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Research

Distribution of Iron in *Desmodium Intortum* and *Talinum Triangulare* Vegetables in Ifo and Ewekoro Local Government Areas of Ogun State, Nigeria.

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Abstract

Iron is an essential trace element required by all forms of life. It is taken up by the root or foliage of plants from soil and air. The distribution of iron in the stems and leaves of water leaf and green leaf in fourteen different two local government areas of Ogun State, Nigeria was determined using Atomic Absorption Spectroscopy. The concentrations of iron in the stems of green leaf at Ifo and Ewekoro Local Governments Areas was in the range 1.53 mg/kg to 117.24 mg/kg and 3.90 mg/kg to 99.48 mg/kg, while that in the leaves ranged from 1.97 mg/kg to 139.36 mg/kg and from 4.71 to 113.45 mg/kg for the samples respectively. The iron contents in the stems of water leaf ranged from 3.55 mg/kg to 79.53 mg/kg, and 1.47 mg/kg to 103.57 mg/kg, while that in the leaves was in the range of 4.60 mg/kg to 90.47 mg/kg and 1.81mg/kg to 126.00 mg/kg for the two Local Government Areas respectively. The transfer factor revealed that more of the iron was transferred from the soil into the leaves than in the stems. Except for Ifo town, Pakoto, Ayede, Akinbo and Ewekoro, the concentration of iron in the vegetables from the local government areas analyzed were within permissible limits of FAO/WHO for iron.

KEY WORDS: Green leaf, Iron, Soil, Water leaf.

Introduction

Vegetables are consumed in a variety of ways as part of main meals and as snacks. Their nutritional contents varies considerably, though generally they contain little protein or fat (Whitaker, 2001; Woodruff, 1995) and varying proportions of vitamins such as vitamins K, vitamins A, and vitamin B6, carbohydrates, dietary minerals etc. Vegetables contain a wide variety of phytochemicals, some of which have been claimed to have antioxidant, antibacterial, anticarcinogenic, antiviral and antifungal properties (Gruda 2005; Steinmetz and Potter 1996). Diets containing recommended amounts of fruits and vegetables may help lower the risk of heart diseases and type-2 diabetes, protect against some cancers and decrease bone loss and help prevent the formation of kidney stones through the production of potassium. According to WHO/FAO (2004), a dietary intake of more than 400 mg/day for vegetable consumed was recommended. The campaign for promoting vegetable consumption specifically in the framework of the International Fruits and Vegetable Alliance is on the increase in many developed countries (Ganry, 2007). Nigeria, a developing country and largest black African nation is adhering to this recommendation gradually and it will be of immense benefit to assess the level of nutrients, and minerals iron in the vegetables commonly consumed.

Iron is a mineral element which is needed by the cells. As part of the protein hemoglobin, the iron carries oxygen from the lungs to other parts of the body, and also part of many enzymes and plays roles in cell functions (Center for Disease Control and Prevention, USA, 2011). Deficiencies in iron result in conditions such as goiter. The average man has about 2 grams of Iron in his blood cells at a given time while women have about 1.6 grams. The average Dietary Allowance (RDA) for Iron varies based on gender, age and source of dietary (National Academy, 2001). For instance, infants may require Iron supplements if they are fed with bottle-cow's-milk; blood donors and pregnant women are at the risk of low iron levels and are often advised to supplement their iron intakes (Milman, 1996).

Iron is an essential part of hemoglobin in red blood cells, required for regular oxygen transport, DNA synthesis and other biological activities in human body. However, iron in its free form or when unbounded from proteins or hemoglobin can induce oxidation or rusting of body tissues and can therefore be destructive in nature. Whereas, little intake of iron or impaired absorption may result in anemia. Further, excess quantity of ingested Iron can cause excessive levels of Iron in the human blood. High level of free ferrous iron in the blood reacts with peroxides to produce free radical which are highly reactive and can damage DNA, lipids and proteins as well as other cellular compounds. Long-term organ damage, liver failure, shock, coma, metabolic acidosis, adult respiratory distress syndrome and even death are among the adverse effects of high level of iron in the body which often affects the liver and heart (Cheney *et al*., 1995). Accumulation of iron above 20 mg for every kilogram of mass results in iron toxicity, while 60 mg per kilogram is considered a lethal dose (Cheney *et al*., 1995). Also, excessive intake of iron can results in iron overload disorders such as hemochromatosis which is estimated to cause disease in between 0.3 to 0.8% of Caucasians (Durupt *et al*., 2000). Hemochromatosis is a genetic predisposition to excess stored iron which is one of the most common genetic diseases which is hard to diagnose and not often caught by healthcare providers. Iron distribution is heavily regulated in mammals partly because iron ions have high potential for biological toxicity (Nanami *et al*., 2005). At the age 18 and above when full age had been attained, about 80% of iron tends to accumulate in the blood at the rate of 1 mg per day (Gutteridge and Halliwell, 1994). Women are less at the risk for iron build up than men due to the blood they lose every month during their menstrual period and as such, women have about half of the circulating iron in their blood as men (Frank and Painter 2000). Because men have no direct outflow for iron, by age of 40, the level of iron in their blood are similar to what is observed in women at postmenopausal at about 70 years old (Frank and Painter, 2000). This amount of iron can result in premature ageing and cause several diseases such as cancer, cataracts, diabetes, arthritis, osteoporosis and brain, renal and liver damage (Emery, 1991).

Sequel to the foregoing, iron is a very important nutrient to understand, not only to researchers and nutritionist but everyone, since we need to be aware of the iron requirements from our foods. Owing to the important roles that iron play in living cells therefore, the study was undertaken with the aim of investigating the uptake of iron vis-à-vis its distribution in two commonly consumed vegetables, *Desmodium intortum* (green leaf) and *Talinum Triangulare* (water leaf) in Ifo and Ewekoro Local Government Areas, in Ogun State, Nigeria.

Materials and Methods

Sample Locations

Ogun State is a state in Southwest Nigeria and it's on coordinates 7°000'N3°35'E with a total area of 16,980.55km2 and a population of 3,751,140. Ifo is a Local Government Area in Ogun State, Nigeria with its headquarters located in the town of Ifo at 6°49′00″N 3°12′00″E which has an area of 521 km² and a population of 524,837 at the 2006 census. Ewekoro is a Local Government Area in Ogun State, Nigeria with its headquarters located at Itori at 6°56′00″N 3°13′00″E and has an area of 594 km² and a population of 55,156 at the 2006 census. It's the chief host the famous 'Elephant Cement' company and many others.

Sample Collection

Samples (n = 5) of edible portion of two vegetables namely *Desmodium intortum* (green leaf) (GL) and *Talinum Triangulare* (water leaf) (WL) were collected from different locations in Ifo and Ewekoro local government area of Ogun State, Nigeria. The leaves were separated from the stems and then dried at room temperature on clean laboratory benches for 28 days and then oven dried for 2 hours at 80ºC. They were then ground into powdery form using mechanical mill and kept in polyethylene containers prior to analysis. Soil samples (n = 5) were equally collected at 0 – 20 cm depth at each point where the vegetables were collected. The samples were air-dried and ground.

Digestion and Iron Determination

In order to determine the iron concentration in each sample, 0.5 g of accurately weighed sample was digested using a mixture of 30% of hydrogen peroxide (Po-Chem, Poland) and 70% of nitric acid (Merck, Germany). The contents was heated to a temperature of 150ºC in a microwave and then allowed to cool initially to 100ºC and then finally to 25ºC. The samples were filtered and then transferred to 100 ml volumetric flask and diluted with deionized water to the mark. The concentration of iron was analyzed using Buck Scientific model 210VGP Atomic Absorption Spectrophotometer. The data were analyzed in triplicate and the mean values were recorded.

Results and Discussion

Table 1: Concentration of iron in soil and vegetable in Ifo Local Government Area

	Green Leaf (GL)			**Water Leaf (WL)**		
Sample Locations	**Soil-1 (mg/kg)**	**Stems (mg/kg)**	**Leaves (mg/kg)**	**Soil-2 (mg/kg)**	**Stems (mg/kg)**	**Leaves (mg/kg)**
Alaja	110.40	14.78	16.42	127.30	10.11	14.86
Ifo Town	216.72	117.24	139.36	141.00	60.80	67.51
Ibogun	17.83	8.49	10.23	10.41	4.30	4.90
Olose	8.29	1.53	1.79	29.94	3.55	4.60
Ayede	50.88	20.26	24.73	105.71	63.92	74.00
Ilepa	80.71	13.10	11.04	71.28	6.39	15.08
Pakoto	129.74	61.90	77.22	150.14	79.53	90.47

Note: Soil-1 and soil-2 are from the locations where the green leaf and water leaf samples were respectively collected in Ifo Local Government Area.

Table 1 shows the concentrations of iron in soil, stems and leaves of GL and WL which were obtained from seven different towns in Ifo Local Government Area of Ogun State, while Table 2 showed the concentrations of iron in soil, stems and leaves of GL and WL which were obtained from seven other towns in Ewekoro Local Government Area of Ogun State. In Table 1 the results of the analysis of the soil samples in Ifo Local Government Area showed that the iron contents in soil-1 samples (where the green leaf samples were collected) ranged between 8.29 to 216.72 mg/kg and from 10.41 to 150.14 mg/kg in soil-2 samples (where the water leaf samples were collected). Among soil-1 samples, Ifo town had the highest concentration of 216.72 mg/kg, while the least value of 8.29 mg/kg was at Olose. For soil-2 samples, the highest value of 150.14 mg/kg was recorded in Pakoto, while Ibogun had the least value of 10.41 mg/kg.

Table 2: Concentration of iron in soil and vegetable in Ewekoro Local Government Area.

	Green Leaf (GL)			Water Leaf (WL)		
Sample Locations	**Soil-3 (mg/kg)**	**Stems (mg/kg)**	**Leaves (mg/kg)**	**Soil-4 (mg/kg)**	**Stems (mg/kg)**	**Leaves (mg/kg)**
Arigbajo	11.42	3.90	4.71	10.88	1.46	2.05
Gudugba	9.38	4.11	5.00	4.90	2.47	1.81
Papalanto	114.27	25.88	29.60	131.45	10.85	19.44
Itori	44.32	21.64	25.97	69.80	33.72	38.50
Akinbo	133.39	58.77	61.72	148.00	64.22	74.90
Ewekoro Town	162.80	99.48	113.45	180.04	103.57	126.00
Wasinmi	110.46	17.28	24.63	102.17	20.99	29.58

Note: Soil-3 and soil-4 are from the locations where the green leaf and water leaf samples were respectively collected at Ewekoro Local Government Area.

From Table 2, the results of the analysis of the soil samples in Ewekoro Local Government showed that the Iron content in soil-3 (where the green leaf samples were obtained) ranged between 9.38 to 162.80 mg/kg and from 4.90 to 180.04 mg/kg for soil-4 samples (where the water leaf samples were collected). In both soil-3 and soil-4 samples, Ewekoro town had the highest iron content (162.80 mg/kg and 180.04 mg/kg respectively), while the least values (9.38 mg/kg and 4.90 mg/kg) were both recorded for the soil-3 and soil-4 samples respectively in Gudugba. On comparing the four soil samples, the iron content in the soil was found to range between 4.90 to 216.72 mg/kg with Ifo soil-1 having the highest value and Gudugba soil-4 with the least. The high iron concentration observed in the soil of Ewekoro, Papalanto, Akinbo and Wasinmi, all in Ewekoro Local Government Area could be attributed to high mining and industrial activities such as the presence of cement factories, for which the Local Government is popular, while that which was observed at Ifo, Alaja and Pakoto might be due to the natural background content of iron in the environment as these are majorly residential areas. It has been observed that iron is present in large concentration in some natural soil (Dara, 1993, Aluko *et al*., 2003). This was corroborated by Eddy, *et al*. (2004), who reported that high concentration of iron in the soil should not conclusively be based on waste materials (pollutants) but other natural sources of iron should as well be put into consideration. On comparing the result from this work with the results of the works carried out by Tsafe *et al*., 2012 (195.25 mg/kg), Adaramodu *et al*., 2012 (62.00 to 108.00 mg/kg), 18.06 to 23.47 mg/kg reported by Umoh and Etim, 2013 and that which was observed by Aremu *et al*., 2010 (249.73 to 257.63 mg/kg) showed agreement although results were lower in some cases. However, results from this work were much higher than 0.990 to 5.00 mg/kg and 0.10 to 1.93 mg/kg reported by Otitoju *et al*., 2012.

From Table 1, the concentration of iron in the stem of GL ranged between 1.53 to 117.24 mg/kg, while that of the leaves was found to range between 1.79 to 139.36 mg/kg. Samples of vegetable from Ifo had the highest concentration of 117.24 mg/kg in the stem and 139.36 mg/kg in the leaves, while the least values of 1.53 mg/kg and 1.79 mg/kg were found in the stem and leave of the GL at Olese village. On analysis of the value of iron contents in the WL obtained from Ifo Local government revealed that the iron contents in the stems ranged between 3.55 to 79.53 mg/kg, while that of the leave ranged between 4.60 to 90.47 mg/kg.

From Table 2, the concentration of iron in the stems of WL ranged between 3.55 to 79.53 mg/kg, while that of the leaves ranged between 4.60 to 90.47 mg/kg. The results for the analyses of iron contents of the GL obtained from Ewekoro Local Government is presented in Table 2 and it can be seen from the table that the concentration of iron in the stem of the green leaf ranged between 3.90 to 99.48 mg/kg, while that of the leaves was found between 4.71 to 113.45 mg/kg. The highest concentration of iron in the stems and leaves were obtained to be 99.48 mg/kg and 113.45 mg/kg in the vegetable sample taken from Ewekoro town, while the least values of 3.90 mg/kg and 4.71 mg/kg were observed in the stems and leaves of the GL at Arigbajo village. The results revealed that higher iron content was present in the stems than in the leaves. This was however not the case in the sample of GL which was obtained from Ewekoro town and the WL sample at Pakoto village.

On comparison of the results from the two Local Government Areas, the highest value of 117.24 mg/kg was observed in the stem of the sample at Ifo town, while the least value of 1.53 mg/kg was found in the sample at Olose. Similar observation was noted in the case of the leaves of the GL. Generally, the leaves of GL obtained at Ifo town had the highest value of 139.36 mg/kg, while the least value (1.46 mg/kg) was found in the stem of the WL at Arigbajo. Shad *et al*., 2008 reported that plants from polluted areas contain iron in the leaves to be 67.00 mg/kg, 13.50 mg/kg in stem, 4.90 mg/kg in the roots and 3.05 mg/kg in seeds, while the results from unpolluted areas indicated that 22.50 mg/kg was found in the leaves, 11.30 mg/kg in the stems, 4.50 mg/kg in the root and 2.85 mg/kg in the seeds which all falls within the data reported in this work. They therefore concluded that high iron content in the aerial parts of the vegetables is due to the foliar absorption from the surrounding air. The recommended Dietary Intake of iron by WHO is 10-28 mg/day. The results of this work also agree with the literature data of 0.56 to 4.50 mg/kg and 0.61 to 8.31 mg/kg reported by Aremu *et al*., 2010 and 54.05 mg/kg reported by Tsafe *et al*., 2012. The results from this work were however lower than the concentration of iron in the leaves of vegetable reported by Ajmal *et al*., 2013 which ranged between 164.7 to 586.1 mg/kg, and from 152.6 to 287.5 mg/kg in vegetable fruits. There was high variation in the iron concentration in plants and soil which may be due to differences in the source of the iron. Iron metal is already present in the plant and the soil will contribute to the iron bioavailability.

Transfer Factor (TF)

In order to evaluate the extent of accumulation of iron in the blood as a result of ingestion, the transfer factor (TF) was calculated using the method described by Cui *et al*., 2004;

Transfer factor = metal concentration in plant (mg/kg)/metal concentration in soil (mg/kg).

The transfer factor expresses the bioavailability of a metal in a particular position on a specific plant which also depends on several factors such as soil pH, organic matter and nature of the plant itself (Tsafe *et al*., 2012).

Oral Intake of Iron

The oral intake of iron via vegetables was calculated by using the modified formula proposed by Sajjad et al., 2009 and is given as:

$$Daily\ intake\ of\ Iron = \frac{C_{iron\ in\ vegetable}\ X\ daily\ vegetable\ consumption}{Average\ body\ weight}$$

The average body weight used was 65 kg for this study.

The transfer factor (TF) of iron at different locations differed as shown in figures 1 and 2. The transfer factor in the stems of the GL at Ifo Local Government Area ranged from 0.134 to 0.58, while that of the leaves range from 0.14 to 0.64. For the WL, the transfer factor ranged between 0.08 to 0.60 in the stems and from 0.12 to 0.70 in the leaves. For the vegetables at Ewekoro Local Government Area, the transfer factor ranged between 0.16 to 0.61 in the stems of the GL and from 0.22 to 0.69 in the leaves. For the analysis of the WL, the transfer factor was found to range between 0.08 to 0.58 in the stem and from 0.19 to 0.70 in the leaves. From figure 1, the leaves of WL from Alaja had the highest transfer factor of 0.70, while the least value of 0.08 was obtained in stem of the WL at Alaja village. From figure 2, the maximum transfer factor of 0.69 was found in the leave of the WL from Ewekoro, while the least value of 0.05 was found in the stem of the WL at Papalanto. This implies that more of the iron contents will be transferred into the leaves than the stems. This could be one of the reasons why the leaves had more iron contents than the stems. The variations in transfer factor among different vegetable species may be as a result of differences in the concentrations of metals in soil, pH, organic matter and differences in element uptake by different vegetables (Cui *et al*., 2004; Tsafe *et al*., 2012). The high transfer factor observed in the leaves could be as a result of the low retention ability of iron in the soil where the samples were collected and is more mobile in the soil, while the low transfer factor could probably be due to the high retention of iron in the soil owning to the precipitation of iron at higher pH. Similar results were reported by Tsafe *et* *al*. (2012); Cui *et al*. (2004); Lato *et al*. (2012) and Adefemi *et al*. (2012).

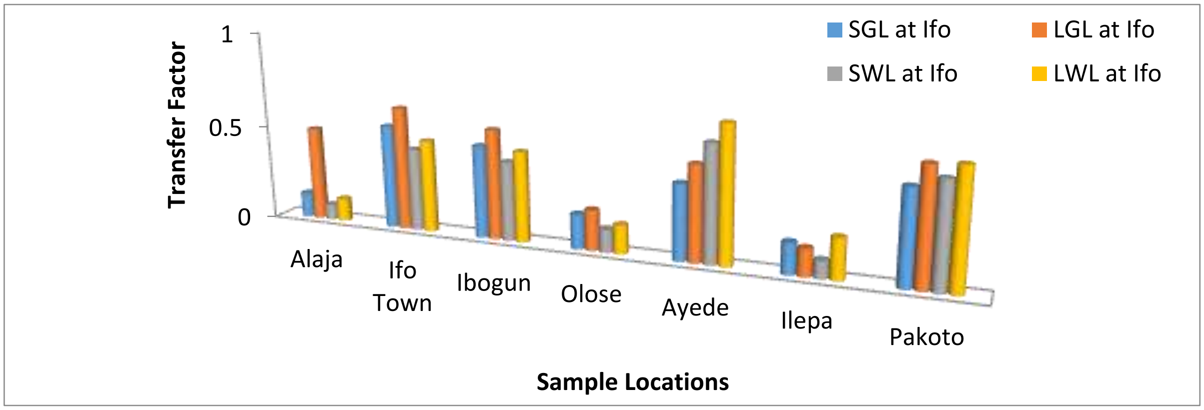

Fig.1: Transfer factors of iron at different locations in Ifo Local Government Area of Ogun State.

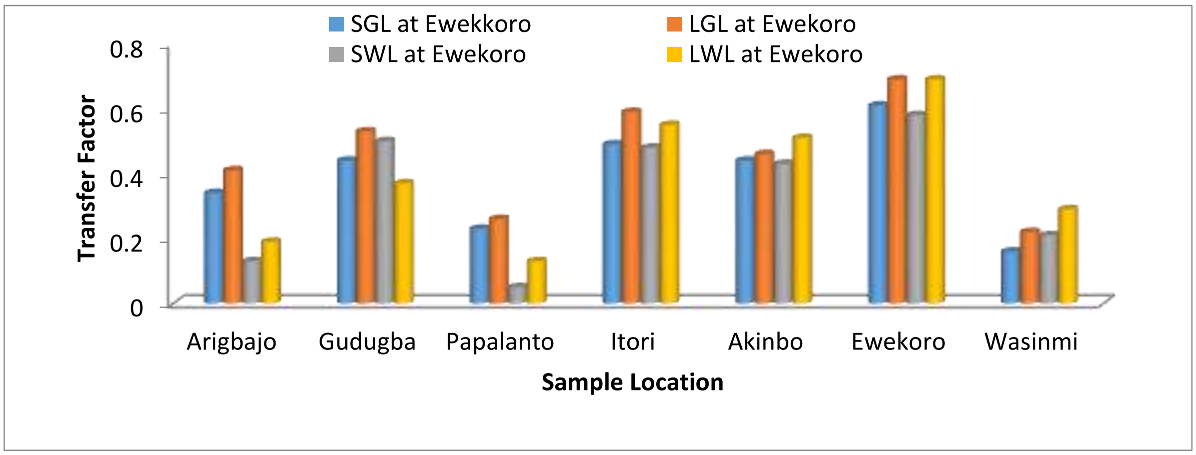

Fig.2: Transfer factors of iron at different locations in Ewekoro Local Government Area of Ogun State.

Where SGL= stems of green leaf, LGL= leaves of green leaf, SWL= stems of water leaf and LWL = leaves of water leaf.

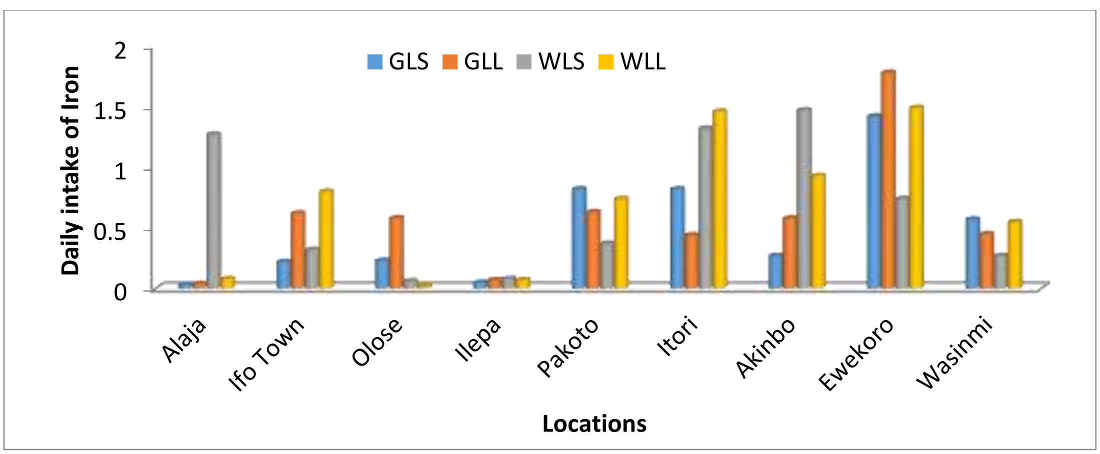

Fig.3: Daily intake of Iron at different locations from Ifo and Ewekoro Local Government Areas.

Where GLS = green leaf stems, GLL = green leaf stems, WLS = water leaf stems and WLL = water leaf leaves.

The extent of toxicity of metal to man depends upon their daily oral intake. Figure 3 showed the results of the oral intake of iron through vegetable consumption. The highest daily intake of 1.78 was observed in the leaves of GL at Ewekoro, while the least value of 0.02 was reported in the leaves of GL at Ibogun town. In few locations such as Alaja, Itori, Akinbo and Ewekoro, the oral daily intake of iron was greater than unity. The amount of metals contributed by vegetables in daily intake varied with the edible portion of the vegetable as demonstrated by this study.

Conclusion

This present work evaluated the distribution of iron in stems and leaves of two widely consumed vegetables, *D. intortum* and *T. Triangulare* in two local government areas of Ogun State, Nigeria. The results of the analyses revealed that leaves of both vegetables concentrated more iron than the stems. This was also confirmed by the results from the transfer factor and daily intake determinations of the investigated vegetables, which were observed to be higher in the leaves than the stems. While the levels of iron in the vegetables from most of the sample locations were within acceptable WHO/FAO limits, it was found to be higher in some other locations such as Ifo town, Ayede, Pakoto, Akinbo and town Ewekoro, which implies that samples from such locations are not fit for human consumptions. Therefore, *D. intortum* and *T. Triangulare* vegetables from other nine locations are thus recommended to pregnant women, blood donors, infants and all vegetables consumers as good sources of iron. However, constant monitoring of iron content in sampled locations is required in other to avoid excessive iron accumulation in the soil.

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