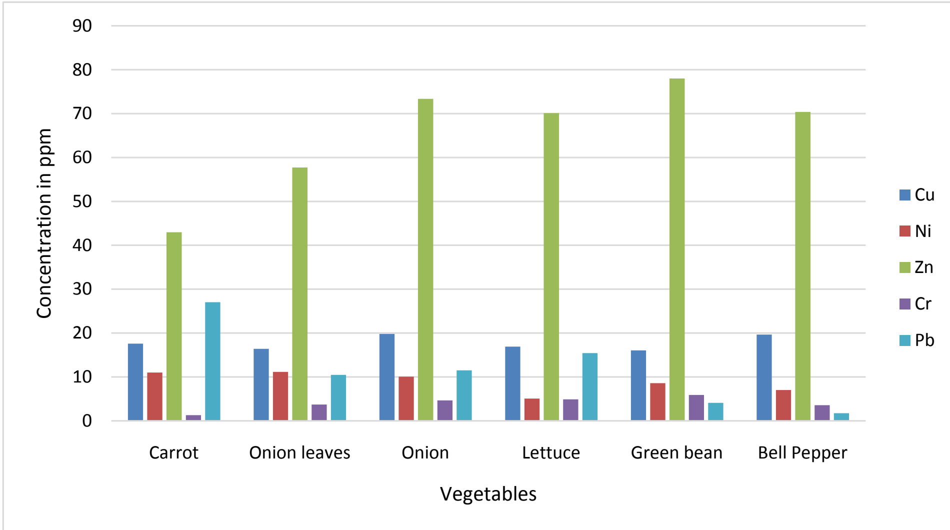

Figure 1. Histogram of heavy metal concentrations in the studied plants.

The carrot accumulated more lead than the other metals studied and its lead concentration is above the limit. Therefore carrot consumers could be exposed to haematological and cardiovascular effects (hypertension), kidney damage [23], and liver disease [22].

Onion leaves are more nickel accumulating. Onion was the most copper accumulator among the plants studied. Hence a high consumption of onions and these leaves can lead to an accumulation of copper and nickel in the body.

The green bean was the plant that accumulated the most chromium and zinc. The concentrations of both storage metals in green bean were above the limit. The consumption of green beans can lead to cancers (lungs, nose, stomach, intestine) and dermatitis [22] also leads to liver and kidney problems [21].

Figure 2 presents the average concentrations of copper, nickel, zinc, chromium and lead in vegetables and gives a comparison between the average concentrations and the FAO/WHO limit values.

The average values of copper and nickel in the studied vegetables were below the FAO/WHO limits. The average concentration of zinc was more than three (3) times greater than the FAO/WHO limit and that of lead is more than thirteen nine (39) times greater. This allows us to say that the consumption of carrot, onion leaves, onion, lettuce, green bean, and bell pepper from Loumbila market garden can be the cause of health problems linked to lead and zinc. The high concentrations of lead and zinc led to an assessment of the health risks associated with the consumption of carrot, onion leaves, onion, lettuce, green bean, and bell pepper.

3.2. Estimated Daily Intake (EDI)

Table 4 shows the estimated daily intake of heavy metals (Cu, Ni, Zn, Cr and Pb) in carrot, onion leaves, onion, lettuce, green bean, and bell pepper from LOUMBILA.

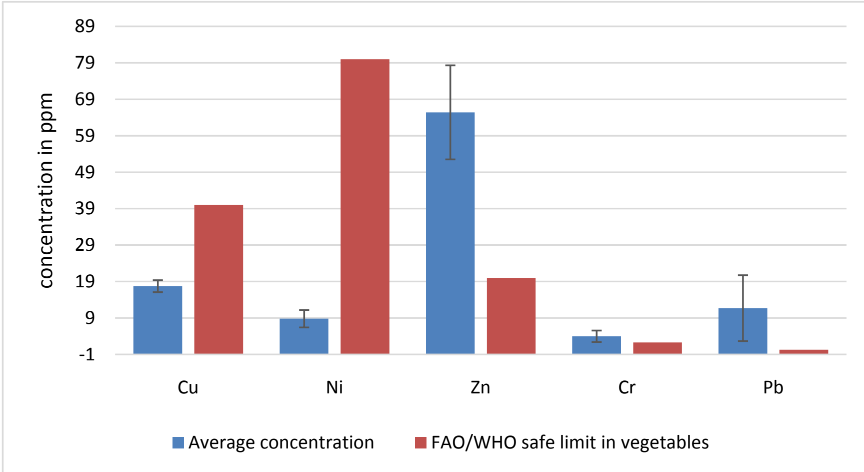

Figure 2. Comparison between average concentrations of heavy metals in vegetables and FAO/WHO limits.

Table 4. Estimated daily intake (mg/day/kg body weight).

Vegetables	Estimated daily intake (EDI)				
	Cu	Ni	Zn	Cr	Pb
Carrot	5.13E-03	3.21E-03	1.25E-02	3.79E-04	7.87E-03
Onion leaves	4.78E-03	3.25E-03	1.68E-02	1.08E-03	3.05E-03
Onion	5.77E-03	2.93E-03	2.14E-02	1.36E-03	3.36E-03
Lettuce	4.93E-03	1.48E-03	2.04E-02	1.43E-03	4.50E-03
Green bean	4.68E-03	2.50E-03	2.27E-02	1.72E-03	1.19E-03
Bell Pepper	5.73E-03	2.04E-03	2.05E-02	1.04E-03	5.04E-04
Total daily intake from vegetables (mg/day)	**2.17**	**1.08**	**8.01**	**0.49**	**1.43**
Maximum Tolerable Daily Intake (MTDI) (mg/day)	**2.5 - 3**	**0.1 - 0.3**	**60 - 65**	**0.035 - 0.2**	**0.21**

The EDI of Cu, Ni, Zn, Cr and Pb were calculated according to the concentration of each heavy metal in each vegetable and the respective consumption rates. The EDI and maximum tolerable daily intake (MTDI) of studied metals from consumption of vegetables are shown in Table 4. Total daily intakes of Cu, Ni, Zn, Cr and Pb were 2.17 mg/day, 1.08 mg/day, 8.01 mg/day, 0.49 mg/day, 1.43 mg/day respectively. Daily intakes of Cu and Zn were less than the MTDI. Daily intake of Ni, Cr and Pb were higher than the MTDI, so consumption of carrot, onion leaves, onion, lettuce, green bean, and bell pepper can lead to health problems related to Ni, Cr and Pb. In vegetables samples, the EDI decreased in the following order: Zn > Cu > Pb > Ni > Cr.

3.3. Target Hazard Quotient (THQ) and Hazard Index (HI)

Target hazard quotient of heavy metals (Cu, Ni, Zn, Cr and Pb) in each vegetable and the Hazard Index of eggplant, African eggplant, okra, pepper, tomato, cabbage, carrot, onion, lettuce, green bean, bell pepper, spinach, African eggplant leaves and onion leaves from LOUMBILA are given in Table 5.

Table 5. Target hazard quotient and Hazard index.

Vegetables	Target hazard quotient (THQ)					Hazard Index (HI)
	Cu	Ni	Zn	Cr	Pb	
Carrot	0.1282	0.1603	0.0417	0.1263	2.2498	2.7064
Onion leaves	0.1195	0.1626	0.0561	0.3614	0.8726	1.5722
Onion	0.1443	0.1464	0.0713	0.4517	0.9592	1.7730
Lettuce	0.1231	0.0742	0.0681	0.4750	1.2856	2.0260
Green bean	0.1170	0.1250	0.0758	0.5722	0.3406	1.2305
Bell Pepper	0.1432	0.1021	0.0684	0.3458	0.1440	0.8036

The target hazard quotient (THQ) of Cu was within the range of 0.1170 to 0.1443. The THQ of Nickel ranged between 0.0742 to 0.1626, with the highest value recorded in onion leaves. Zinc THQ value ranged between 0.0417 to 0.0758. The highest THQ of Zn was observed in green bean. The THQ of Chromium was within the range of 0.1263 to 0.5722 and the highest target hazard quotient was observed in green bean. The THQ of lead ranged between 0.1440 to 2.2498, with the highest value recorded in carrot.

Lead is the metal with the highest THQ values in vegetables. Lead THQ values in carrot (2.2498) and lettuce (1.2856) were greater than one. The consumption of carrots and lettuce can cause lead-related diseases.

Figure 3 shows the hazard index in carrot, onion leaves, onion, lettuce, green bean, and bell pepper from LOUMBILA.

The hazard index (HI) of heavy metals (Cu, Ni, Zn, Cr and Pb) in vegetables from LOUMBILA was between 0.8036 and 2.7064. The highest value of HI was observed in carrot. The HI shows when a population is at risk. In this study, it was observed that the HI values for carrot, onion leaves, onion, lettuce and green bean were greater than (>) one (1) which indicates that there might be a potential health risk to those consuming these vegetables. The HI value for bell pepper was less than (<) one (1).

Lead was the metal that contributes the most to the hazard index of carrots, onion leaves, onions and lettuce. Copper contributes the most to the hazard index of green beans and bell peppers.

3.4. Cancer Risk (CR) and Target Cancer Risk (TCR)

Cancer risk (CR) of heavy metals (Cu, Ni, Zn, Cr and Pb) in each vegetable and the Target Cancer Risk (TCR) of carrot, onion leaves, onion, lettuce, green bean, and bell pepper from LOUMBILA are given in Table 6.

The cancer risk value of copper in the plants studied varies between 1.40×10^{-3} and 1.73×10^{-3}. Copper cancer risk values were above the maximum threshold value of 1×10^{-4} [10] [28], which indicates that there is a very high risk for consumers to develop cancers related to copper.

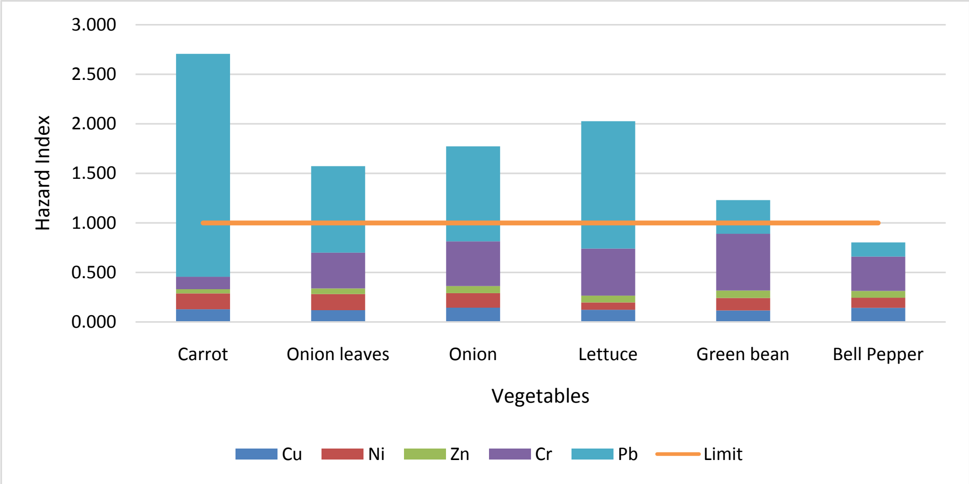

Figure 3. Hazard index of some vegetables from LOUMBILA.

Table 6. Cancer Risk (CR) and Target Cancer Risk (TCR).

Vegetables	Cancer Risk (CR)					Target Cancer Risk (TCR)
	Cu	Ni	Zn	Cr	Pb	
Carrot	1.54E-03	5.45E-03	3.76E-03	1.89E-04	6.69E-05	1.10E-02
Onion leaves	1.43E-03	5.53E-03	5.05E-03	5.42E-04	2.60E-05	1.26E-02
Onion	1.73E-03	4.98E-03	6.41E-03	6.78E-04	2.85E-05	1.38E-02
Lettuce	1.48E-03	2.52E-03	6.13E-03	7.13E-04	3.82E-05	1.09E-02
Green bean	1.40E-03	4.25E-03	6.82E-03	8.58E-04	1.01E-05	1.33E-02
Bell Pepper	1.72E-03	3.47E-03	6.15E-03	5.19E-04	4.29E-06	1.19E-02

The minimum cancer risk value for nickel was 2.52×10^{-3}, which is a threshold of 1×10^{-4}. So, the consumption of carrots, onion leaves, onions, lettuce, green beans and bell peppers can lead to nickel-related cancers.

The cancer risks of zinc and chromium were above the threshold of 1×10^{-4}, which may lead to the development of cancers related to zinc and chromium for consumers of carrot, onion leaves, onion, lettuce, green bean and bell peppers.

All the cancer risk values for lead were below the 1×10^{-4} threshold, which shows that the consumption of carrots, onion leaves, onions, lettuce, green beans and bell peppers from LOUMBILA does not present any risk of developing a lead-related cancer.

However, 4 out of 5 (80%) heavy metals in samples of carrot, onion leaves, onion, lettuce, green bean and bell peppers from LOUMBILA, for which the estimated CR values were found to be at origin of a risk of cancer for the population.

The TCR value for Cu, Ni, Zn, Cr, and Pb due to consumption of carrot, onion leaves, onion, lettuce, green bean, and bell peppers from LOUMBILA ranged between 1.09×10^{-2} and 1.38×10^{-2}. All the plants studied have their TCR for Cu, Ni, Zn, Cr and Pb greater than 1×10^{-4}, which can lead to cancers linked to these metals in consumers.

4. Conclusions

The main objective of this paper was to estimate the heavy metal concentrations in carrot, onion leaves, onion, lettuce, green bean, and bell pepper from Loumbila vegetable farms and evaluate Human Health Risk. This study showed that the concentrations of Zn and Pb in the studies vegetables were higher than the permissible levels set by FAO/WHO.

The HI values were greater than (>) one (1) for carrot, onion leaves, onion, lettuce and green bean and less than (<) one (1) for bell pepper. The consumption of carrot, onion leaves, onion, lettuce and green bean can lead to health risks. TCR values for Cu, Ni, Zn, Cr and Pb due to consumption of carrot, onion leaves, onion, lettuce, green bean and bell peppers also exceeded the maximum threshold value of 10^{-4}. This generally suggests the presence of a potential Cu, Ni, Zn, Cr and Pb related cancer risk for the population due to the consumption of carrot, onion leaves, onion, lettuce, green beans and bell peppers grown in LOUMBILA.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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