# Comparative Analysis of *Allium cepa L. and White Onion as Bioindicators of Heavy Metals inGroundwater*

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***Abstract- In this study, biological test using allium cepa L. and white onion was carried out to monitor the quality of groundwater sample. The two species of onions were subjected to different concentrations of heavy metal and their mean daily root growths were measured after 24hrs, 48hrs, 72hrs and 96hrs. Results indicate that a linear relationship exists between the percentage root growth inhibition and different metal concentrations (0.3mg/l, 0.5mg/l, 0.7mg/l, and 0.9mg/l) in Allium cepa L. species. Root growth inhibition increased with increase in metal concentration and duration of exposure. The highest root growth inhibition (91.4%) was observed at 0.9mg/l concentration of iron metal. For the white onion species, a non-linear relationship existed and does not follow any sequence. Hence, it is not a good indicator for monitoring water quality while bioassay using Allium cepa L. as indicators is a useful screening test for the evaluation of toxicity of heavy metal and can be used to support chemical analysis.***

***Indexed Terms- Allium cepa, White onion, Bioindicators, Root growth inhibitor***

## I. INTRODUCTION

One of the most urgent problems facing us today is the environmental pollution resulting from human activities. Rapid industrialization and urbanization have resulted in elevated emission of toxic heavy metals entering the biosphere. In general, a strong relationship between contaminated drinking water with heavy metals and the incidence of chronicdiseases such as renal failure, liver cirrhosis, hair loss and chronic anemia has been documented. It has been shown that, the prevalence of gallbladder diseases is high which is attributed to environmental exposure to heavy metals (Roosbroeck and Amlalo, 2006)

In Nigeria, over 80% of the industries discharge solid wastes, liquid effluents and gaseous emissions directly into the environment without any treatment (Federal Ministry of Water Resourse, 1994). Despite existing legislations, of the 200 randomly assessed industries, only 18% perform rudimentary recycling prior to disposal of the wastes (FEPA, (1998). .Tests with plant roots have provided cheaper, easier, sensitive, useful, reliable and valuable alternative methods for the determination of the adverse effects of environmental pollutants to the usual chemical assays carried out on experimental animals. Most of the studies indicate that there is an excellent correlation between chromosome abnormalities and mutagenic activity found in root systems and those found in mammalian cell systems. Observation of the root system of plants therefore constitutes a rapid and sensitive method for environmental monitoring(Majer, 2005).

In 1938, the use of *Allium cepa* was introduced as a biological test system to evaluate the cytogenetic effects of colchicine cells (Levan, 1938). Since then, *A. cepa L* (common onion) has been a biological material of wide use in laboratory tests, due to the fast growth of its roots and the response of genetic material to the presence of potential cytotoxic and genotoxic substances in test liquids. The *Allium* test has been applied to evaluate the quality of underground, surface waters and effluents in a simple way through the study of macroscopic parameters, such as the values for root growth inhibition,cytological parameters such as aberrations cellular metaphase and anaphase and cellular division inhibition. In the last decades, the pollution level or river water quality has been determined by physical/chemical tests, saprobiological, radiological, cytogenetical and genotoxical analysis in Allium cepa L. (FEPA, (1998). Inhibition of root length is suitable for evaluation of substances in various concentrations.

The aim of this work is to compare the efficiency of Allium cepa and white onion as bioindicators of heavy metals for groundwater analysis.

## II. LITERATURE REVIEW

Udiba et al; (2015) studied investigatation of concentrations of lead, chromium, nickel and manganese were n onion (Allium cepa L.) bulbs cultivated along the river basin around Dakace industrial area using Shimadzu atomic absorption spectrophotometer (model AA- 6800, Japan) after wet digestion. The overall mean concentrations of the metals were: 1.11±0.8 mg/kg for Lead, 1.51±0.9 mg/kg for chromium, 3.28±1.76 mg/kg for nickel and 1.68±2.72 mg/kg for manganese. Lead and chromium concentrations were found to be above WHO/FAO permissible levels. Average values of Estimated Daily Intakes (EDI) were higher compared to Recommended Daily Intakes (RDI) and Upper Tolerable Daily Intakes (UL) for the metals. Target Hazard Quotient (THQ) computed to estimate the risk to human health pose by each metal were within the safe limit of unity, lead (Pb) being the only exception. Hazard Index (HI) used to evaluate the potential risk to human health due to the combined effect of the four heavy metals was 2.83. The relative contributions of Pd, Cr, Ni, and Mn to the aggregated risk were 64.18%, 0.21%, 33.33% and 2.41% respectively. Consumption of onion bulbs from the study area thus poses a serious toxicological risk. The study concludes that uptake and subsequent accumulation of these metals in onions bulbs which is a measure of the degree of bioavailability of the toxic metals in the growth media indicates that River Galma basin ispolluted.

Palacio; (2005) studied correlation between heavy metal ions (copper, zinc, lead) concentrations and root length of *Allium cepa l*. In polluted river water. The test waters were collected at two sampling sites: at thebeginningand the end of the Toledo River. The bulbs of *Allium cepa l.* were grown in test water with nine concentration levels of copper, zinc and lead from 0.1 to 50 ppm. In the laboratory, the influence of these test liquids on the root growth was examined during five days. For test liquids' containing below 0.03- ppm dissolved cu the root growth was reduced by 40% however, the same reduction occurred for 1-ppm dissolved Zn. For dissolved Pb, results reveal toxicity above 0.1 and 0.6 ppm at the beginning and the end of the Toledo river water,respectively

Ukaegbu, and Odeigah (2009). in the genotoxic effect of eewage effluent on *Allium Cepa.* In this work, the genotoxicity of sewage effluent was investigated using both morphological and root chromosome assay. The mean root lengths of onions exposed to different concentrations of the effluent were measured every day for 5 days and EC50 values were determined from the growth curve as 47%. The result the mean root length was statistically evaluated by the analysis of variance and least significant difference. There was a significant decrease in root length of the experiment. The mitotic index also decreased as concentration increased. Total aberrations increased significantly as concentration increased ($p<0.05$). These results demonstrate that the *Allium* test is a useful screening test for the evaluation of toxicity in sewageeffluent.

## III. MATERIALS AND METHOD

### A. Preparation of Onion Bulb

Medium sized onion bulbs (allium cepa L. and white onion) were commercially obtained from Eke Awka Market, Awka, Anambra State, Nigeria and were sun-dried for one week. The sun-dried bulbs were later used to test for root growth inhibition. The test material was easily stored under dry conditions. For the experiment, mould-attacked were discarded. Still there were some poorly grown onions, care was taken to avoid poorly grown onions, to account for a number of bulbs in the population that would be naturally slow or poor growing, seven replicate bulbswere used for each test sample and control and the best five bulbs were chosen for examination (Rank, and and Nielsen, 1993). The outer scales of the bulbs and the brownish bottom plate were first removed. The rings of the root primordial were left intact. A series of cleaned small sized bulbs of onions, (Alliun cepa) were first sprouted in water as described by (Fiskesjö, 1987). After 24 hours, the best in terms of root growth were selected. Since many onions are to be started at the same time, the peeled bulbs were put into fresh water during the continued cleansing procedure to protect the primordial from drying.

B. Method

All water samples were obtained from a borehole at kwata, Awka. Anambra State. The onions were peeled by removing the outer scales and bottom plate. The rings of the root primordial were left intact. The peeled bulbs were put into fresh water during the continued cleansing procedure to protect the primordial from drying. A series of cleaned small sized bulbs of onions, (Allium cepa) were first sprouted in water as described by (Fiskesjö, 1987).

After 24 hours, the bulbs with good growth tendency were selected. The selected were then exposed directly to the different concentrations of the heavy metals contained in transparent containers of 310ml each. Ground water without any metal induced wasused as the control. Measurement were carried out every 24hrs. Four samples of water containing four different concentration of each metal in the range of 0.3mg/l, 0.5mg/l, 0.7mg/l and 0.9mg/l were used for the experiment. The root lengths from the four samples were measured and the mean root length was calculated for day 1,2,3,4 and 5.

The percentage root growth length inhibition of each concentration can be calculated thus;

$$\frac{\text{root length of control} - \text{root length at conc.(cm)} \times 100}{\text{root length of control(cm)}}$$

Table 1: Initial Concentration of Groundwater Sample

| Metal | Concentration |
|---|---|
| Chromium | 0.007ppm |
| Iron | 0.056ppm |
| Lead | 0.0651ppm |
| Cadmium | undetected |

C. ExperimentalSetup

Plate 1: Allium cepa L. and white onion placed in different metal concentration

The setup for the experiment was carried out at a room temperature of 20oC, and a relative humidity of 55/75%. at room temperature and samples were also arranged and tagged according to the name and concentration of the heavy metals contained as used in the experiment. These were monitored every 24hrs and length of roots recorded, water level is also made up every 24hrs to account for shortage due to absorption by plant and displacement by the onion base.

## IV. RESULTS ANDDISCUSSIONS

D. Mean daily root growth rate of Aliium cepa L. and white onion species for cadmiummetal.

Comparing the growth rate of both species it can be observed that Allium cepa L. Specie showed linearity depending on the concentration of the cadmium metal and duration of exposure to the metal while white onion did not. The mean daily growth rate of both species on onion can be represented in Figure 1;

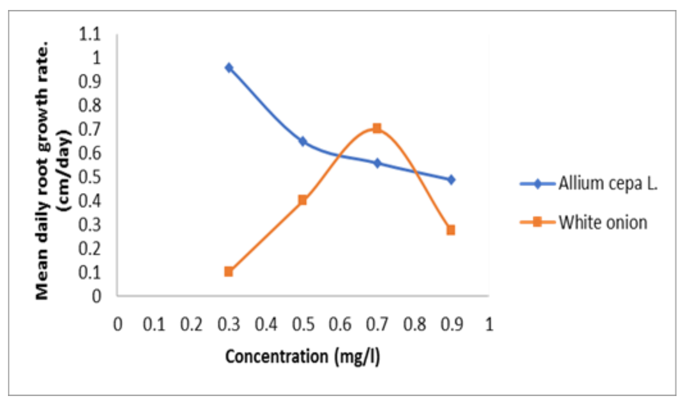



Figure 1: showing mean daily growth of roots for both onion species in different concentration of cadmium metal.

E. Mean daily root growth rate of aliium cepa L.and white onion species for Iron metal

The mean daily growth rate for both onion species in the different iron concentrations can be represented in Figure 2;

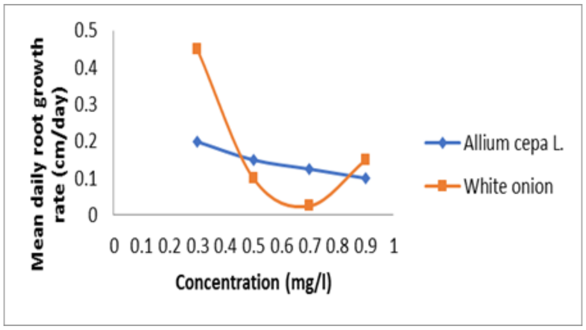



Figure 2: showing mean daily growth of roots for both onion species in different concentration of iron metal.

From Figure 2, it can be observed that the mean daily growth rate of Allium cepa L. roots is directly proportional to the concentration and duration of exposure, that is, as the concentration and duration of exposure increases the mean daily growth rate decreases.

F. Mean daily root growth rate of aliium cepa L. and white onion species for chromium metal

Allium cepa L. roots showed an almost linear relationship with the concentration of the chromium metal and duration of exposure, but white onion showed a nonlinear response. The mean daily root growth of both species of onions can be represented in Figure 3

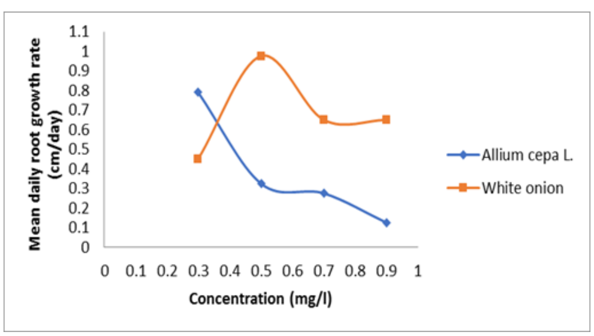



Figure 3: showing mean daily growth of roots for both onion species in different concentration of chromium metal.

G. Mean daily root growth rate of aliium cepa L and white onion species for Lead metal

Allium cepa L. roots showed an almost linear relationship with the concentration of the chromium metal and duration of exposure, but white onion showed a nonlinear response. The mean daily root growth of both species of onions can be represented in figure 4;

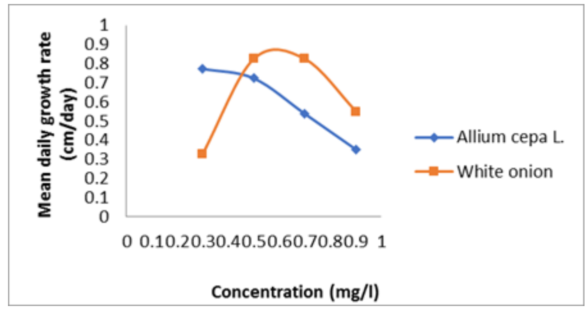



Figure 4: showing mean daily growth of roots for both onion species in different concentration of chromium metal.

H. Relationship between the percentage growth inhibitions of the different heavy metals on the plant indicators.

The effects of the heavy metals on the allium cepa L. was profound and followed an almost linear relationship, that is to say that the root length growth inhibition increased with increase in the metallic content. The highest root length inhibition for these species was observed at 0.9mg/l of iron metal resulting in about 91.4% inhibition.

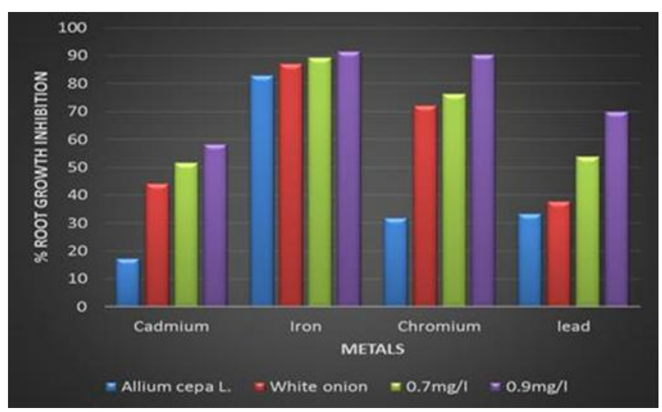
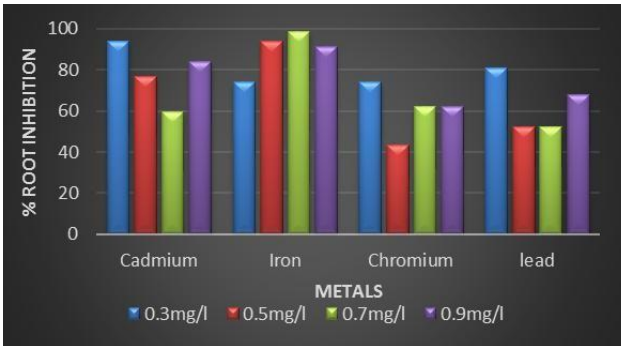



Figure 5: percentage root growth inhibitions of allium cepa L at different concentration of each metal

For the white onion species, the percentage inhibition did not follow any sequence and this can be represented in Figure 6




## V. CONCLUSIONS

The present study provides additional and valuable information about the toxic effects of heavy metals on two species of onion roots grown in varying concentration. The test demonstrated different sensitivities showing correlation to the presence of heavy metals in the water. With regards to the biological test carried out, the following conclusions were drawn;

1. Allium cepa L. is a very good bioindicator and can be used in the bioassay of heavy metals present in water. The effects of the heavy metals on the allium cepa L. was profound and followed an almost linear relationship, that is to say, the root length growth inhibition increased with increase in the concentration of heavy metals, the highest root length inhibition for these species was observed at 0.9mg/l for each of the metal.
2. In white onion, it was also observed that although the presence of the heavy metals inhibited the growth of the roots with respect to the control, the order at which it does is nonlinear and does not follow any sequence. Hence, it is not a good indicator for monitoring water quality
3. Amongst the heavy metals (cadmium, iron, chromium, and lead) used for this test, iron metal exhibited the highest growth inhibition at 0.9mg/l (91.40%) of the metal on allium cepa L. roots. While the least inhibition was recorded in cadmium concentration at 0.9mg/l (58.07%).

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