

Quantitative Determination of Heavy Metal Concentrations in Onion Leaves

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ABSTRACT: The concentration (mg/kg dry weight) of Cd, Cr and Pb were determined in onion leaves samples using the atomic absorption spectrometry. A total of 16 onion leaves each were collected from both the study and control sites for analysis. The heavy metals, Cd, Cr and Pb in onion leaves of study sites were found in the range of 0.667 – 0.933, 3.870 – 7.870 and 5.870 – 7.537mg/kg respectively, while the results of control sites showed values ranging from 0.583 – 0.700, 0.447 – 0.842 and 3.833 – 7.333mg/kg for Cd, Cr and Pb respectively. The trend of abundance of heavy metals in both sites followed the same sequence: Pb > Cr > Cd. The metals levels in both sites are higher than WHO/EU recommended limits with exception of Cd. The high levels of the metals suggest that effluent water irrigated fields could be indicative of bio-accumulation of the metals in the leaves, consequently putting the consumers of this vegetable crop are at health risk.

Key words: Heavy metals, Onion, leaves, Challawa, Northern, Nigeria

INTRODUCTION

Onions leaves are part of human meal and contain trace metals in very minute quantities. Trace metals get into the onions leaves through water used for the irrigation, and soil by mineralization by crops. The levels of these trace metals increase as a result of natural weathering of rocks, disposal of wastes like car batteries, used metallic household appliances, use of fertilizers, pesticides, herbicides and industrials effluents (Awofolu *et al.*, 2005; Francis, 2005). Mumba *et al.*, (2008) found that the concentration of Cd is generally high in cabbages that are irrigated with reservoir water. Kano, a city in northern Nigeria, is home to 70% of Nigeria's tanneries. Most of the tannery industries in Kano are in Challawa Industrial Estate. The effluents generated by the tanneries are channelled into drains and subsequently into the Challawa River. Consequently, the amount of pollutants and wastes generated by the tanning industries pose significant stress on the vegetable crops grown on the Challawa River bank since the polluted river is used for irrigation to water the vegetable crops along the river bank. Thus, in a bid to struggle for survival, the Challawa farmers use the

contaminated Challawa River water for irrigation purposes. As a result, trace metals may enter tomatoes and onions thereby exposing consumers of these vegetable crops to bioaccumulation of trace metals with time.

There is some information on the levels of trace metals on water, soil, sediments, tomatoes, pepper and onion bulbs of Challawa River in the literature. However, there are no reports on the levels of trace metals in onion leaves which are commonly used as spices in food. Although spices represent too little amount of total food intake, considerable levels of heavy metals may occur in these when they are grown in contaminated soils. Thus, there is the need to carry out extensive screening on the food and vegetable crops grown in the vicinity of the Challawa River for toxic heavy metals (Cd, Cr and Pb), especially onions leaves in order to have some insight into the impact of tannery operations on vegetable crops grown on the bank of the river.

MATERIALS & METHODS

Analytical (AnalaR) grade reagents and distilled water were used throughout the

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experiment. All glassware and plastic containers used were washed with liquid soap, rinsed with water, soaked in 10% nitric acid for 24hrs, cleaned thoroughly with distilled water and dried in such a manner to ensure that any contamination does not occur. As shown in (Fig. 1), farms used for irrigation on the Challawa River bank were divided into study area (after tannery effluents discharge point into the River) and control area (before tannery effluents discharge point into the River). Sixteen (16) irrigated onion leaves samples were freshly collected from both the study and control areas in the month of April, 2006. These were packaged into paper bags, labeled and transported immediately to the laboratory for processing. In the laboratory, each of the irrigated onion leaves sample was washed with tap water and thereafter with distilled water. The samples were then cut

into nearly uniform size. This was done to facilitate drying of the pieces at the same rate. The cut pieces were placed in clean acid-washed porcelain crucible according to label and oven-dried at 105°C for 24hrs in Mommert oven (Schutzart DIN 400-50-IP20) until they were brittle and crisp. At this stage no micro-organisms can grow and care was taken to avoid any source of contamination. All crucibles were labeled according to sample numbers. The dried onion leaves samples were grinded using acid-washed mortar and pestle and sieved to obtain fine powder. These were finally stored in screw capped plastic containers and labeled appropriately for analysis. In order to ascertain the efficiency and reliability and precision of the atomic absorption spectrometry machine and the reliability of the digestion method used for the analysis of Cd, Cr and Pb in the irrigated onion

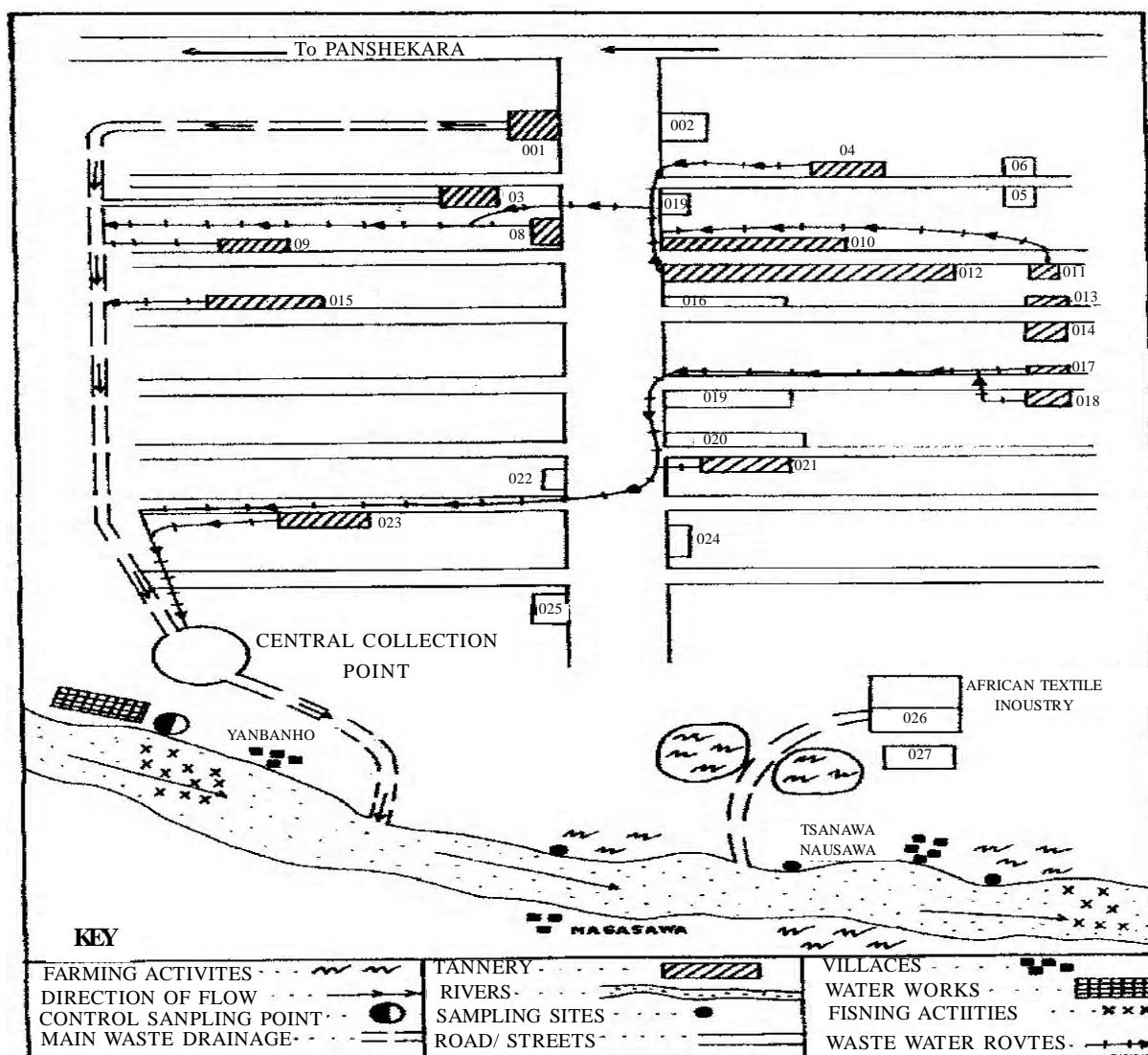


Fig.1. Sketch map of Challawa Industrial Estate Showing the Sampling Sites

leaves samples, three sub-samples of one of the onion leaves samples were spiked with (0.5mg/L Cd and Cr, and 3.00mg/L Pb) multi-element standard solution.

Samples and blanks were digested as described by (Awofolu, 2005). About 0.5g of powdered onion leaves samples were weighed into a 100ml beaker. 5ml concentrated nitric acid and 2mL of Perchloric acid, together with few boiling chips were added. The mixture was heated at 70°C for 15minutes until a light coloured solution was obtained (digestion complete). The samples solution was not allowed to dry during digestion. The sample was then filtered into a 50ml standard flask and two 5ml portions of distilled water were used to rinse the beaker and the contents filtered into the 50ml flask. The filtrate was allowed to cool to room temperature before dilution was made to the mark and the content mixed thoroughly by shaking. The digestion was carried out in triplicate for both samples and blank. The digests were run on the atomic absorption spectrometry machine. Similarly, spiked and unspiked samples were digested and analysed as above.

RESULTS & DISCUSSION

The mean percentage recoveries revealed the following trends: Pb > Cd > Cr respectively. Also, the results showed that Pb has the highest recovery of 96.60. Generally, acceptable recoveries were obtained in all cases, which validate the experimental procedure and the efficiency of the Atomic Absorption Spectrophotometer. Average metal concentrations and ranges (mg/kg dry weight) found in onion leaves from study area and control areas are shown on (Table 1). Cd, Cr and Pb concentration levels also ranged from 0.667 – 0.933, 3.870 – 7.870 and 5.870 – 7.537mg/kg respectively. The profile of the metal content of onion leaves in the study area were found to be in the order Pb > Cr > Cd. As (Table 2) shows, positive correlation was found between all the metal in the samples from the study area. This indicates the appearance of local high concentration of other metals, which suggests that the metals might have originated from the same anthropogenic source. Generally, the level of contamination of Cd, Cr and Pb shown on (Table 1) were slightly higher at the study area than at the control ones, which suggest that the investigated onion leaves of study areas were

noticeably contaminated by these metals. However, the trend of occurrence of trace metals in onion leaves samples of the study area revealed that the concentration of Cd has highest value of 0.701mg/kg in samples analysed. This is also similar to Reimann et al. (2001) that Cd accumulates in seven of nine species, grown in contaminated areas as compared to unpolluted ones. The highest total mean concentration obtained in this study is however higher than world average of 0.06mg/kg (Forstner and Wittmann, 1984). Also, comparable to others studies the highest mean concentration was higher than 0.15 – 0.60mg/kg and 0.01 – 0.03mg/kg reported by Sardans et al. (2005) and Ellen et al. (1990), respectively. Levels of Cd obtained in this study were lower than range of 2.5 – 4.00mg/kg and mean value 4.10mg/kg reported by Chandrappa and Lokeshwari (2005) and Okoronkwo et al.(2005) respectively. The reason for the high concentration could be that Cd is relatively easily taken up by food crops and especially leafy vegetables (Chandrappa and Lokeshwari, 2005). In comparison to standard limits, mean concentration of Cd in eaves revealed values below the WHO/EU, ICRCL and EU (1986) limits. The highest total mean concentration of Cr

Table 1. Mean (\pm SD) and Range (mg/kg) d.w of trace metal contents in onion leaves samples of study and control area

Site	Trace Metal		
	Cd	Cr	Pb
Study Area			
Mean	0.824 \pm 0.071	6.058 \pm 1.276	6.599 \pm 0.561
(\pm SD)			
Range	0.667 – 0.933	3.870 – 7.870	5.870 – 7.537
Control Area			
Mean	0.640 \pm 0.041	0.598 \pm 0.124	4.760 \pm 1.447
(\pm SD)			
Range	0.583 – 0.700	0.447 – 0.842	3.833 – 7.333
EU Limit	1-3	-	50 - 300
ICRCL	0-1	-	1-50
Limit			
WHO/EU	0.2	0.1	5.0
Limit			

Table 2. Correlation matrices between trace metals in onion leave samples

Factor	Cd	Cr	Pb
Cd	1.000		
Cr	0.893	1.000	
Pb	0.975	0.971	1.000

(7.870mg/kg) was found in samples. This could strongly indicate the influence of tannery industries on the level of Cr. Compared to literature, highest value obtained from this study exceeded 6.4mg/kg reported by Sardans et al. (2005) and 0.1mg/kg limits set by WHO/EU (1993) and lower than world average of 100mg/kg reported by Forstner and Wittmann (1984). However, the high level of Cr obtained in this study could be attributed to the release of untreated effluent from the tanneries. The maximum concentration of Pb in onion leaves is much lower than highest values of 42.00mgkg⁻¹ reported by Sardans et al. (2005) and 375.0mg/kg reported by Anthony and Balwant (2004) but, higher than 0.015mg/kg, 1.56mg/kg and 10mg/kg reported by Awofolu et al. (2005), Audu and Lawal (2005) and Forstner and Wittmann (1984), respectively. Generally, Pb content was within the permissible limits given by ICRCL (1987), although higher than WHO/EU (1993) limits. The high level of Pb in this study could be attributed to acid-Pb batteries as waste dumped in the river, which are subsequently used to irrigate the farmlands. This may also be responsible for high level of Pb in the control site.

CONCLUSION

The results have shown that the use of effluent water from industries can increase the intake of heavy metals by vegetable. Abundance in the vegetable seemed to be due to heavy metals in soils, though further studies are needed to confirm this. The higher concentrations of Pb and Cr in the plants than the allowed values could be a health risk to consumers and although the concentration of Cd is below the recommended guidelines. It is therefore recommended that there should be continuous monitoring of these metals in the vegetables to avoid toxic effects in the consumers. Further research into the uptake of the heavy metals by different vegetables under the same conditions would also be necessary.

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