DETERMINATION OF SOME METAL IONS IN LETTUCE (*Lactuca Sativa*) FROM FARMS AROUND KETEREN-GWARI MECHANIC SITE, MINNA. NIGER STATE

By

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Abstract
The concentrations of sodium, potassium, copper, iron, chromium and zinc ions in lettuce (Lactuca sativa) samples obtained from farms around mechanic site in Keteren Gwari area in Minna have been studied using atomic absorption and flame emission spectroscopic methods. The result showed that the concentration of Cu ranged from 7.88 to 12.40mg/kg, Cr and Fe showed 0.1 to 0.22mg/kg and 5.94 to 6.34mg/kg respectively. Zn has a range of 2.80 to 3.48mg/kg. The concentration of Cr, Fe and Zn ions at the site of activity were higher than either upstream or downstream. The level of Cu ion was however low at the site of activity. Sodium and potassium ions were higher in concentration than the other metal ions studied. The increased activity at the site may be responsible for this observation. The health implication of high doses of the ions considered in such a popular vegetable cannot be overemphasized and is discussed in this paper

***Key words**: Lactuca sativa, metal ions, atomic absorption, flame emission, mechanic site*

Introduction

Farming is the major occupation of the inhabitants of Niger state. In the dry season, (October – April), local famers cultivate a number of crops and vegetables by surface irrigation. As a result, farming activities are concentrated on streams and river banks. These sources of water pass through areas of domestic activities such as mechanic sites, where farmlands are being cultivated. These activities not only introduce waste products including metal ions into water bodies, but also to the surrounding soils. The content of such soils and water used for irrigation process may increase and be absorbed by the crops and vegetables cultivated which may have physiological effects on the animals and man that may finally consume them.(Chu-fung, 1996).

Lettuce,(*Lactuca* spp), popularly called 'letus' in Yoruba, Hausa and Igbo is one of the vegetables cultivated by surface irrigation and belongs to the family Asterancea along with other garden plants. A number of species are known including *L. Virosa*, *L. semola*, *L. sativa* and *L. capitata*. Each species consist of several varieties and each of the varieties has several cultivars. Lettuce grows well in both cold and temperate climates with well drain soil which has good water retention capacity and high organic matter. Although the nutritional values vary among species, lettuce is a good source of Ca, Mg, P, Fe and Cu, as well as vitamins A, C and K. Some species contain little amounts of amino acids with low or no cholesterol. Lettuce is taken for the treatment of insomnia, whooping cough and rheumatism among other ailments. For painful menstruation, indigestion, scorpion and spider bites, lettuce is also taken. Species such as *L.* Sariola and *L.* Virosa are sedatives and pain killers due to high concentration of lactucarium. Lettuce seed is reported to have

about 35.2 % semi-drying-oil which is useful in soap making and paint manufacturing. (DermNet, N.Z, 2007; John, V.D,1994).

Nutritional elements widely required for body structure and functions are derived from plants and vegetables which are consumed as food. Metal ions such as Fe, Cr, Cu, Co, Zn, Na and K are essential to man due to their involvement in some physiological processes, although elevated levels have been found to be toxic (Awofolu, 2004).

Potassium and sodium play important role in the acid-base balance in animals. Potassium functions as a principal cation in cells and in the nerve and muscular excitation and carbohydrate metabolism. Sodium is concentrated in the soft tissue and body fluids of animals and humans. It plays a vital role in the acid-base balance and osmotic regulation of the body fluids.

In human, prolonged vomiting and diarrhoea may cause deficiency of potassium resulting in weakness and drowsiness. A deficiency of sodium in diet leads to lowering of the osmotic pressure, which results in dehydration. Symptoms of deficiency include poor growth and reduced utilization of digested protein and energy, (MC Donald *et al* 1981, Merrill *et al* 2001)

Iron plays a central role in the metabolic processes involving oxygen transport and storage as well as oxidative metabolism and cellular growth. Its deficiency results in anaemia, mucosal and epithelial abnormalities, defect in immunity, skeletal muscle dysfunction, behavioural and neurological abnormalities, listlessness and fatigue and palpation on exertion. In children, iron deficiency leads to depressed growth, anorexia and decreased resistance to infection (Shamberger 1979; Macrae *et al*, 1997; Merrill *et al*, 2001).

Zinc is an essential element whose physiological functions include cell growth and replication, antioxidant protection, regulation of neurotransmission, insulin metabolism, sexual maturation, spermatogenesis and Oogenesis, appetite regulation and hormonal immunity. Zinc deficiency in humans include behavioural alteration and central nervous system changes, which include depression, psychosis, night blindness. In children and adolescents, Zinc deffeciecy results in delayed development of puberty and secondary sexual characteristics. (Shamberger, 1979; Donaldson, 1982; Solomon, 1988; Cousins and Hempe, 1990; Pasad, 1990; Macrae *et al*, 1997 and Merrill *et al*, 2001).

Copper is essential in enzymes required for heart function, bone formation, energy metabolism, nerve transmission, elastin synthesis, normal hair growth and red blood cell production. (Macrae *et al*, 1997; Merrill *et al*, 2001). Signs of deficiency in humans include, brain, heart, bone and blood disorders. (Shamberger, 1979; Macrae *et al*,1997).

Chromium, although needed in trace amounts, is essential for the enhancement of insulin, which is involved in the metabolism of carbohydrate, fat and protein. It has also been identified to play a vital role in maintaining stable blood glucose level (the glucose tolerance factor).

Deficiency of chromium (III) in the body can lead to heart diseases, disruption of metabolic activities, improper functioning of the nervous system and diabetes insipidus (Type 2). Excess of it can cause skin irritation. Other health problems caused by chromium VI are kidney and liver damage, alteration of genetic material and death, (Zubair, 2007).

The importance of vegetables and the physiological effect of metal ions to animals and humans, cannot be overemphasized. The aim of this investigation is to determine the level of some essential metal ions in lettuce (*Latuca sativa) grown*

around a mechanic site and to evaluate the effect of mechanic activities on the concentration of these metal ions in *Lactuca sativa*. This investigation is therefore justified since it will shed light on the amount of these metal ions in lettuce and the level of supplementation that may be required to maintain a balanced intake.

MATERIALS AND METHODS

Sample Collection and Treatment

Samples of lettuce for analysis were collected from three different locations namely, upstream,(U), at the site, (A) and downstream, (D), of the mechanic site located at Keteren Gwari Minna, Niger State. The locations were chosen with respect to the direction of flow of a stream northwest to southeast where the site is located. Positions northwest of the site were those *upstream* while *downstream* referred to the positions southeast of the site. Sampling was done once every second week of the month between January and March 2007. Fresh samples were collected ~70 meters upstream, at site and ~100 meters downstream into polyethylene bags and labelled. The specie was identified in the Biology Laboratory to be *Lactuca sativa*.

The samples of *Lactuca sativa* were carefully washed under running tap water in the laboratory to free them from debris and then rinsed with distilled de-ionized water. They were sun-dried on white sheets of cardboard paper and later kept in a Gallenkamp moisture extraction oven at 105°C and dried to constant weight. Using a porcelain mortar and pestle, the samples were made into powder and packaged in an air-tight transparent polyethylene bags and stored in a dry locker in the laboratory pending further analysis.

Sample Preparation and Analysis

About 0.25g of the previously dried powdered sample, was measured into 125cm^3 Erlenmeyer flask and digested using a mixture of H_2SO_4 : $HClO_4$: HNO_3 in a ratio of 1: 2 : 12.5 (Allen *et al*, 1974;Puyuoan, *et al*, 1970). 25cm^3 of distilled de-ionised water was added to the mixture and boiled on the burner for about a minute and allowed to cool before filtering with a Whatman No. 42 filter paper into a 100cm^3 volumetric flask and made to the mark with distilled de-ionised water. This procedure was repeated for all samples. The digests were stored in a refrigerator pending analyses. A blank was prepared similarly.

Sodium and Potassium were determined using Flame Emission Spectrophotometer (FES), with the aid of a Gallenkamp flame analyzer while Copper, Chromium, Iron and Zinc were determined using atomic absorption spectrophotometer. Standard solutions were prepared from suitable salts of each ion where calibration curves were constructed after optimizing the instrumental conditions as in the user's manual. .

From the calibration curves, the concentrations of the metal ions in the samples were extrapolated. Blank samples were also aspirated in each case. Triplicate determinations were made in each case and the mean values were obtained.

RESULTS AND DISCUSSION

Results

Table 1: concentration of metals in *Lactuca sativa* (mean values mg/kg)

	Cu	Cr	Fe	Zn	Na	K
U	0.721	.200	.296	.203	18.503	67.501
A	.887	.220	.346	.486	5.506	73.001
D	2.401	.170	.945	.805	2.009	08.002

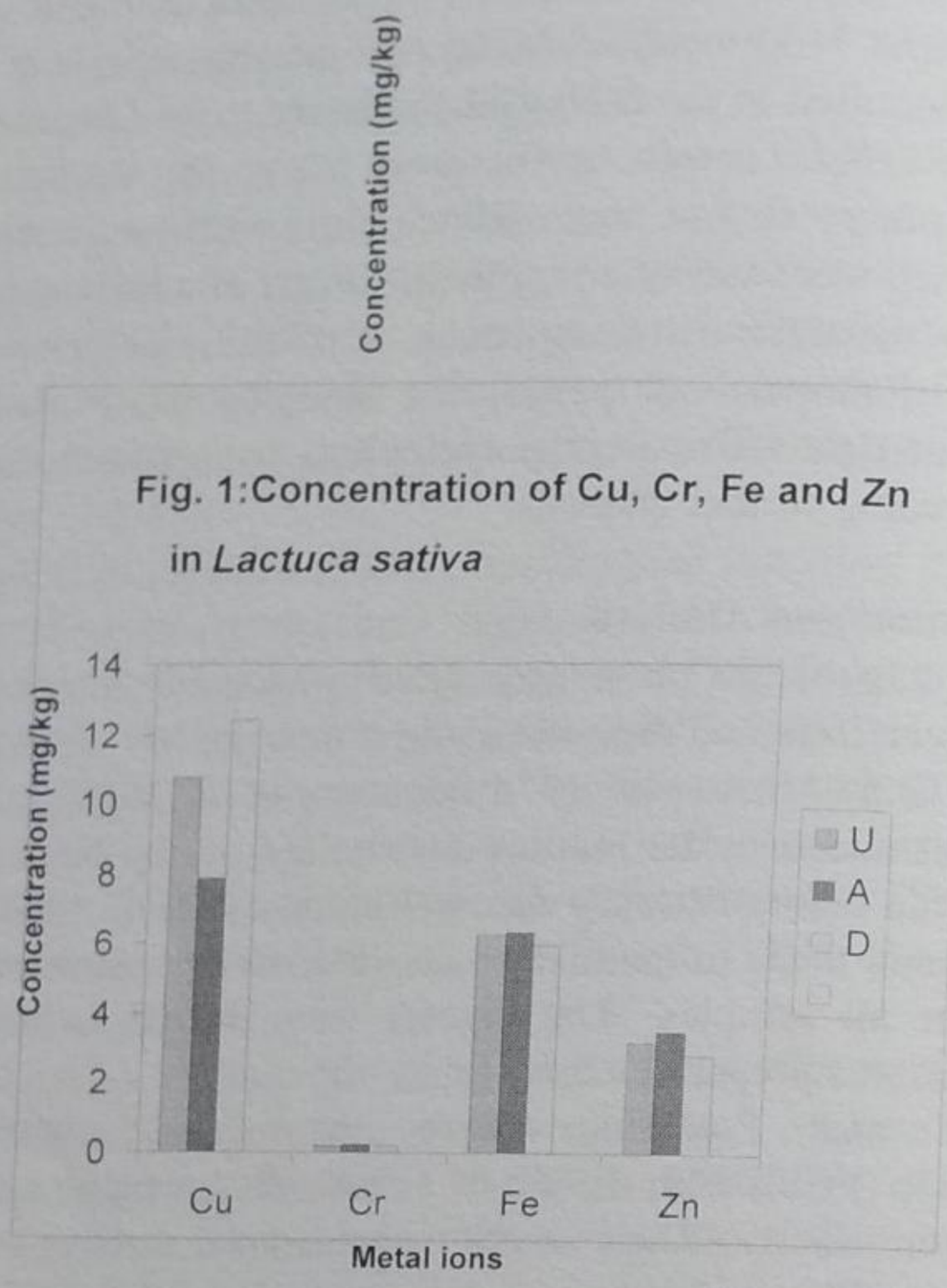

Fig. 1:Concentration of Cu, Cr, Fe and Zn in *Lactuca sativa*

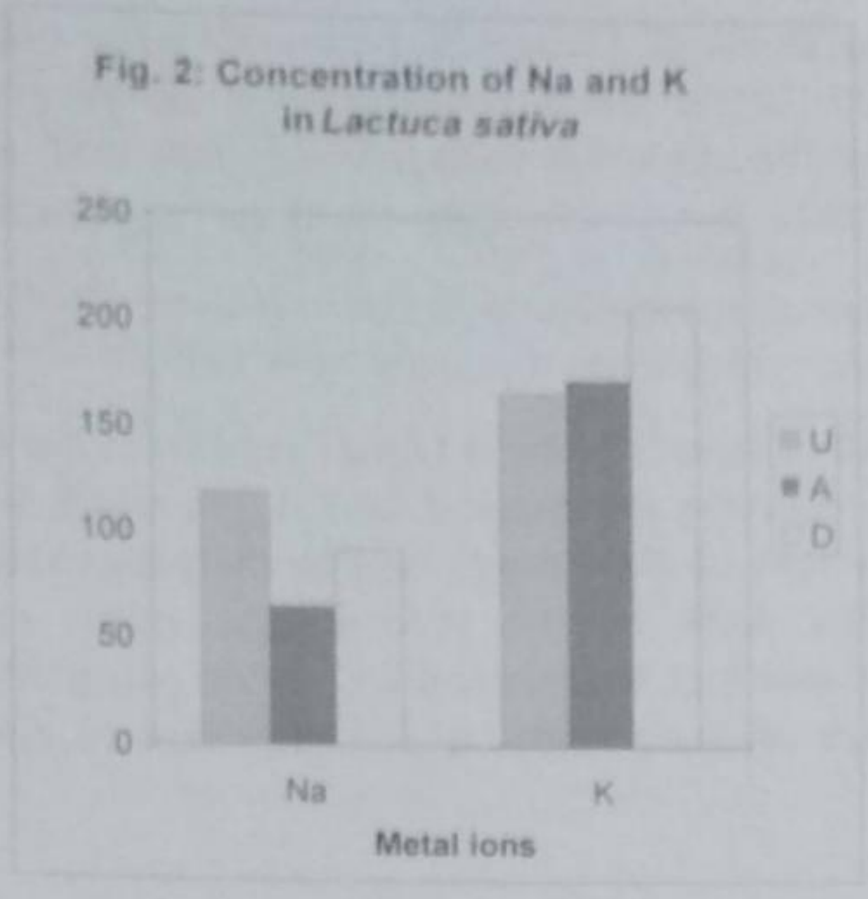

Fig. 2: Concentration of Na and K in *Lactuca sativa*

Discussion

The concentrations of the metal ions in *Lactuca sativa* are depicted in table 1.0 and Figures 1 and 2. From the table, the concentrations of Cr(0.22), Fe, (6.34), and Zn, (3.48) mg/kg are higher at the site of activity. This indicates that the activity at the site have a profound effect on the concentration of these metal ions in L. *sativa*. The value of Fe is lower than 0.5 – 1.4mg/100g found in species of lettuce recorded by USAD Nutritional data(USAD, 1998). Oniawa *et al(2001)* observed the concentration of zinc in lettuce to be 2.30mg/kg. The highest concentration of 0.22mg/kg observed for Cr at site of activity is slightly higher than the value of 0.10mg/kg quoted by Johnson(1997). It is also observed that the level of Cr is least compared to other metal ions determined. This may be due to the fact that Cr is very mobile in the soil thereby making it unavailable for absorption by the plant. Onianwa *et al*,(2001) have noted that while mobility of an element in the soil affects its concentration in plants, activities as well as the composition of a particular soil play important roles. These differences in the observed values are therefore not surprising.

The concentration of Cu at site is lower than the concentrations upstream and downstream. These values are quite higher than those obtained for lettuce by Onianwa et all, 2001. Copper is essential in enzyme and is required for proper functioning of the heart, bone formation and nerves impulse transmission. Its availability in lettuce is therefore of great advantage as long as the tolerable limit is not exceeded.

Compared to other metal ions determined, the concentration of Cu is high. This indicates that Cu is not very mobile in the soil; therefore it is readily available for absorption.

The concentration of Na ion is low at the site of activity (65.50mg/kg) and highest upstream (118.50mg/kg). This low concentration may be due to presence of Fe, Cr and Zn ions which are higher at the site. This could prevent absorption of Na ions at the site.

Although N.P.K. fertilizers are used on the farms, the level of potassium ions is least upstream and higher down stream (208.0mg/kg). Probably the presence of Cr, Fe and Zn, which are higher at the site of activity, may have hindered the absorption of the potassium. This is worthy of study.

Generally, the levels of Na and K ions are higher than those of other metal ions determined. While the later are needed for some subtle purposes by the plant, the former are important for transport of water and minerals as well as cell metabolism among other functions. This could be responsible for the high levels observed.

Conclusion

From the result obtained, there is higher concentration of Cr, Fe, and Zn ions at the site of activity. Reverse is observed for Cu, Na and K ions, which may be due to the absorptive behaviour of these metal ions by the plant, activity at the site and the mobility of the metal ions in the soil among other reasons. Although the concentrations of the metal ions determined are within permissible levels, the effect of anthropogenic activities on such farms which may lead to contamination should be viewed seriously.

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