CHROMIUM, IRON AND LEAD CONCENTRATIONS IN FRESH AND CONTAMINATED WATER CARROTS (*Daucascarota*)

I.R. Yalwa: Department of Chemistry,
Sa'adatu Rimi College of Education,
Kumbotso, Kano-Nigeria.

Abstract

Some crops and vegetables are produced through irrigation using contaminated water from industries and other similar sources. Hence, this work is aimed at quantifying chromium, iron and lead concentrations in carrots irrigated by fresh and the contaminated water to see the level of the contamination.The fresh water carrot samples were collected from Danbatta, Danbatta Local Government area of Kano State, Nigeria, while the contaminated water carrot samples were collected from Kwakwachi of Fagge Local Government area. The samples were crushed, dried at 105^{0}C and ashed at 450^{0}C. The concentrations of chromium, iron and lead metals were determined by using Atomic Absorption Spectrophotometer (AAS). The average moisture contents were found as 87.85 and 87.17% for fresh and contaminated water carrots respectively,while the average ash contentswere obtained as 1.21 and 1.30% respectively for the fresh and contaminated water carrot samples. The metallic contents were found as 0.583and 1.67mg/100g for chromium, 5.0 and 10.03mg/100g for iron, and 0.013mg/100gfor lead in the fresh and contaminated water carrots respectively.The metal concentrations determined were found to be much lower than the permissible levels of World Health Organization (WHO). Hence, consumption of these vegetable will not constitute any health hazard to humans at the time of the study and as far as the sampling areas are concerned.

Keywords: Chromium, Iron, Lead, Fresh and Contaminated Water, Carrot

INTRODUCTION

Chromium is a steely – grey, lustrous hard and bristle metal which takes a high polish, resists tarnishing and has a high melting point (Cronin, 2004). Chromium is the 22nd most abundant element in earth's crust with an average concentration of 100ppm (Emsley, 2011). Chromium compounds are found in the environment due to erosion of chromium containing rocks and can be distributed by volcanic eruptions (Kotas and Stanie, 2000).

Major factors governing the toxicity of chromium compounds are oxidation state and solubility. Cr (VI) compounds which are powerful oxidizing agents and thus tend to be irritating and corrosive appear to be a much more toxic system apically than Cr (III) compounds, given, similar amount and solubility, although mechanisms of biological interactions are uncertain. Trivalent chromium occurs in trace amounts in foods, wine and water.In contrast, hexavalent chromium (Cr(VI) or Cr^{6+}) is highly toxic and mutagenic when inhaled. Ingestion of chromium(VI) in water has been linked to stomach tumors, and it may also cause allergic contact dermatitis (ACD).In the United States, the dietary guidelines for daily chromium intake were lowered in 2001 from 50–200 µg for an adult to 35 µg (adult male) and to 25 µg (adult female). In 2014, the European Food Safety Authority published a report stating that the intake of chromium(III) has no beneficial effect on healthy people, thus the Panel removed chromium from the list of nutrients and essential elements (EFSA - NDA, 2014).

Pulmonary irritant effects following inhalation of chromium dust can include asthma, chronic bronchitis, chronic irritation, chronic pharyngitis, chronic rhinitis, congestion and hyperaemia, polyps of the upper respiratory tract etc (Dayan and Paine, 2001). In addition to lung cancer, a number of epidemiological studies of workers in chromate industries also showed significantly increased risk for nasal and sinus cancers (ATSAR, 2005) on the basis of these and other studies. The US environmental protection agency for research on cancer IARC have classified inhaled Cr (VI) as a known human carcinogen. However, chromium was found to play an important role in maintaining proper carbohydrate and liquid metabolism at the molecular level.

Lead (Pb) is a bright silvery metal with a very slight shade of blue in a dry atmosphere as described by Polyansky, 1986. Lead is often quoted as the heaviest stable element (Lide, 2002). Some researchers have suggested that lead continues to contribute significantly to socio-behavioural problems such as juvenile delinquency and violent crimes. It is important to prevent all lead exposure while the immediate health effect of concern in children is typically neurological. It is important to remember that childhood lead effect later in life including renal effects, hypertension, productive problems and developmental problems with their offspring. In children, acute expose to very high level of lead may produce encephalopathy and other accompanying sign of ataxia, coma, convulsion, death, hyperirritability, stupor etc. The BLLs association with encephalopathy in children vary from study to study, but BLLs of 70-80ng/dL or greater appear to indicate serious risk (ATSDR, 2005). The extent of lead contamination in 10 common vegetables around Kolkata in India was determined and the implication of contamination on food safety was assessed. Lead gets into vegetables through many ways of exposure.

Iron is said to be the most common element on the earth forming much of earth's outer and inner core by mass. It is the fourth most common element in the earth crust. Iron is the most abundant element in the core of red giants and is the most abundant metal in the dense metal cores of planets such as earth.Iron uptake is tightly regulated by the human body which has no regulated physiological means of excreting it. Only small amounts of iron are lost daily due to mucosal and skin opithelial cell sloughing, so control of iron level is mostly by regulation of uptake. (Ramzis et al., 1999). Large amount of ingested iron can cause excessive level of iron in the blood. High blood levels of free ferrous iron react with peroxide to produce free radicals, which are highly reactive and can damage DNA protein, liquids and other cellular component. Thus, iron toxicity occurs when there is free iron in the cell which generally occurs when iron level exceed to the capacity of transferring to bind the iron. Damage to cells of the gastro intestinal tract can also prevent them from regulation iron absorption leading to further increases in blood level. Iron typically damage cell in the heart, liver, and elsewhere, which can cause significant adverse effect including coma, metabolic acidosis, shock liver failure coagulopathy, adult respiratory distress syndrome long term organ damage and even death (Cheney, Gumbiner, Benson and Lenen, 1995). Human experience iron toxicity above 20 milligrams of iron for every kilogram of mass and 60 milligram per kilogram is considered a lethal dose (Medscape, 2010). Over consumption of iron, often as a result of children eating large quantities of ferrous sulphate tablets intended for adult consumption is one of the most common toxicological causes of death in children under six (Medscape, 2010).The medical management of iron toxicity is complicated and can include use of a specific chelating agent called deferoxamine to blind and expel excess iron from the body (Cheney et al., 1995).

In this part of the country, carrot is mostly obtained by irrigation and varieties of water are used in watering the crop. In some areas clean river or dam (fresh water) water is used, while in others stream water from town drainage or industrial area (contaminated water) is involved. Hence, this work is aimed at quantifying the three metals in carrots grown and watered by using the two water types separately. The results can therefore be used to testify the edibility ofthis crop as far as the concentrations of these metals are concerned, especially the one irrigated with contaminated water. A lot of consumers are not satisfied with the way the carrot is being irrigated with contaminated water, because of the possibility of it having high concentration of these and other heavy metals.

MATERIALS AND METHOD

The samples of the carrot were collected from two different areas, Danbatta and Kwakwaci area both in Kano state. The fresh carrot samples were collected from the irrigation area of Gari Dam Danbatta, while the contaminated carrot samples were collected from Kwakwaci garden in Fagge local government area which is part of the Kano municipality. All the glassware and other materials were washed with detergent and tap water, then rinsed thoroughly with deionized water. The samples were washed with tap water, rinsed with deionized water and stored in two different containers in a cool and dry place before crushing. The samples were cut into small pieces with non-metallic object (plastic knife) and crushed with motor and pestle. The crushed samples were weighed using digital electronic weighing machine. The samples were dried at 105^{o}C until constant weight and the moisture content was thus calculated.

1.0g of each sample was weighed into crucibles. The samples were then placed into a muffle furnace and ashed at 450^{0}C (Ayodele and Yalwa, 2005). The ashes were dissolved in 0.1M nitric acid in 100ml volumetric flasks and made up to the mark with deionised water. The solutions was transferred into sample bottles after rinsing with them. The standard solutions were then prepared using the nitrate salts of the metals. Both the standard and sample solutions were analysed using atomic absorption spectrometer (AAS) instrument model ALPHA-4.The blank was aspirated to zero the reading before the aspiration of each solution. The absorbance for each was recorded and standard calibration curve of absorbance against concentration was prepared. The concentrations of the various sample solutions were then extrapolated from the calibration curve and the results recorded in tabular forms.

SPSS 16.20 was used in the statistical analysis of the results and for all the parameters tested for.

RESULTS AND DISCUSSION

The results of all thedeterminations in both fresh and contaminated water carrots are summarised in Tables 1, 2 and 3.

Table 1: Moisture Contents

S/N	Sample	Average Moisture Content (%)
1	Fresh Water Carrot	87.85±1.50
2	Contaminated Water Carrot	87.17±0.95

The moisture content shown above is high as the dry matter is just around 12-13% of the whole. Standard water content of carrot is 87% (Mala, 2016) and these experimental values of moisture content are 87.85% for the fresh water carrot, and 87.17% for the contaminated water carrot, so the values obtained can be said to be within the standard range.

Table 2: Ash Contents

S/N	Sample	Average Ash Content (% of dry matter)
1	Fresh Water Carrot	1.21±0.50
2	Contaminated Water Carrot	1.30±0.33

The ash contents are as shown in Table 2. It can be seen as low when compared to the whole carrot. However, it is high if compared to the dry matter which is just 12-13% of the whole. This means the ash is about 10% of the dry matter which is big comparatively. The contaminated water carrots have slightly higher ash content which is possibly due to the addition minerals (contaminants).

Table 3: Metallic Contents

S/N	Sample	Chromium (Cr) Concentration (mg/100g of dry matter)	Iron (Fe) Concentration (mg/100g of dry matter)	Lead (Pb) Concentration (mg/100g of dry matter)
1	Fresh Water Carrot	0.58±0.14	5.0±2.2	0.013±0.06
2	Contaminated Water Carrot	1.67±0.31	10.3±3.5	0.013±0.011

The percentage of chromium found in carrot of fresh water was low as compared with that of contaminated water. Fresh water carrot, chromium concentration is 0.0583 ppm or 0.58±0.14mg/100g, while the contaminated water carrot chromium is 0.167 ppm or 1.67±0.31mg/100g.The chromium concentration of contaminated water being higher than thatof the fresh water carrot might be due to some industrial or domestic effluent in the contaminated water. While the chromium concentration of fresh water carrot is low possibly due to nature of the water which is fresh and therefore contains comparatively little amount of chromium that is naturally there in it. According to Abduljalal et al. (2010), carrot has the concentration of 2.23± 1.28 ppm, which is much higher than both fresh and contaminated water carrot chromium concentrations of this work. This might be due to the difference in location or nature of the effluent.

The percentage of iron found in carrot of fresh water sample is also low as compared with contaminated water carrot. The fresh water carrot iron concentration is 0.5ppm or 5.0±2.2mg/100g, while the contaminated water carrot iron concentration is 1.03 ppm or 10.3±3.5mg/100g. It shows that the iron concentration of contaminated water carrot is more than twice the iron concentration of fresh water carrot due to the irrigation water which is contaminated because of industrial waste around the area of the irrigation. While the iron concentration of fresh water carrot is little because the water is fresh and the level of iron is possibly due to the natural soil level. The iron concentrations obtained in this work are also much higher than that of Motogaokar and Salunke, (2012) which was 0.455mg/100g, although there was no indication of the nature of the water used in the carrot production.

The percentage of lead found in carrot of fresh water and contaminated water carrot is the same, which is 0.0013 ppm or 0.013mg/100g. Iron has the highest concentrations, which is much higher than those of chromium follow by lead which has the least concentrations in both samples. According to Motogaokar and Salunke, (2012), the value of ash was 1.027% and 1.84mg/100g as the value of iron concentration is so much lower than the value for this work that is 10.3mg/100g. According to Adelene et al, (2013), the value of lead was found to be 13.92 ± 0.75ppm which also is so much higher than that of this determination work. This is most probably due to the difference in the nature of the irrigation waters and soils. According to the World Health Organization (WHO), the maximum permissible concentration (mg/kg) of lead is 0.30a, iron is 425a and chromium is 2.03a as compared with the value of lead in this experiment which is 0.003ppm of both fresh and contaminated water carrots. Chromium and iron concentrations are also very far below the WHO permissible value.

ANOVA analysis of the results showed no significant difference in the moisture and ash contents among the two sample types.

CONCLUSION

From the results obtained, the order of the concentrations of the heavy metals is iron (Fe) >chromium (Cr)> lead (Pb). Iron and chromium concentrations higher in the contaminated water carrot than fresh water, while the lead concentrations remained the same for both carrot samples. The metal concentrations determined were also found to be much lower than the permissible levels of World Health Organization (WHO). Hence, consumption of these vegetable as food will not constitute any health hazard to humans at the time of the study and as far as the sampling areas are concerned. The result obtained in this study would go a long way in providing a base line data for the assessment of the distribution of the metals in carrot (*DaucusCarrota)* grown in Danbatta and Kwakwaci in Kano state. However, farmers should be educated on the problems associated with excessive usage of fertilizer and any other chemicals as well as irrigating crops with contaminated and all sorts of polluted water, and the need to grow crops with safe level of heavy metals.

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