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Short Communication

Comparative Analysis of Heavy Metals Accumulation in Okra Grown in Waste Water and Deepwell Sites at Ibadan

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Abstract

Okra grown at two different production sites (wastewater and deep well irrigated sites) in Ibadan was analyzed for heavy metal contamination. Cr and Pb in both sites and Mn in Iletitun were below detection limits in the water, but occurred at different concentration in the soil with Podo having several folds more in all heavy metals tested but the concentration was below the maximum permissible limit set by Great Britain. Okra planted in Podo site accumulate higher of concentrations heavy metals. Roots had higher concentration of Cr, Pb and Fe. Concentrations of essential elements (Zn, Mn and Cu) were higher in the root. Transfer factors (TF) of non essential element (Cr and Pb) were several times higher in Podo. Transfer factor for Cu and Zn were higher at Iletitun. Okra grown in polluted site accumulated heavy metals above both Indian and WHO/FAO recommended limits. There is a need to adopt technology that will reduce the uptake of heavy metals by the crop to reduce health risk.

Keywords: Okra, waste, heavy metals, accumulation, vegetable

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Introduction

Okra (*Abelmoschus esculentus*) has been described as an important vegetable crop in the tropics and sub-tropical zones of the world (Adebisi *et al,* 2007). Okra is a rich source of many nutrients such as calories (25g), dietry fibre (2g), protein (1.5g), carbohydrates

(5.8g), vitamin A (460 IU) in a 100g of green Okra pod and others (Schilling, 2002). It is cultivated either as a sole or intercrop for its nutritious leaves, fruits and these have provided alternative sources of livelihood for population in recent times. Many people in urban centres are currently involved in vegetable production using available undeveloped vacant land and river banks. The use of urban waste water in agriculture is a widely established practice, particularly in urban and peri-urban areas of arid and seasonally arid zones. Waste water is used as a source of irrigation as well as a source of plant nutrients such as nitrogen, phosphorus, potassium and trace elements (Fe, Mn etc) which allows farmers to reduce the purchase of fertilizers and organic matter that serve as soil amendments and replenish humus. River and channel banks around the cities are prone to waste disposal from industries, municipality and domestic sources. This poses a health risk to urban communities growing and consuming food crops and vegetables grown in these areas. Crop grown on metal contaminated soils accumulate heavy metals in quantities, excessive enough to cause clinical problems. A number of studies have shown heavy metals as an important contaminant of vegetables (Sharma *et al.,* 2008). Very limited information regarding the accumulation of heavy metal in vegetables raised in industrially polluted areas of Ibadan is available such information is vital for the production of quality vegetables as well as healthy food stuff. Therefore the study is aimed at determining heavy metals contamination present in the vegetable raised in two different production sites.

Materials and Methods

The study was carried out at two vegetable production sites in Ibadan. The first site at Podo is an area where wastewater from industrial plant had been used for crop production for several decades, while the second site (Iletitun) had no record of waste water use but rain and well water are used for crop production which serve as the control. Nine sampling points were randomly chosen at both sites. Three replicates of soils were collected from the top 30cm and bulked. The soils were air dried, crushed, passed through 2mm mesh sieve and stored at ambient temperature prior to analysis for heavy metal concentration. Three replicated plastic bottles (acid washed) of capacity 100ml were immersed one after the other in the wastewater and well water used for irrigation. The solutions were filtered and concentrated HNO_3 was added to prevent microbial utilization of heavy metals. Ten (10) Okra was randomly selected from each location. The plants were cut and separated into roots, leaves and fruits and were sun dried. The samples (soils, water and okra parts) were analyzed for heavy metals determination using a standard laboratory procedure (Sharma *et al.,* 2008). Data obtained were analyzed using Genstat Release 7.22 DE (PC/Windows).

Results and Discussion

Levels of heavy metals in okra

An accumulation of all the heavy metals differed significantly in the two locations and plant parts with higher accumulation at Podo (Table 1). Concentration of Fe and Mn were higher in both locations followed by Cr and Zn while Pb and Cr were least accumulated. It might reflect the easy mobility of these metals from soil to plant. Okra grown in Podo, where wastewater is used for irrigation have higher concentration of metals partly due to the fact that both soil and water have been polluted because of untreated effluent from industries and domestic sources than the second location where well water is used. The concentrations of these metals were several times more in okra planted in Podo over those from Iletitun. Pb was not detected in Iletitun but present in okra from Podo. Concentration of Pb, Mn and Fe were higher than the recommended maximum limit while Cu and Zn levels were below the maximum limit by WHO. Awasthi, (2000) observed that average values of heavy metals in the vegetables collected from production site are lower than the PFA standard. Rajesh *et al.,* (2009) also reported Pb in vegetable tested from both production and market sites were below the PFA standard but were several folds above EU standards.

Pb and Cr occurred mostly in the root of okra in both locations this is similar to the report of Nwoko and Egunjobi (2002) that Pb concentration in soil and vegetable in the abandoned battery factory site in Ibadan and reported the presence of Pb in the tissues of plants, with roots containing higher residual Pb than shoots in most cases. The more recent study has also shown high levels of Cr in the roots of *Brassica campretris* and emergent species like *Cyperus esculentus* (Gosh and Sigh, 2005) (Table 1).

Transfer Factor (TF)

The ability of a metal species to migrate from the soil to into plant roots is referred to as transfer factor. If the value of the translocation factor is higher for plants; the more elements would be accumulated by them (Saglam, 2013). Transfer factor is similar in both locations with respect to Mn, Fe, Cu, and Zn) are higher at Iletitun compared to Podo site. For Pb and Cr transfer factor are many folds higher at Podo. Trace elements (Mn, Fe, Cu, and Zn) have higher values than non-essential elements (Cr and Pb). Sajjad *et al.,* (2009) noted that if the transfer factor of a metal is greater than 0.5, the plant will have a greater chance of the metal contamination by anthropogenic activities (Table 2).

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Order of preference of heavy metal accumulation in okra

Pb and Cr accumulated more in the roots except at Iletitun site where Cr concentration was higher in the leaves and least in the root. Studies have revealed that Pb is not readily accumulated in the fruiting part of vegetables and on the surface of root crops (Rose, 2002). Ademoronti (1995), showed that vegetables accumulate a considerable amount of heavy metals (Pb, Cr, Cu and Zn) in roots and leaves. Fe accumulates mostly in the roots and least in the fruit while Zn accumulates in the shoot than the root with the exception of Fe, trace elements (Zn, Mn and Cu) were translocated to the shoot. This result is similar to Sharma *et al.,* (2008) who observed that the metals concentration varies in the different parts of vegetable plants. Moreover, the results indicate that Fe tends to accumulate in root and leaves, but Zn accumulates in the roots and translocate gradually to the leaves (Table 3).

Concentration of heavy metals in soils and water at Podo and Iletitun

The pH of both sites is slightly acidic, although Podo site is more acidic. The concentration of these heavy metals in Podo is several times higher than Iletitun site where well water is used for irrigation. Heavy metals in these production areas are below maximum permissible limit set by Great Britain. The presence of higher levels of these metals in Podo site where waste water is used for irrigation is similar to the report of Nrgholi, (2007) that long-term use of waste water resulted in accumulation of heavy metals in the soil and their transfer to the various crops under cultivation with levels of contamination that exceed permissible limits (Table 4).

Table 1: Accumulation of heavy metals (mg/kg) in parts of Okra and maximum permissible standards

Metals	Iletitun			Podo					
	Root	Leaf	Fruit	Root	Leaf	Fruit	LSD	Indian Standard	WHO Standard
Cr	0.35	0.57	0.42	2.83	2.45	1.8	0.09	20.0	NA
Pb	0.73	0.46	-----	54.4	22.5	1.94	0.58	2.5	5.0
Mn	162	434	133	243.0	564.2	159.6	18.71	NA	NA
Fe	1332	321	821	2131.2	501.0	1067.3	110.20	NA	5
Cu	21	19	23	29.4	43.7	52.9	2.88	30	40
Zn	21	45	59	54.6	72.0	64	13.06	50	60

Table 2: Transfer Factor (TF)

Metals	Iletitun			Podo		
	Leaf	Root	Fruit	Leaf	Root	Fruit
Cr	0.036	0.022	0.027	0.11	0.13	0.08
Pb	0.013	0.021	No	0.26	0.62	0.02
Mn	5.25	1.96	1.61	5.63	2.43	1.59
Fe	1.69	7.01	4.32	1.76	7.48	3.75
Cu	3.80	4.20	4.60	2.06	1.38	2.49
Zn	3.43	1.60	4.50	0.70	0.53	0.64

Table 3: Order of Preference of heavy metals accumulation in Okra parts

Element	Okra parts
	Podo
Pb --------------	Root > Leaf > Fruit
Cr --------------	Root > Leaf > Fruit
Cu --------------	Fruit > Leaf > Root
Mn -------------	Fruit > Leaf > Root
Fe --------------	Root > Fruit > Leaf
Zn --------------	Leaf > Fruit > Root
	Iletitun
Pb --------------	Root > Leaf > Fruit
Cr --------------	Leaf > Fruit > Root
Cu --------------	Fruit > Root > Leaf
Mn -------------	Leaf > Root > Fruit
Fe --------------	Root > Fruit > Leaf
Zn --------------	Fruit > Leaf > Root

Table 4: Concentration of heavy metals in soil (mg/kg) and water (mg/L)

Metals	Soil		LSD	Water		Maximum (mg/kg)	Indian Standard
	Iletitun	Podo		Iletitun	Podo		
pH	6.19	6.20	---	---	---	---	---
Cr	15.75	21.50	0.07	ND	ND	50	---
Pb	35.26	87.25	0.77	ND	ND	400	250 - 500
Zn	13.12	102.25	10.66	0.06	0.08	300	300 - 600
Cu	5.00	21.5	2.35	0.08	0.05	100	135 - 270
Mn	82.75	100.20	15.28	ND	0.02	300	
Fe	190.00	285.00	90.00	1.2	3.4	NA	

WHO/ FAO (2001) and Indian standard Awasliti (2000)
ND – No detectable

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