

COMPARATIVE ASSESSMENT OF HEAVY METALS UPTAKE OF VEGETABLES CULTIVATED ON A DUMPSITE AT ABRAHAM ADESANYA POLYTECHNIC IJEBU-IGBO, OGUN STATE, NIGERIA.

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ABSTRACT

Growing and harvesting of plants on contaminated site as remediation method is a technique that may be employed for the purpose of environmental remediation. Seeds of jute (*Corchorus Olitorius*), spinach (*Celosia argentea*) and okra (*Abelmoschus esculentus*) were planted on a dumpsite at Abraham Adesanya Polytechnic Ijebu Igbo, Ogun state. They were harvested five weeks after visible growth and maturation was observed. The soil from the dumpsite and harvested vegetables were dried, digested and analysed for possible absorption of heavy metals (Lead, Manganese, Copper, Cadmium and Iron) using Atomic Absorption Spectrophotometer. The analyses revealed an appreciable level of concentration (mg/kg) of manganese, iron, lead, copper and cadmium in the cultivated vegetables. However, a higher absorption capacity for Fe was observed in *Abelmoschus esculentus* which revealed its potential as soil remediation for Fe. Movement of Cd was also strong from the soil to all the cultivated vegetables but mild for Cu, Pb and Mn. The results obtained for the cultivated vegetables showed they are presently within the safe limits of NAFDAC and European Union but may later pose a health risk to consumers if the constant practice of refuse and sewage disposal of inorganic contaminants on the dumpsite is not controlled.

Key words: Absorption, Vegetables, Heavy metals, Contaminants, Health

INTRODUCTION

Soil contamination by heavy metals is of the most important apprehension throughout the industrialized world [1]. Heavy metal pollution not only result in adverse effects on various parameters relating to plant quality and yield but also cause changes in the size, composition and activity of the microbial community [2]. Therefore, heavy metals such as Cu, Ni, Cd, Zn, Cr, and Pb are considered as one of the major sources of soil pollution. [1].

Lagos spinach (*Celosia argentea*) is a vegetable whose leaves and flowers are edible. It is widely grown in Africa and Southeast Asia. In West Africa and Nigeria in particular, it is one of the main vegetables where it is known as *soko yòkòtò* in Yoruba or *farar áláyyafó* in Hausa. [3].

Jute (*Corchorus olitorius*) is also an important leafy vegetable in Nigeria and other West Africa Countries. Amongst the Yoruba of Nigeria, the leaves are called ewedu while northerners call it turgunuwa or lallo. In Nigeria the leaves are boiled to make a sticky, mucilaginous sauce which is served with balls of cassava which are otherwise rather dry. [3].

Okra (*Abelmoschus esculentus*) is a vegetable plant which has products that are mucilaginous, resulting in the characteristic slime when the seed pods are cooked. The mucilage contains soluble fiber. Pods are cooked, pickled, eaten raw, or included in salads. In India the pods stuffed with spices are a popular dish. Okra may be used in developing countries to mitigate malnutrition and alleviate food insecurity. [4]. In Nigeria, Okra is a nutritious vegetable which plays important role to meet the demand of vegetable where they may be scanty in the market [4].

Generally, phytoremediation is an emerging technology using selected plants to degrade and clean up the contaminated soil and environment from hazardous contaminant to improve the soil and environment quality. [5], [6].

Uptake of heavy metals by plants and subsequent accumulation along the food chain is a potential threat to human health. [7], [8]. The consumption of heavy metal contaminated food can seriously deplete some essential nutrients in the body that are further responsible for decreasing immunological defenses, intrauterine growth retardation, disabilities

associated with malnutrition and high prevalence of upper gastrointestinal cancer rates [9].

With various studies [10], [11] which have shown that heavy metal pollution poses a great potential threat to the environment and human health, this study is set out to explore the strength of phytoremediation of vegetables cultivated on a dumpsite and possible health risk based on the level of absorption or uptake of heavy metals from the soil if consumed.

MATERIALS AND METHODS

Study Area

Abraham Adesanya Polytechnic Ijebu Igbo, Ogun state occupies a landed area of 300 hectares, and located at the North-western side of Ijebu-Igbo, on the rolling hills of Atikori. Three hills exist with valleys and rivers in between within the campus, and the Polytechnic is bounded by another town – Ojowo, in Ijebu-Igbo.

Cultivation

Seeds of Jute, Lagos spinach and Okra were planted on a dumpsite at Abraham Adesanya Polytechnic Ijebu Igbo, Ogun state; harvested five weeks after visible growth and maturation was observed.

RESULTS AND DISCUSSIONS

Sample Collection

The soil and the harvested vegetable samples were collected randomly from the dump Site. The soil samples were air-dried, crushed and sieved. The leaves were plucked, rinsed with water to remove contaminants before drying in oven at 105°C until stable weights were obtained. The dried samples were ground with a mortar and pestle.

Digestion

One gram (1.0g) of ground vegetable samples and soil were digested with 10 ml nitric acid, and 10ml hydrochloric acid. The samples were placed on a shaker machine for 30 min. On cooling, the digest were filtered and made up to the mark with distilled water. [12]. The resulting solutions were then aspirated into Atomic Absorption Spectrophotometer to read the elements. Blanks were prepared to check for background contaminations by the reagent used. The metals analyzed in all the samples were Lead (Pb), Copper (Cu), Iron (Fe), Cadmium (Cd), and Manganese (Mn).

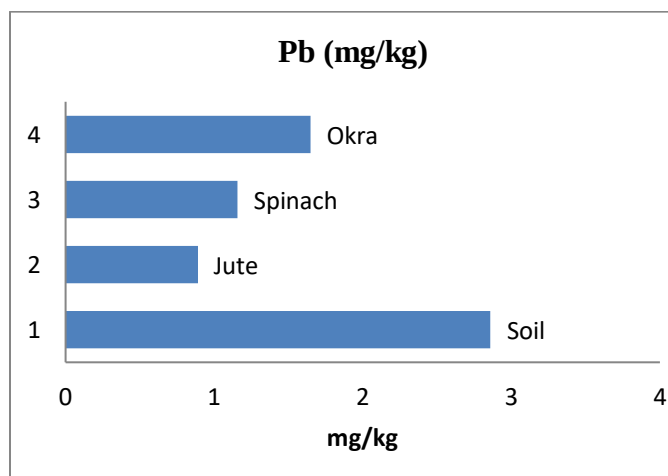
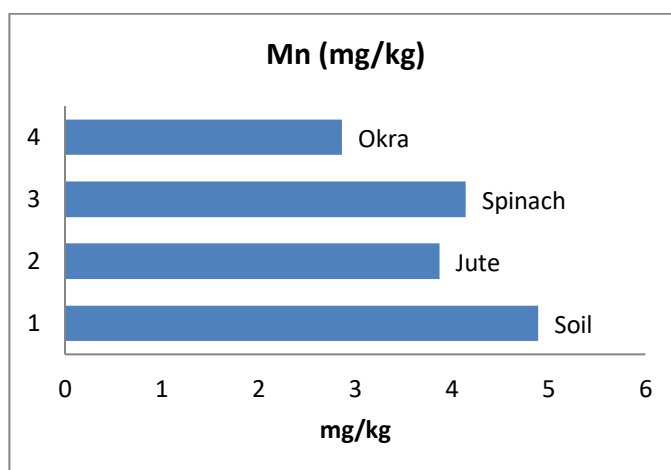
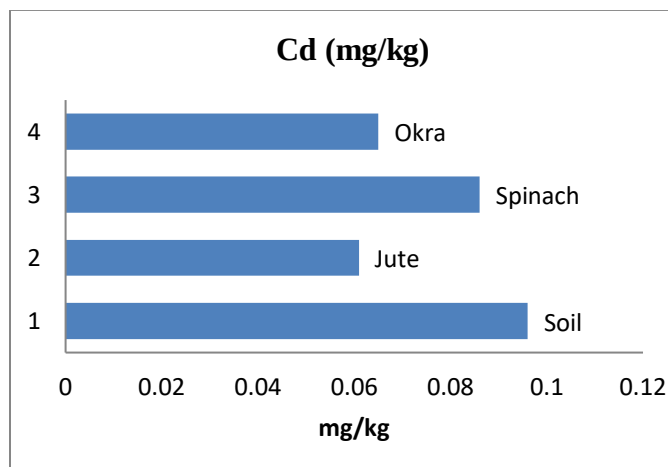
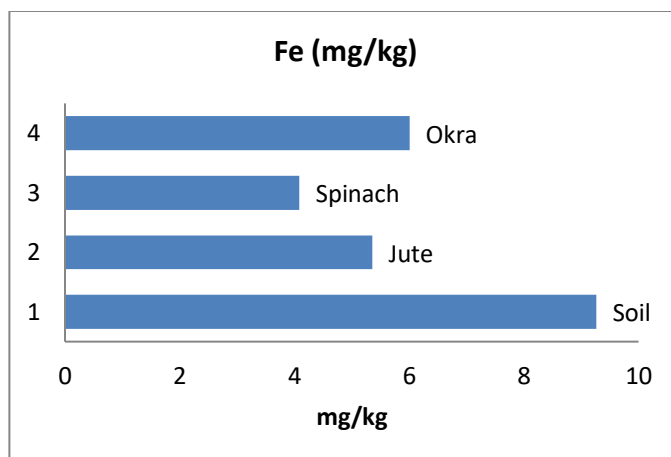
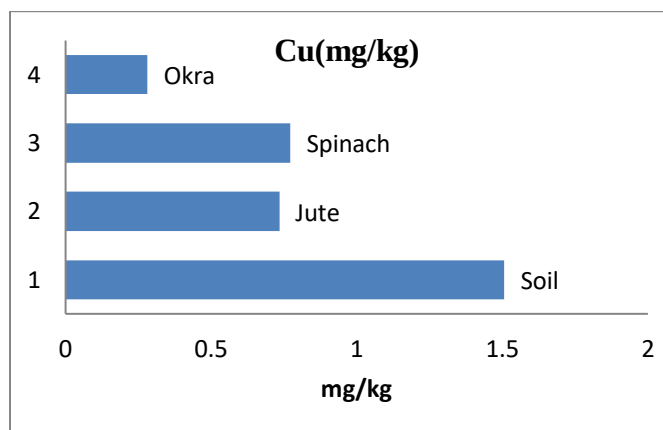
Table 1: Heavy Metal Analysis of Dumpsite and Cultivated Vegetables

Heavy Metals	Soil Sample	<i>C. olitorius</i>	<i>C. argentea</i>	<i>A. esculentus</i>
Cu	1.506 ± 0.39	0.735 ± 0.55	0.771 ± 0.69	0.281 ± 0.21
Cd	0.096 ± 0.01	0.061 ± 0.01	0.086 ± 0.02	0.065 ± 0.01
Pb	2.860 ± 0.01	0.891 ± 0.01	1.157 ± 0.01	1.649 ± 0.01
Fe	9.261 ± 0.45	5.361 ± 0.06	4.088 ± 0.87	6.010 ± 0.02
Mn	4.890 ± 0.13	3.872 ± 0.13	4.142 ± 0.26	2.863 ± 0.09

Table 2: European Union and NAFDAC Standards for Some Heavy Metals

Standard	Cd	Cr	Cu	Ni	Pb
European Union Standards (2002) for soil (mg/kg)	3.0	150	140	75	300
European Union Standards (2006) for vegetables (mg/kg)	0.2	0.3	40	2.3	0.3
Indian Standard for plant (mg/kg)	1.5	20.0	30.0	1.5	2.5
NAFDAC standards for fresh vegetables (mg/kg)	--	--	--	2.7	2.0

Source: WHO/FAO 2007, (Aweng *et al.*, 2011), Abdulmojeed *et al.* (2011).



The heavy metal concentrations in soil samples from the dumpsite and cultivated vegetables were determined and the Mean results are as shown in table 1 above.

The results obtained for Cu in soil sample from the dumpsite is 1.506 ± 0.39 while 0.735 ± 0.55 , 0.771 ± 0.69 and 0.281 ± 0.21 were determined for *Corchorus olitorius*, *Celosia argentea* and *Abelmoschus esculentus* respectively. This indicates that *Abelmoschus esculentus* has the lowest Cu absorption from the soil. However, these values are lower than 0.53 ± 0.16 reported for spinach by [15]. Values determined are also lower than European Union Standards for soil and vegetables. [14]

The mean values of Cd determined in *Corchorus olitorius*, *Celosia argentea* and *Abelmoschus esculentus* are, 0.061 ± 0.01 , 0.086 ± 0.02 , and 0.065 ± 0.01 respectively. These values are not significantly different from the 0.096 ± 0.01 determined from the soil. This may be as a result of

easy absorption of Cd by plants through the roots to the stem and leaves. [16].

The concentrations of Pb (mg/kg) in the *Corchorus olitorius*, *Celosia argentea* and *Abelmoschus esculentus* (0.891 ± 0.01 , 1.157 ± 0.01 and 1.649 ± 0.01) respectively are lower than NAFDAC maximum permissive limits or standard with the exception of the Pb (2.860 ± 0.01) determined in the soil. Moreover, all these values are also lower than 105.37 ± 45.37 reported for cocoyam leaves by [17]. The least absorption of Fe was obtained in *Celosia argentea* with *Abelmoschus esculentus* having the highest absorption of Fe (6.010 ± 0.02) from the soil. However, these values are lower than 730.24 (mg/kg) and 71,240.26 (mg/kg) reported for Fe in vegetables cultivated on soil receiving industrial waste water before and after irrigation respectively by [18].

The mean values obtained for Mn (mg/kg) in the soil, *Corchorus olitorius* and *Celosia argentea* are 4.890 ± 0.13 , 3.872 ± 0.13 , and 4.142 ± 0.26 with *Abelmoschus esculentus* having the lowest absorption of 2.863 ± 0.09 . These values are closely related to 4.28 ± 0.67 reported for vegetables growing on Oke ogi dumpsite by [19].

In conclusion, the analyses revealed an appreciable level of concentration (mg/kg) of manganese, iron, lead, copper and cadmium in the cultivated vegetables. However, a higher absorption capacity for Fe was observed in *Abelmoschus esculentus* which indicates its potential as soil remediation for Fe. Movement of Cd was also strong from the soil to all the cultivated vegetables but mild for Cu, Pb and Mn.

Though, the concentration of metals analysed in the cultivated vegetables are presently within the safe limits of NAFDAC and European Union, they may later pose a health risk to consumers if the constant practice of refuse and sewage disposal of inorganic contaminants on the dumpsite is not controlled.

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