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BIOCONCENTRATION OF SOME TRACE METALS IN *Panicum maximum AND Colocaesia esculenta* FROM TWO AUTOMOBILE WORKSHOPS IN CHOBA AND ALAKAHIA, OBIO-AKPOR LOCAL GOVERNMENT AREA, RIVERS STATE, NIGERIA.

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ABSTRACT

The levels of Pb, Ni, Cr, Zn, Cd and V and their bioconcentration factors in two plant species commonly found around automobile workshops in Alakahia and Choba areas of Rivers state were investigated using Atomic Absorption Spectrophotometer. Results showed that the concentration of Pb in plants ranged from 0.220 to 0.330 mg/kg with a mean bioconcentration factor of 0.121, Ni ranged from 0.013 to 0.030 mg/kg with a mean bio-concentration factor of 0.078, Cr ranged from 0.185 to 0.251mg/kg with a mean bioconcentration factor of 0.332, Zn ranged from 1.537 to 2.327 mg/kg with a mean bioconcentration factor of 0.591, while Cd and V were ≤ 0.001 mg/kg with a mean bioconcentration factor of 0.017 to 1.000 respectively. The results indicated possible Pb and Cr toxicity. Also, the Bioconcentration factors were < 1 showing the possibility of bioaccumulation of the metals. Despite a certain degree of metal enhancement from soil to plants, humans who consume the plants should pay more attention to the activities that introduce these metal pollutants to the environment due to their toxicity.

Keywords: Bioconcentration, trace metals, panicum maximum, colocaesia esculenta, toxicity

INTRODUCTION

Heavy metal pollution has been most destructive and affects the vegetation and soil, causing illnesses of all sorts to both man and livestock. Oil and gas exploration activities in Nigeria has resulted in increased pressure on the environment resulting in changes that directly affect soil and the ecosystems. An example of such change is the activities of large number of automobile workshops which generate metallic waste that accumulate in the soil and then, in plants. Concentrations of trace metals in soils and plants make available information about their movement in the environment, bio-concentration, trophic transfer, and probable toxicological consequences.

Generally, the accumulation of contaminants in soil and plants can have destructive effects on the environment and on human health. Contaminants present in soils can enter the food chain and seriously affect animal and human health [1]. Trace metals are the metal subset of trace elements; that is, metals normally present in small but measurable quantities in animal and plant cells and tissues which are a necessary part of nutrition and physiology, e.g Iron, Magnesium, Calcium, Manganese, Cobalt, Zinc, Potassium [3].

It must be noted that industrialization and urbanization, despite their myriad advantages to man are the major facilitators of heavy metal pollution. If an environment is altered in composition or condition, it becomes less suitable for any or all the functions and purposes for which it would be suitable in its natural state, it is then said to be polluted [9].

Industrial activities have been found to deposit a number of toxic elements in environment where those elements were previously either not present or were found in trace amounts. It is important to measure the amount of these pollutants relative to guidelines to properly study the effects they have on the environment and its inhabitants.

Most activities that can contribute to the introduction of heavy metals in the automobile workshops are paints applied on or scrapped off the surface of cars, antifreeze agents used in the radiator to prevent the car from overheating, petrol used to wash off grease stained tools and equipment, condemned oil usually siphoned from the engine and dumped around the site, indiscriminate dumping of car batteries and its components, Fine particles of metal and paint become aerosol, eventually returning to the soil through rain or as settling dust.
Bioaccumulation can be defined as the accumulation of substances such as pesticides, or other chemicals in an organism. It occurs when an organism absorbs a possibly toxic substance at a rate faster than that at which the substance is lost by catabolism and excretion [2].

Bio-concentration is the intake and retention of a substance in an organism entirely by respiration from water in aquatic ecosystems or from air in terrestrial ecosystems. Bio-concentration factor is expressed as the ratio of the concentration of a chemical in an organism to the chemical's aqueous concentration.

Motor servicing centers are known to the layman as "mechanic workshops", these are places where automobiles are taken to for repair. They remain a major source of automobile waste in urban areas and Obio-Akpor local government area is one of such urban centers.

In land uses, fossil fuel products of different types are used leading to excess accumulation of heavy metals which are major constituents of the products in soils in and around these locations. These accumulations deteriorate vegetation that are nearby, accumulate in the plants tissues, deteriorate surface runoff and percolate the water table causing non-point pollution [3].
The two plant species used for this studies are *panicum maximum* commonly known as the guinea grass, a tropical grass which is a native of Africa; it serves as a major source of animal fodder. *Colocasia esculenta* is the common cocoyam plant, they are herbaceous perennial plants belonging to the family *araceae* and are grown primarily

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for their edible roots although all parts of the plant are edible.

The aim of this research is to assess the level of pollution posed by trace metal contamination within the mechanic workshops and to determine the amount of heavy metals bioaccumulating in plants found around these areas.

EXPERIMENTAL

Description of Study Area

The study areas are Choba and Alakahia communities of Obio-Akpor Local Government Area, Rivers state Figure 1. This area lies geographically between latitude 4°9′40″N to 4°56′10″°N and longitude 6°54′40″ °E to 7°1′10″ °E. Alakahia and Choba areas are have many automobile workshops, markets, restaurants, schools and farms. The presence of these automobile workshops has led to a high rate of heavy metal pollution.

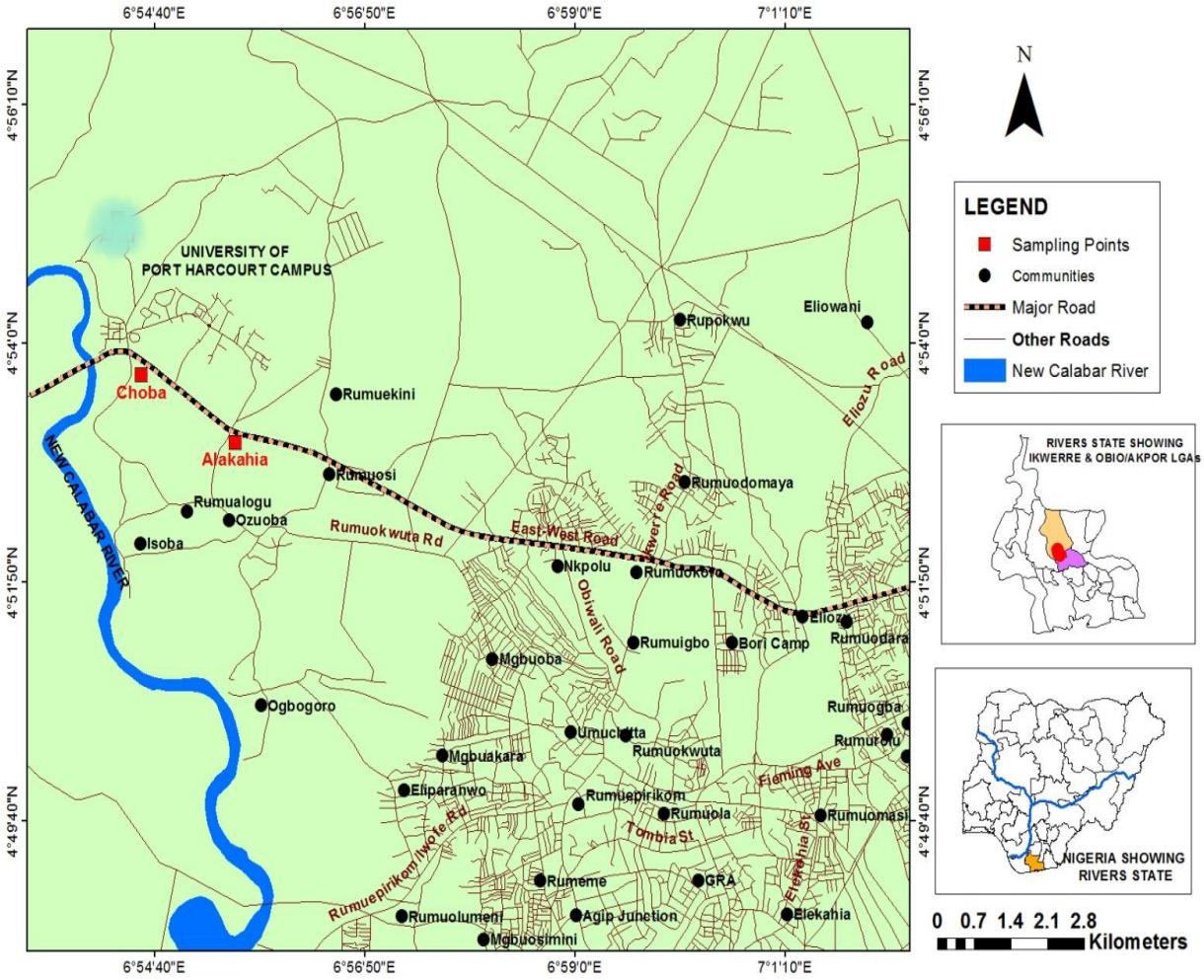

Figure 1: Map of study area showing Alakahia and Choba areas in Rivers state.

Sample collection and analysis

Two Plant species were collected around two automobile workshops and taken to Plant Science and Biotechnology department of the University of Port Harcourt for proper identification. They were identified as *panicum maximum* (guinea grass) and *colocasia esculenta* (cocoyam plant). Fifty grams (50g) of the samples were heated in a muffle furnace at

630^{o}C until it turned to ash and then five grams (5g) of the ash were placed into two separate conical flasks and properly labelled. 1ml of HCl was quantitatively transferred into each conical flask. The flask was made up with water to the 50ml mark and allowed to settle. It was then decanted into the appropriate labelled sample bottle dried, digested and the concentration of some trace metals such as Pb, Ni, Cr, Zn, Cd and V were analysed using Atomic absorption spectrophotometer model A200.

Bio-Concentration Factor of Heavy Metals from Soil to plant species

Bio-concentration factor (BCF) refers to the bioaccumulation potential of a chemical; it correlates with the octanol-water partition coefficient (K_{ow}), experimental measurement of the bio-concentration factor is time-consuming and expensive and is not feasible for a large number of chemicals of regulatory concern. The BCF can be predicted from the log K_{ow} through computer programs based on quantitative structure activity relationship (QSAR). A BCF greater than 1 is indicative of a hydrophobic or lipophilic chemical, it is an indication of how probable a chemical is to bioaccumulate; these chemicals have high lipid affinities and will concentrate in tissues with high lipid content instead of in an aqueous environment like the cytosol.

The uptake efficiency of the heavy metals by *panicum maximum* (guinea grass) and *colocasia esculenta* (cocoyam plant) were evaluated by determining the bio-concentration factor as the ratio of concentration of the heavy metal in plant species to their concentration in respective soil zone using the equation below:

$$BCF_{plant} = C_{plant}/C_{soil}$$

Where, C_{plant} and C_{soil} are the concentration of heavy metal in plant species and soil zone by dry weight (DW) basis, respectively [4].

RESULTS

Table 1: Concentration of trace metals (mg kg^{-1}) in plant species and soil

Trace metals	Sample identity						
	PMC	PMA	CEC	CEA	SSC	S SA	WHO permissible limit
Cd	0.001	0.001	0.001	0.001	0.034	0.248	0.200
Cr	0.210	0.251	0.221	0.185	0.679	0.629	2.300
V	0.001	0.001	0.001	0.001	0.001	0.001	-
Ni	0.013	0.020	0.018	0.030	0.473	0.202	10.000
Pb	0.220	0.280	0.280	0.330	1.700	3.210	2.000
Zn	2.246	1.537	2.327	1.715	3.210	3.460	6.000

PMC= panicum maximum Choba; PMA = panicum maximum Alakahia; CEC = colocasia esculenta Choba; CEA = colocasia esculenta Alakahia; SSC = Soil sample Choba; SSA=Soil sample Alakahia

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Table 2: Calculated Bio-concentration Factors (BCF) for *panicum maximum* and *colocasia esculenta* from the automobile workshops.

Trace metal	BCF_{PMC}	BCF_{CEC}	BCF_{PMA}	BCF_{CEA}	Mean
Cd	0.029	0.029	0.004	0.004	0.017
Cr	0.309	0.325	0.399	0.294	0.332
V	1.000	1.000	1.000	1.000	1.000
Ni	0.027	0.038	0.099	0.149	0.078
Pb	0.129	0.165	0.087	0.103	0.121
Zn	0.700	0.725	0.444	0.496	0.591

The concentrations of the six trace metals analyzed in the plant species are shown in table 1. The heavy metals concentration in the soil and plant species investigated varied considerably. The distribution of heavy metals in the soil and plant system is determined by some physical processes which include capillary action, run off, leaching and root uptake [5]. Heavy metal concentrations from the soils of the automobile workshops are shown in table 1. It was observed that Zn and Pb concentrations in the soil were higher compared to other metals studied. V recorded the least value with a concentration of 0.001 $mgkg^{-1}$. Cd and Pb exceeded the WHO 2002 [6], permissible limits of 0.200 $mgkg^{-1}$ with values of 0.248 and 3.210 $mgkg^{-1}$ respectively. Higher Cd and Pb concentration in soils may be due to due activities such as paints applied on or scrapped off the surface of cars, petrol used to wash off grease stained tools and equipment, condemned oil usually siphoned from the engine and dumped around the site, indiscriminate dumping of car batteries and their components, Fine particles of metal and paint become aerosol, eventually returning to the soil through rain or as settling dust.

Cadmium can be toxic to plants at lower soil concentrations than other heavy metals and is more readily taken up than other metals [7]. It has severe sublethal and lethal effects at low concentrations in the environment [8]. It is also associated with increased mortality, growth reduction, and reproduction. It bioaccumulates in the livers and kidneys of fish and at all trophic levels [9, 10]. Elevated levels of Pb in plants, can cause reduced growth, photosynthesis, mitosis, and water absorption [11]. At higher trophic level and organisms, organolead compounds, sinkers or paint are some sources of Pb poisoning, which affect hematologic and neurologic processes [11].

Results showed the concentrations of heavy metals such as Cr, V, Ni and Zn in soil and plant species to be below the WHO permissible limit of 2.300, 0.500 and 6.000 mg kg^{-1} for food crops respectively [12]. But the concentration of Zn is high which can be toxic to plants at elevated levels, causing adverse effects on growth, survival, and reproduction [8].

Bio-Concentration Factor (BCF) of Heavy Metals in soil and plant species

The most prominent pathway for humans to get exposed to trace metals in the food chain is through soil by plant transfer. The assessment of the BCF values in plants assist in the determination of the bioavailability of heavy metals, the higher the BCF, the more available the metal is and this varies significantly with the metal and plant species [13].

The calculated BCF of the trace metals for the plant species varied from 0.004 - 0.029 for Cd, 0.294 - 0.325 for Cr, 1.000 for V, 0.027 - 0.149 for Ni, 0.087 - 0.165 for Pb and 0.444 - 0.725 for Zn (Table 2). The results show that each trace metal has its distinct BCF in each plant species. The BCF for all plant species were all below 1 except for V which had the value of 1.000. Some researchers have shown that a higher BCF value indicates a higher accumulation potential of metals [13, 14]. Results from table 2 indicate that V has the highest capacity for transferring from soil to the plants species than the other five metals, the BCF order for the other trace metals is Zn > Cr > Pb > Ni > Cd in soil of the study area.

It has been observed that the transpiration rates in some plants is usually faster than others, thus, metal uptake by plant roots can be enhanced, resulting in the translocation of metals from roots to other plant tissues [15, 16, 17]. Due to the broad leaf area, the leaves of *colocasia esculenta* are more predisposed to contaminant accumulation by the dust from soil and rainwater. Metal pollution in these plants (which are consumed directly by humans and animals which feed on them) can be alleviated by avoiding activities which introduce these metals either directly or indirectly into the soil or by planting them in soil with low metal content. It is also worthy of note that some factors such as soil properties which include soil pH, organic matter, clay content and metal concentration, and other environmental conditions such as atmosphere and industrial pollution affect metal bioconcentration in these plants [18].
Panicum maximum which serves as a major source of animal fodder and *Colocasia esculenta* a source of food commonly consumed in the study area make them suitable to be examined for trace metal contaminants. Pb and Cr had concentrations higher than the WHO permissible limits, and the bio-concentration factors of trace metals Cr, V, Pb and Zn, were also found to be high. Long term evaluation studies should be carried out as considerable seasonal variations in trace metal uptake from the investigated plant species may occur under natural conditions. Since most grazing animals feed on the plants and human beings also consume the animals, more attention should be paid to the activities that introduce these metal pollutants to the environment due to their sensitivity.

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