Anti- Nutritional Status, Hazard indices, (Transfer Factor, TF and Hazard Quotients, HQ) in Carrot, Cabbage, lettuce, Spinach and Spring Onion Obtained from Farin gada Vegetable farm Jos North Local Government, Plateau State. Nigeria.

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Abstract

Carrot, cabbage lettuce, spinach and spring onion are vegetables with great health benefits to human beings, based on their nutritional contents which produce vitamins that help strengthen bones and minerals that benefit the skin. This study investigates the heavy metal present in the soil and vegetables. Six heavy metals of zinc, cadmium, copper, arsenic, lead and chromium were determined in the five sample of vegetables and the soil samples. The heavy metal concentration was used to determine the transfer factor from the soil to the vegetable and the hazard quotient showed that the values were less than one and this implies that they are below the daily recommended dose of the metals. Hence the vegetable was not affected by transfer of metal from soil to the vegetables. Thereby making them safe for consumption and good for health. The heavy metal content of the soil sample was found to be less than the permissible limit except for that of Arsenic which was found to be greater than the permissible limit of consumption.

Keywords: Transfer factor, hazard quotient carrot, cabbage, lettuce, spinach, spring onion

Statut Anti-Nutritionnel, Indices de Danger (Facteur de Transfert, TF et Quotients de Risque, HQ) dans la Carotte, le Chou, la Laitue, les Epinards et l'Oignon Nouveau Obtenus de la Ferme Maraichère Farin gada du Gouvernement Local de Jos North, Etat du Plateau. Nigéria.

Résumé

La carotte, la laitue, les épinards et la ciboule sont des légumes très bénéfiques pour la santé de l'être humain, en raison de leur contenu nutritionnel qui produit des vitamines qui aident à renforcer les os et des minéraux bénéfiques pour la peau. Cette étude étudie les métaux lourds présents dans le sol et les légumes. Six métaux lourds, le zinc, le cadmium, le cuivre, l'arsenic, le plomb et le chrome, ont été déterminés dans les cinq échantillons de légumes et de sol. La concentration de métaux lourds a été utilisée pour déterminer le facteur de transfert du sol au légume et le quotient de risque a montré que les valeurs étaient inférieures

à un, ce qui implique qu'elles sont inférieures à la dose quotidienne recommandée de métaux. Le légume n'a donc pas été affecté par le transfert de métal du sol vers les légumes. Cela les rend sans danger pour la consommation et bons pour la santé. La teneur en métaux lourds de l'échantillon de sol s'est avérée inférieure à la limite autorisée, à l'exception de celle en arsenic qui s'est avérée supérieure à la limite autorisée de consommation.

Mots-clés : Facteur de transfert, quotient de risque carotte, chou, laitue, épinards, oignon nouveau

الجزر وخس الملفوف والسبانخ والبصل الأخضر هي خضروات ذات فوائد صحية كبيرة للبشر، بناءً على محتوياتها الغذائية التي تنتج الفيتامينات التي تساعد على تقوية العظام والمعادن التي تفيد جلد الإنسان تبحث هذه الدراسة في المعدن الثقيل الموجود في التربة والخضروات تم تحديد ستة معادن ثقيلة من الزنك والكادميوم والنحاس والزرنيخ والرصاص والكروم في العينة الخمس للخضروات وعينات التربة تم استخدام تركيز المعادن الثقيلة لتحديد عامل الانتقال من التربة إلى الخضار أظهر حاصل الخطر أن القيم كانت أقل من واحدة وهذا يعني أنها أقل من الجرعة اليومية الموصى بها من المعادن ومن ثم لم تتأثر الخضار بنقل المعادن من التربة إلى الخضار. وبالتالي جعلها آمنة للاستهلاك ومفيدة للصحة وجد أن المحتوى المعدني الثقيل لعينة التربة أقل من الحد المسموح بها باستثناء الزرنيخ الذي تبين أنه أكبر من الحد المسموح به للاستهلاك.

Introduction

Carrots are a root vegetable also known as *Daucus carota,* a member of the Umbelliferae family and thus related to parsley, dill and celery. Like the rest of these vegetables, the carrot plant has an “umbrella like inflorescence called an umbel” 1, a structure seen when the pedicles of each flower all diverge out of a common point on the larger stem of the plant. Nowadays the most commonly cultivated variety called *carota sativus* has an orange root, and were cultivated from earlier yellow versions. In comparison, the wild carrot commonly called Queen Anne 's lace is often white while other varieties of carrots can be purple. The yellow carrots were probably mutated varieties of purple ones that became more popular through extensive breeding. In addition to being different colors, carrots also have many varieties in shape. The most common versions we see today are long and tapering, but other varieties are more round and bulbous or thick and cylindrical. In its second year the plant will flower, a process called bolting at which point the main stalk grows and the many umbels form, displaying small white flowers.(Sinha, 2011) Cabbage or headed cabbage (comprising several cultivars of *Brassica oleracea*) is a leafy green, red (purple), or white (pale green) biennial plant grown as an annual vegetable crop for its dense-leaved heads. It is descended from the wild cabbage, *B. oleracea* var. *oleracea,* and belongs to the "cole crops", meaning it is closely related to broccoli and cauliflower (*var. botrytis*); Brussels sprouts (*var. gemmifera*); and savoy cabbage (*var. sabauda*). Brassica rapa is commonly named Chinese, celery or napa cabbage and has many of the same uses. Cabbage is high in nutritional value. (Shittu, 2015)

Lettuce (*Lactuca saliva L.*) belongs to the family Composite that is the most popular salad crops in the world. It is leafy herb with milky juice crop. It produces a short stem early in the season, a cluster of leaves varying considerably in shape, character and color in different varieties. Later in the season a seed stock is produced. It is mainly a cold loving crop. The best temperature range for lettuce cultivation is 18°C to 25°C and the night temperature is 10°C to 15°C. Lettuce is popular for its delicate, crispy, texture and slightly bitter taste in fresh condition. The nutritive value of lettuce is very high but rests largely upon a good

content of minerals and a moderate storage of vitamins to the human diet plus substantial amount of fiber and that of water. It also contains protein, carbohydrate and vitamin C. Per hundre6 gram of edible portion of lettuce contains moisture 93.4 g, protein 2.1 g, fat 0.3 g, minerals 1.2 g, fiber 0.5 g, carbohydrates 2.5 g, calcium 310 mg, phosphorus 80 mg, iron mg, vitamin A 1650 I.U thiamine 0.09 mg, riboflavin 0.13 mg and vitamin C 10 mg. It is usually used as salad with tomato, carrot, cucumber or other salad vegetable. It is often served alone or with dressing. Its nutritive value is not spoiled. Moreover, it is anodyne, sedative, diuretic and expectorant. (Zinia, 2007)

The word "spinach" is derived from the Persian word "*ispanai*" which means „green hand, which later became *"spanachia*". in late Latin, and ultimately "spinage". and then "spinach". in English. Spinach, or "roundleaf spinage", is a staple of the early American vegetable gardens. It is a relatively quick-growing vegetable and easy to maintain. Spinach is in the classification system Family *Amaranthaceae*. *spinacia oleraceae* being its official scientific classification name. Within *Amaranthaceae* there are about 102 genera and 1400 species worldwide. It is within the family of leafy green vegetables, referred to as "greens "or" potherbs", because they were historically cooked before eating. Spinach ranges in color from light to dark green and comes in two general types: the crinkle leaf variety and the smooth leaf variety, although there are varieties that contain characters of both, known as "semi-Savoy Spinach." (Sinha, 2011)

The onion is a subspecies and primary member of the genus Allium. Because many Allium species share the common name onion, the "garden onion" also known as the "bulb onion" and "shallot"is referred to as Allium cepa. The plant's name comes from the Latin unio, or annianus, and is associated with the Welsh minion, meaning "anvil." (Katherine et al., 2008)

Onions (*Allium cepa* L.) are bulbous vegetables from the *Liliaceae* family, important in terms of domestic consumption and export. Onions are grown mainly as food materials. They are highly valued for their flavor and for their nutritional value. Onion bulb which may be red, white or yellow in colour, is consumed in its tender state, raw, ripe, pickled or in form of powder. The bulbs are boiled and used in soups and stews, fried or eaten raw. They are also preserved in the form of pickles. Onion leaves are also used in salads and soups. (Maria, 2009)

Materials and methods

Materials

Distilled water, nitric acid (HNO_3) *hydrochloric acids (HCl), (sigma Aldrich). All reagents were used as received.*

Sampling Area

The Farin Gada vegetable garden is located at Jos North Local Government, Plateau State. The vegetable garden is situated along the river band that is sourced from river Dilimi. The river is used for irrigating the planted crops and vegetables in the garden. The vegetable produced at Farin Gada vegetable garden is one of the largest and best vegetables in Plateau state and Nigeria at large. Jos-North local government is located at the extreme north of Plateau State on Latitudes $09^0\ 53^1$ and $09^0\ 59^1$ North, and Longitudes $08^0\ 51^1$ and $09^0\ 02^1$ East. It shares a boundary to the North with Toro Local Government Area of Bauchi State; to the South with Jos-South Local Government area; to the North-East with Jos-East Local Government Area; and to the West with Bassa Local Government

Area. Jos-North Local Government enjoys a temperate climate with average temperatures of between 28^{0}C (81.7^{0}F) maximum and 11^{0}C (51.7^{0}F) minimum. It covers a total land area of 291 km^2 (112 sq mi) with the 2006 provisional population census figure of 429,300 people. The warmest temperatures usually occur in the dry season months of March and April. Similarly, Jos-North Local Government is characterized by a mean annual rainfall of between 1317.5mm (131.75cm) and 1460.00mm (146.0cm), mostly from May to August. The Onset and Cessation of rainfall in Jos-North are experienced in April (±15 days in April), and October (±15 days in October) respectively. The relative humidity is characterized by a marked seasonal variation.

Samples Collection

Three soils from three different locations as well as five vegetables were obtained from farms within the Farin Gada vegetable Garden Vegetables samples of cabbage, carrot, lettuce, spinach and spring onion were obtained from farms within the Farin Gada vegetable garden. They were taken to the Department of Plant Science and Biotechnology, University of Jos for identification. The samples were air-dried for six weeks. The vegetable leaves and fruits were harvested, destalked, and washed with clean cold tap water.

Figure1: Carrot *(Daucus carota L.*)

Figure2: Cabbege (Brassica *Oleracae*)

Figure 3 : lettue (*Lactuca sativa*)

Figure 4; Spinach (*Spinacia oleracea)*

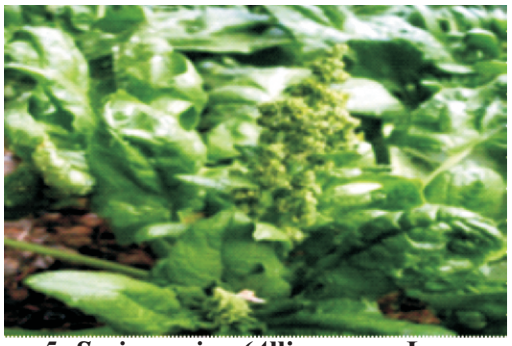

***Figure 5: Spring onion (A*llium cepa L. var. cepa)**

Sample Preparation

Samples were crushed and powdered using a pistol and mortar and kept in air-tight containers for further analysis.

Digestion of sample

*The soil samples (2.5g) and approximately 1g of the soil sample were transferred into a crucible before being mixed with 10ml of aqua regia with consistent of HCl:HNO_3 (3:1). The mixture was then digested on a hot plate at 95°C for one hour and was allowed to cool to room temperature. The sample was then diluted with to 50ml using deionized distilled water and was left to settle overnight. The supernatant was filtered through Whatmann No 42 filter paper, (*Alina *et* al., 2012)

Determination of Heavy Metal in Carrot, Cabbage, lettuce, Spinach and Spring Onion

The heavy metals of the vegetable were determined using Microwave Plasma Atomic Electron Spectroscopy (MPAES).

Determination of Transfer factor of the Heavy Metal from S1, S2 and S3 to the Vegetable of Farin gada Vegetable Garden

The heavy metal transfer factor from Soil to the plant was established according to (Alina *et* al., 2012) by using the formula:

TF = Mp/Ms ---------- (1)

Where:

TF = Transfer Factor

Mp = Metal Content in Plant (Vegetable)

Ms = Metal Content in Soil

Determination of Hazard Quotient of the Vegetable from farin gada Vegetable farm

The concentration of the metal is used to determine the chronic daily intake CDI, the hazard quotient, HQ on both adult and children to estimate the potential risk of the heavy metal determined Mathematically,

CDI can be calculated using the relation which is similar presentation of daily exposed route from (USPEA, 1992) and (Chrowtoskoi, 1994).

CDI = Cx. DI/Bw ---------- (2)

Where

C is the Concentration of the contaminant (mg/L), DI average daily intake rate of the metal and Bw is the body weight in kg.

The hazard quotient (HQ) is calculated using the following equation (Kavcar, *et* al, 2009) and (FAO/WHO; 2015)

HQ = CDI/RFD ---------- (3)

Where

RFD is the reference dose (mg/kg).

Results

Table 1: Heavy Metal Content of Soil Samples at Farin gada Vegetable farm (mg/kg)

Sample	Zn	Cd	Cu	As	Pb	Cr
S1	5.70±0.02	0.05±0.00	0.51±0.00	0.48±0.04	0.53±0.00	0.37±0.00
S2	4.62±1.32	0.03±0.00	0.28±0.00	0.51±0.06	0.43±0.00	0.23±0.00
S3	2.84±0.33	0.04±0.00	0.31±0.00	0.44±0.06	0.60±0.00	0.35±0.00
WHO Standards(mg/kg)	50.00[13]	0.90-3.0[11]	0.400[12]	20.00[11]	30-50[11]	100.00[12]

Key: S1= Soil from Farm One, S2 = Soil from Farm two, S3 = Soil from Farm Three, WHO = World Health organisation, 11 = FAO/WHO (2015), and Commission Regulation (EU) 2015/100, 12= Adu et al. (2012). WHO (1996), 13 = Ogundele DT, Adio AA.

Table 2: Heavy Metal Content of Vegetable Samples from Farin gada Vegetable Farm (mg/kg).

Sample	Zn	Cd	Cu	As	Pb	Cr
CT1	1.36±0.16	0.02±0.00	0.18±0.00	1.28±0.05	0.03±0.00	0.06±0.00
CB1	0.83±0.32	0.00±0.00	0.04±0.00	0.99±0.07	0.04±0.00	0.18±0.00
LT2	0.94±0.20	0.04±0.00	0.24±0.00	1.17±0.05	0.00±0.00	0.09±0.00
SP2	3.00±0.10	0.01±0.00	0.22±0.00	1.18±0.07	-0.01±0.00	0.03±0.00
OS3	1.53±0.83	0.01±0.00	0.18±0.00	1.18±0.08	0.00±0.00	0.06±0.00
WHO Standard	99.40[14]	0.05-2.00[12]	73.00[13]	0.10-0.20[15]	0.300[15]	0.10[15]

Key: CT1= Carrot from Farm One, CB1 = Cabbage from Farm one, LT2 = Lettuce from Farm Two, SP2 = Spinach from Farm Two, OS3 = Spring Onion from Farm Three WHO = World Health organization, 14 =Shuaibu l. K.et al, 15 = de Vries W et al. (2002) and Joint FAO/WHO, (2001), 12 = Adu et al. (2012), 15= EU,(2015/2006).

Table 3: Transfer Factor (TF) of S1, S2 and S3 to Vegetables

Metal	CT1	CB1	LT2	SP2	OS3
Zn	0.239	0.140	0.203	0.639	0.539
Cd	0.400	0.000	1.333	0.333	0.250
Cu	0.350	0.078	0.857	0.786	0.581
As	2.667	2.060	2.294	2.314	2.682
Pb	0.057	0.076	0.000	0.023	0.000
Cr	0.160	0.486	0.391	0.130	0.171

Key: CT1= Carrot from Farm One, CB1 = Cabbage from Farm one, LT2 = Lettuce from Farm Two, SP2 = Spinach from Farm Two, OS3 = Spring Onion from Farm Three WHO = World Health organization.

Table 4: Hazard Quotient (HQ) of Vegetable Samples

Metal	CT1	CB1	LT2	SP2	OS3
Zn	1.10	0.70	78.3	2.50	9.12
Cd	6.60	0.00	1.30	3.00	3.00
Cu	0.60	1.40	8.40	0.80	7.76
As	0.43	19.4	23.00	1416	1416
Pb	0.02	0.30	0.00	-0.70	0.00
Cr	0.40	6.60	0.60	11.10	4.00

Key: CT1= Carrot from Farm One, CB1 = Cabbage from Farm one, LT2 = Lettuce from Farm Two, SP2 = Spinach from Farm Two, OS3 = Spring Onion from Farm Three, HQ = Hazard Quotient (The values of the table were in standard forms of $\times 10^{-4}$)

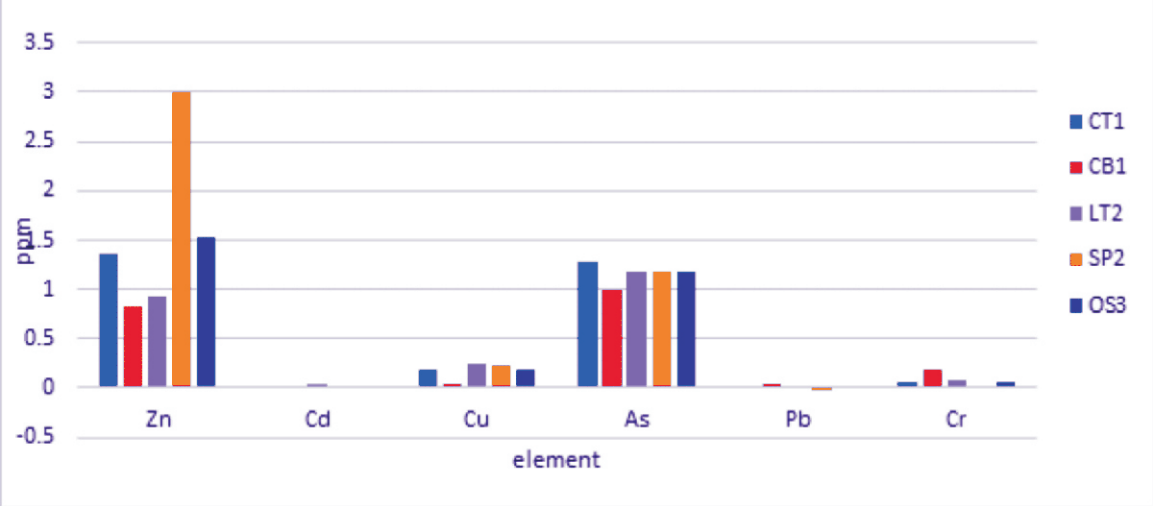

Figure 6: Heavy Metal Concentration of Carrot, Cabbage, lettuce, Spinach and Spring Onion Obtained from Farin gada Vegetable farm**.**

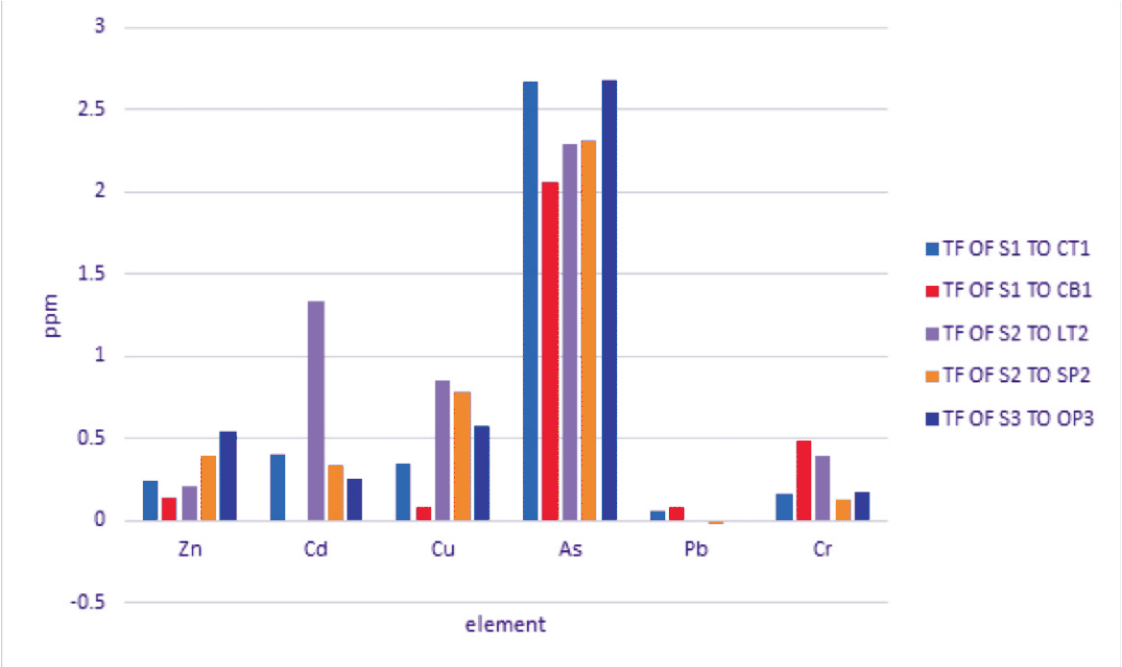

Figure 7: Transfer Factor (TF) of Farin soil to the Vegetables

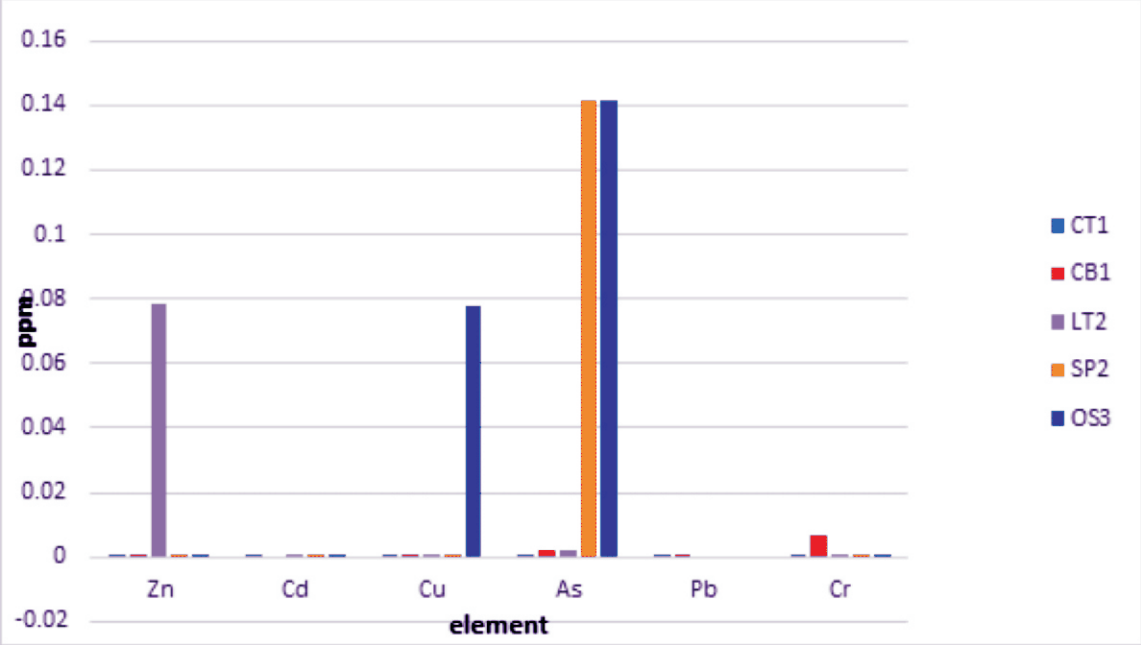

Figure 8: Graph of the hazard quotient of the Farin gada vegetable farm

Discussion

The metal content analysis (table1) shows that the Soil from Farin gada vegetable farm Zinc (Zn) ranges from 2.84±0.33 to 5.70±0.02, Cadmium (Cd) ranges from 0.03±0.00 to 0.05±0.00, Copper (Cu) ranges from 0.28±0.00 to 0.51±0.00, Arsenic (As) ranges from 0.44±0.06 to 0.51±0.06, Lead (Pb) ranges from 0.43±0.00 to 0.60±0.00 and Chromium (Cr) ranges from 0.23±0.00 to 0.37±0.00. Zinc (Zn) ranged from 0.83±0.32 to 3.00±0.10, Cadmium (Cd) ranged from 0.01±0.00 to, 0.04±0.00, Copper (Cu) ranged from 0.18±0.00 to 0.04±0.00, Arsenic (As) ranged from 0.99±0.07 to 1.28±0.05, Lead (Pb) ranged from -0.01±0.00 to 0.04±0.00 and Chromium (Cr) ranged from 0.03±0.00 to 0.18±0.00

The Transfer Factor (table 3) of Zinc (Zn) in the vegetable samples was less than one which reveal that it is good for consumption since it does not exceed the limit. Cadmium (Cd) was also less than one with the exception of LT2 which is greater than one and this reveal that is not safe for consumption because it is greater than one. In copper (Cu), the transfer factor (TF) is values in all the vegetable is less than one which reveal that they are safe from contamination and are good for consumption. Arsenic(As) TF in all the vegetables sample is greater than one, this implies that this implies that they are polluted and have potential health risk, Lead (Pb) TF value in all the vegetables is less than one and reveal that and hence are normal and safe for consumption. Chromium (Cr) TF values are also less than one in all the vegetable which shows that they are all normal for consumption and can be transported or supply anywhere for commercial purposes.

The transfer factor (TF) values in all the vegetable is less than one which reveal that they are free from contamination and are good for consumption. Arsenic (As) TF in all the vegetables sample is greater than one, this implies that this implies that they are contaminated and have potential health risk.

Conclusion

The Hazard Quotient of the Vegetables cultivated at Farin gada Vegetable farm shows that the values were all less than one and this implies that they are below the daily recommended dose of the metals and are safe. Hence the vegetable was not affected by transfer of metal from soil to the vegetables. Thereby making them safe for consumption and good for health. The heavy metal content of the soil sample was found to be less than the permissible limit except for that of Arsenic which was found to be greater than the permissible limit of consumption.

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