Biological and Environmental Sciences Journal for the Tropics 9(2), June, 2012 ISSN 0794 – 9057

BEST JOURNAL 9(2): 159 - 163
Date received: January 06, 2012
Date accepted: March 13, 2012
Printed in Nigeria

METAL IONS IN *CARICA PAPAYA* FRUITS FROM FARMS AROUND A MECHANIC SITE IN KETAREN-GWARI, MINNA, NIGER STATE. NIGERIA

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ABSTRACT

Environmental pollution is a global phenomenon which has raised a lot of concern. This informed the need to study the effect of mechanic activities on metal ions content of Carica papaya fruits from various farms around the mechanic site. The study can be used to determine the safety of consuming the fruits. The mechanic site is located at the bank of a tributary of River Suka, Ketaren-Gwari area Minna, Nigeria, which is used for irrigating the farms. Fresh Carica papaya fruits were collected from the farms. Dried samples were digested with a conc.$HClO_4$ -HNO_3- H_2SO_4 (2:12:1) mixture and analyzed for the presence of copper, iron, chromium, zinc, magnesium, manganese and lead using the Atomic Absorption Spectrophotometer, while sodium, calcium and potassium ions were determined with the aid of a flame photometer. The result of the analysis showed that the highest concentration of K, Zn and Pb; 50.00±0.75mg/kg, 5.812±0.087mg/kg and 0.606±0.009mg/kg respectively were recorded at the site of activity. Farms located upstream recorded the highest concentration of Ca (19.50±0.29 mg/kg), Na (12.20±0.18 mg/kg), Mn (0.495±0.007 mg/kg), Cr (0.915±0.014 mg/kg) and Fe (0.178±0.003 mg/kg). While Mg and Cu levels, (55.77±0.084 mg/kg) and 0.625±0.009 mg/kg respectively), were the highest downstream.

Keywords: Carica papaya, Metal ions, AAS, FES, Mechanic site, Keteren Gwari, River Suka.

INTRODUCTION

Introduction of minerals to soils or water bodies through industrial and domestic waste disposal and other commercial activities not only affects the composition and characteristics of soils and water such as pH, color, taste etc, but may also play a role in the absorption of such minerals by plants and animals which concentrate them in certain tissues, sometimes to toxic level (Merrill *et al.*, 2001; Ako and Salihu, 2004; Dauda *et al*, 2011).

Generally, elevated levels of all metal ions or their compounds have been found to be toxic (Merrill *et al.* 2001). Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver, and other vital organs. Long-term exposure may result in slowly progressing physical, muscular, and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy, and multiple sclerosis. Allergies are not uncommon and repeated long-term contact with some metals or their compounds may even cause cancer. (International Occupational Safety and Health Information Centre, 1999).

The symptoms indicative of acute toxicity are easily recognized because they are usually severe, rapid in onset, and associated with a known exposure or ingestion: cramping, nausea, and vomiting, pain, sweating, headaches, difficulty in breathing; impaired cognitive and language skills, mania, and convulsions. Symptoms of toxicity resulting from chronic exposure such as impaired cognitive, motor and language skills; learning difficulties; nervousness and emotional instability, insomnia, nausea, lethargy etc, are also easily recognized. However, they are much more difficult to associate with their cause due to similarity with the symptoms of other health conditions and often develop slowly over months or even years (International Occupational Safety and Health Information Centre, 1999).

Some metal ions such as Ca, Na, Mg and K are required in large quantities by the body tissues, while others including Zn, Mn, Co and Cu are required by the body tissues in trace amounts due to their involvement in certain physiological processes. (Merrill *et al.*, 2001; Onianwa *et al.*, 2001; Ako and Salihu, 2004).

For example, magnesium plays a role in the activation enzymes involved in DNA and RNA synthesis, glycolysis, intracellular mineral transport, nerve impulse generation and cell membrane electrical potential. It is also important in the synthesis of protein, regulation of the levels of Ca, Co, Zn, K, Vitamin D and other nutrients in the body system. In plants tissue, it is the core content of chlorophyll (Ako and Salihu, 2004; Merrill *et al.*, 2001; Casas and Sordo, 2006). Deficiency of magnesium in humans results in muscular weakness, mental derangement and nausea (Merrill *et al.*, 2001).

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Potassium, alongside sodium and chlorine is involved in osmo-regulation of body fluids and the acid-base balance in animal and humans. This helps in cell metabolism. Weakness, drowsiness and irrational behavior characterize the deficiency of potassium. Intakes of potassium in doses larger than 18000 mg cause muscular weakness, low blood pressure, mental confusion and eventually heart attack (Jurak Corperation Worldwide, Inc. 2004)

Research has shown that sodium plays a role in the transmission of nerve impulse and absorption of sugars and amino acids from the digestive track as well as the acid-base balance and osmotic regulation of the body fluids, (WHO, 1993; Laybe, 1996). Deficiency of sodium in diets leads to a lowering of the osmotic pressure, which results in dehydration. Symptoms of deficiency include poor growth and a reduced utilization of digested protein and energy, (Merrill *et al*, 2001).

Chromium is required by the body in trace amount, for the enhancement of insulin for the metabolism of carbohydrate, fat and protein. Chromium (VI) causes kidney and liver damage, alteration of genetic material and even death (Merrill *et al.*, 2001; Ako and Salihu, 2004).

Zinc is involve in the stimulation of about 100 enzymes, quick wound healing, maintaining senses of taste and smell and growth and development during pregnancy. (Donaldson, 1982; Macrae *et al.*, 1997; Onianwa *et al.*, 2001). Zinc deficiency in humans result behavioral alteration and central nervous system changes, such as depression, psychosis, night blindness etc. Other signs are rough skin, loss of scalp, facial and body hairs, impaired wound healing and reduced immunity. (Pasad, 1990; Macrae *et al.*, 1997, Merrill *et al.*, 2001; Onianwa *et al.*, 2001).

Iron is a vital component of hemoglobin. It is responsible for oxygen transport and storage as well as oxidative metabolism and cellular growth. The deficiency of iron results in anaemia, mucosal and epithelial abnormalities, defect in immunity, skeletal muscle dysfunction, behavioral and neurological abnormalities. Other effects are listlessness and fatigue (Macrae *et al.*, 1997; Merrill *et al.*, 2001; Ako and Salihu, 2004).

Calcium plays a role in coagulation of blood and building of bones and teeth. The deficiency of calcium in young animals and humans results in rickets (Ako and Salihu, 2004).

Copper is essential for enzymes required for heart function, bone formation, energy metabolism, nerve transmission, elastin synthesis, pigmentation of skin, normal hair growth and red blood cell production (Johnson, 1997; Macrae *et al.*, 1997; Merrill *et al.*, 2001; Onianwa *et a.l*, 2001). Signs of deficiency of Cu in humans such as brain, heart, bone and blood disorders are explained by decreases in copper metallo-enzymes (Macrae *et al.*, 1997; Onianwa et *al.*, 2001)

Lead poisoning in children can affect almost every part of their system. It can result in convulsion, encephalopathy, osteoporosis, reduced IQ, learning disabilities, attention deficit, muscle and joint pain, irritability and lack of concentration (Macrae, *et al.*, 1997; Merrill *et al.*, 2001; Casas and Sordo, 2006).

In view of the danger posed by waste disposal and the effect of metal ions on living tissues, a study was conducted on the concentration of some metal ions in *Carica papaya*. Pawpaw (*Carica papaya*) commonly called *Gwanda* (Hausa) and *Ibepe* (Yoruba) is native to America. It is widely cultivated throughout tropical Africa and other regions (Mcgrath and Karahadian, 1994).

The uses of pawpaw may be classified into medicinal, nutritional and industrial. For example, papain, the proteolytic enzyme, in pawpaw is used as a meat-tenderizer and for the treatment of stings, rashes and burns. Green papaya has been used in India, Pakistan and Sri Lanka as folk remedy for contraception and abortion. The seeds are sometimes ground and used as substitute to black pepper. The fresh leaves are used in combination with other herbs for the treatment and management of malaria and typhoid fever locally. In cosmetics, the fruits are used in some dentifrices, shampoos and face-lifting preparations (Mahabir and Gulliford, 1997).

The fruits and seeds extracts have pronounced bacterial activity against *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli* and *Pseudomonas aureginosa*. The juice is important for curing warts, cancer and tumor. The unripe pulp of the plant is reported to possess hypoglycemic property (Jones and Layne, 1997 Olagunju *et al.*, (1995)). The ripe fruit pulp can be incorporated into a variety of food formulations and has the potential to function as a carbohydrate based fat replacement in baked products (Templeton *et al.*, 2003).

Pawpaw fruits, seeds, latex and leaves contain carpaine, an anthelmintic alkaloid used in removing parasitic worms from the body (Anonymous, 2010)

The leaves, twigs, and bark of the tree also contain natural insecticides known as acetogeinin which can be used to make organic pesticides. The presence of saponins and cardenolides contributes to its medicinal value (Jones and Layne, 1997, Duffrin and Pomper, 2006).

Reports have shown that pawpaw has saturated (32%), mono-unsaturated (40%) and poly unsaturated (28%) fatty acids. Some research has shown that papaya contains high levels of potassium, calcium and iron. In addition, it has essential vitamins thus making it an excellent food source (Templeton *et al.*, 2003).

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MATERIALS AND METHODS

Sampling and Sample Treatment

Fresh samples of ripe *Carica papaya* fruits were collected into polyethylene bags from three different farms located upstream, at site, and downstream of the mechanic site in Keteren-Gwari Minna, Nigeria. They were identified in the Biological Science Department of the Federal University of Technology, Minna. Locations for sampling were chosen with respect to the direction of flow the tributary of River Suka (northwest to southeast), the bank of which the mechanic site is located which serves as a source of water for irrigating the farms. Northwest of the site were farms "upstream", "downstream" referred to farms southeast of the site while farms close to the mechanic shades were those "at site". Sampling was done 70 metres upstream, at site and 100 metres downstream. Sampling was done on six locations on each farm.

The fruits were washed in the laboratory under running tap water and rinsed with distilled water. They were sliced with an aluminium knife and the seeds were discarded. The slices were dried in a Gallenkamp moisture extraction oven regulated at 85^{0}C, on white sheets of cardboard paper. The oven-dried slices were micronized with the aid of the porcelain mortar and pestle and then packed in air tight transparent polyethylene bags and stored in a large brown screw cap sample bottle for further analysis (Ako and Salihu, 2004).

Digestion and determination of the metal ions

Dried 0.25g of the micronized *C. papaya* fruit sample was weighed into a 250 cm^3 capacity beaker and digested at 65°C in a conc.$HClO_4$ / HNO_3 / H_2SO_4 (2:12:1) mixture on a hot plate. The beaker was removed and allowed to cool for 20 minutes. 25 cm^3 of distilled water was added and the mixture was placed on a hot plate at 65°C for 2 minutes. The mixture was allowed to cool before filtering with a Whatman No 42 filter paper into a 50 cm^3 volumetric flask and made up to the mark with distilled water.

Levels of copper, iron, chromium, zinc, magnesium, manganese and lead ions were determined with the aid of the Atomic Absorption Spectrophotometer (Model 990 - P.G. Instruments Ltd., U.K.) while sodium, calcium and potassium ions levels were determined using the JENWAY PFP 7 Flame photometer.(Ako and Salihu, 2004) The data was subjected to One-way ANOVA statistical analysis using Minitab 14 at 95% confidence level and Turkey's [illegible] 2009; Doi, 2010).

highest concentration of K, Zn and Pb; 50.00±0.75, 5.812±0.087 and 0.606±0.009 mg/kg respectively were recorded from farms close to the mechanic site (A), while Mn had the lowest concentration of 0.357±0.006 mg/kg from the same farms.

In the farms Upstream (U), the concentration of Ca, 19.50±0.29 mg/kg, Na, 12.20±0.18 mg/kg, Mn 0.495±0.007 mg/kg, Cr, 0.915±0.014 mg/kg and Fe, 0.178±0.003 mg/kg were recorded as the ions with the highest concentration. On the other hand, ions with the least concentration at the same sampling position were Pb, Zn and Cu having 0.143±0.002, 4.593±0.069 and 0.375±0.006 mg/kg respectively.

The trend of the concentration of metal ions determined from the farms downstream (D), is such that Ca, Na, K, Cr and Fe showed least levels, while the ions with the highest amount from the same farms are Mg and Cu.

However, statistical analysis indicated that there is significant difference ($p<0.05$) between the concentration of ions in all farms except at U and A, where Ca and K showed no significant difference. Also, at U and D, the concentration of Mg showed no significant difference.

Low level of some ions observed at D can be attributed to the mobility of the ions into the surrounding soil as they go downstream, which make them unavailable for absorption by the plant. At farms close to the mechanic site the observed low level, can be attributed to a kind of "leaching" due to the presence of certain metal ions introduced into the environment through mechanic activities, while the same observation upstream may be due to unavailability of such metal ions for absorption as a result of low concentration of the ions in the soil.

On the other hand, the observed amounts of metal ions upstream is likely due to the physiological importance of such metal ions to the plant since there is little or no influence of mechanic activities upstream. The same reason of physiological importance can be used to explain high levels of some elements on farms close to the mechanic shades, but in addition, deposition of metal alloys and car batteries to the surrounding is a contributory factor especially for Zn and Pb. For Downstream, reasons such as low mobility of the ions in the soil can make them available for absorption by the plant (Dauda *et al.*, 2008).

Except on farms close to the mechanic shades, magnesium (Mg) recorded the highest concentration, of all the metal ions determined. However, this level is quite low compared to the recorded average of 10mg/100g (Anonymous, 2010). The observed [illegible] could be due to the composition

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The concentrations of sodium and potassium range from 7.50±0.11 to 12.20±0.18 mg/kg and 37.47±0.56 to 50.00±0.75 mg/kg respectively. These ranges are quite low compared to 65.50 to 118.50 mg/kg and 167.50 to 208.00 mg/kg recorded in *Lactuca sativa* from the same farms; other ions which showed high levels in L. *sativa* compared to C. *papaya* are Cu and Fe. Also recorded levels 4.593±0.069 to 5.812±0.087 mg/kg and 0.620±0.09 to 0.915±0.014 mg/kg of Zn and Cr respectively in C. *papaya* are higher than those in L. *sativa,* from the same farms, which are 2.80 to 3.48 mg/kg and 0.170 to 0.220 mg/kg (Salihu, *et al.,* 2008).

Table 1: Mean values of metals (mg/kg) in ripe pawpaw (*Carica papaya*) fruit obtained from Keteren-Gwari, Minna. Nigeria.

Sites	Metal Ions Concentration (mg/kg)									
	Ca	Na	K	Mg	Mn	Cr	Fe	Cu	Zn	Pb
U	*19.50 ±0.29	12.20 ±0.18	*49.95±0.75	*55.37±0.83	0.495 ±0.007	0.915 ±0.014	0.178 ±0.003	0.375 ±0.006	4.593 ±0.069	0.14[illegible] ±0.0[illegible]
A	*19.10±0.29	9.70 ±0.15	*50.00±0.75	48.72 ±0.73	0.357 ±0.006	0.665 ±0.010	0.143 ±0.002	0.487 ±0.007	5.812 ±0.087	0.60[illegible] ±0.0[illegible]
D	17.17 ±0.26	7.50 ±0.11	37.47 ±0.56	*55.77±0.84	0.412 ±0.006	0.620 ±0.009	0.134 ±0.002	0.625 ±0.009	5.296 ±0.079	0.2[illegible] ±0.0[illegible]

Key: * No significant difference at 95% confidence level
U = Upstream; A = Atsite; D = Downstream

CONCLUSION

From the result of the analysis, it can be concluded that mechanic activities affect the level of K, Zn and Pb in *C. papaya* fruit. Despite the presence of such mechanic activities, the level of the other elements determined in *C. papaya* fruit surprisingly, including Fe were not unusually high on farms close to the mechanic shades when compared to either upstream or downstream.

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