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Evaluation of Some Heavy Metals in Aerial Parts of Wild Rice Plant in Kaduna State, Nigeria.

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ABSTRACT

This study was designed to evaluate the level of Cd, Co, Fe and Zn in the aerial/upper parts of wild rice plant in three locations (Gure, Kagoro, and Kaduna) of Kaduna state. HNO_3-H_2O_2 was used to digest the plant samples and analyzed using AA320N model Atomic absorption spectrophotometer. The results obtained revealed that, the concentration(mg kg^{-1} dry weight basis) of the heavy metals analyzed in the upper parts of wild rice plant were 0.242, 0.028, 2.947 and 19.145 for Cd, Co Fe, and Zn respectively. Also in the grain, the concentration of metals was found to be 0.223, 0.023, 2.003 and 19.050 for Cd, Co, Fe, and Zn respectively. The ANOVA result showed that the concentration of Cd, Co and Fe were not significantly different within the plant parts while that of Zn was different at 95% confidence limit. The concentration of Zn, Fe and Co in the wild rice plant and grain were within the limits obtained in most world crops and vegetables and WHO/FAO reference standards. Although, the concentration of Cd in grain was a little higher than the recommended limit of WHO/FAO reference standard. The dietary implication of the elements, suggests that the consumption of the wild rice plant/grain analyzed may not cause much health hazard to grazing animals and human beings.

Keywords: Aerial part, Grain, Heavy metals, Wild rice

INTRODUCTION

Environmental contamination and exposure of heavy metals to plants and animals is a serious problem throughout the world. However, some elements like zinc, copper, manganese and iron are found as component of either cells, vitamin, enzymes or certain molecules in animals and plants. In small and required quantity, they are nutritionally important and they are referred as essential elements. Although at higher concentration, they are detrimental to plants and animals health including human beings (Thakur, 2006). Some heavy metals such as cadmium, copper, lead, chromium and mercury are important environmental pollutants particularly in areas with high anthropogenic pressure. Their presence in the atmosphere, soil and water even in traces, can cause serious problems at all organism (Ejaz ul *et al*., 2007). When these metals are distributed in a higher concentration in plants, it will directly or indirectly be transferred to animals and human being in the ecosystem.

In other part of the world, wild rice is being cultivated in large quantity for consumption locally or for commercial purposes. Today the grain is being considered as a delicacy in north central United State and Canada (Benette *et al*., 2000). In Nigeria much studies on wild rice plant has not been done. However, this plant is considered as a cereal not cultivated plant found as weed where rice (*Oryza sativa*) are cultivated or grown along the river bank (Lowe, 1989). In Kaduna state of Northern Nigeria, the researcher observed that, the aerial/upper parts of these plants are eaten by the lower animals. The seeds are eaten mostly by the birds while the stems and the leaves are eaten by the herbivorous animals.

In the Northern part of Nigeria, especially Kaduna state, studies by Umar and Wunzani, (2013), Otitaju *et al.* , (2014), have shown that the concentration of some heavy metals vary within the locations and plant parts of wild rice and some local rice cultivated in these areas. Since metal's properties and the source of which its come from are some of the influential factors in its mobility

from the soil and distribution in plant parts (Kakulu, 2002), this means that, there is, no certainty on the bioaccumulation of any other heavy metals in wild rice plant even in the same location or species.

Therefore, the main objective of this study was to determine the level of heavy metals (cadmium, cobalt, iron and zinc) in the aerial/upper parts (stem, leaves and grain) of wild rice (*Oryza longitaminata*) from the three geographical zones (North, Central and South) of Kaduna state.

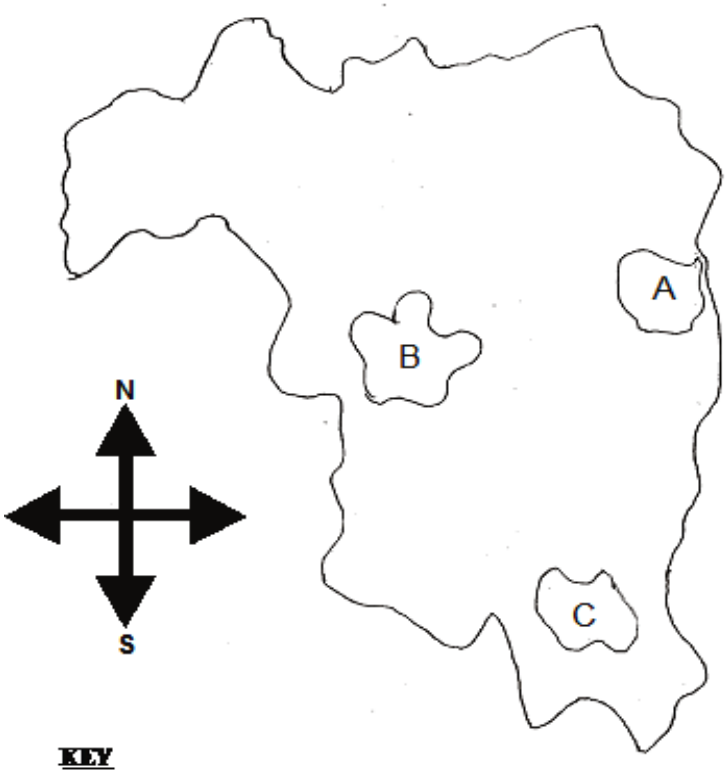
MATERIALS AND METHOD

Study Area

The study was conducted in Kaduna state which is located in northwest of Nigeria. Karimbo/ Gure sampling area are in Lere local Government area of Northern geographical zone in Kaduna state and it is a remote area. The wild rice in this area is grown as weed with paddy cultivated rice at about 100m from the rocky mountains. Kagoro sampling area is a farm land situated at about 2km from Kagoro Secondary School and 4km away from Kagoro hill from southern geographical zone. The wild rice in this area is also grown as a weed in a paddy rice field. Unguwan Barde is in Kaduna metropolis, situated in Kaduna south industrial area and about 4km away from Nigerian National Petroleum Corporation (NNPC). It is in central geographical zone. The wild rice in this area is grown in paddy uncultivated land.

Sampling of material

The samples of wild rice plants were selected and harvested, from the three locations (Gure, Kagoro and Kaduna) as indicated in Fig. 1, then pooled together to form a composite sample for a given location. The samples were air dried at room temperature for seven days and stored in labeled polyethene bags, then brought to the laboratory of University of Abuja for further preparation and treatment.



A. Gure/Karimbo (Lere Local Governement) Northern Zone

B. U/Barde/Kaduna Metropolis (Chikun Local Government) Central Zone

C. Kagoro (Kaura Local Government) Southern Zone

Fig I. The Map of Kaduna State Showing the Sampling Areas

Method

In the laboratory, the samples were thoroughly washed with distilled water to remove any soil particles and dust and after that, they were oven-dried at constant weight at 70°C for 2hrs. The seeds were de-hulled with ceramic pestle and mortar, then, each samples of the stem, leaves and grains were ground to fine powder in an agate mortar and pestle. The samples were pre – digested with 1:1 mixture of HNO_3-H_2O_2 for 24hrs, then, finally digested by heating at 100°C for about 2hrs (Onianwa and Ajayi 1987). The concentrations of heavy metals (Cd, Co, Fe and Zn) were determined using AA320N Model of Atomic Absorption Spectrophotometer system. The data obtained were statistically analyzed for the mean, standard deviation and variance, using a fixed model analysis of variance (ANOVA)

All samples were analyzed in the maximum analytical replication measurements in triplicate. Glass wares were properly cleaned, the reagents used were of analytical grate and double distilled water was used throughout the studies. The standard solutions were prepared according to the specified guides (Pye Unicam. Atomic Absorption Data Book 1979). Assurance programs were conducted by carrying out recovery studies and preparation of blank solution.

RESULTS AND DISCUSSION

The concentration of Cd in the upper parts of wild rice plant and grain as recorded in Table 1, are 0.242 and 0.223 $mgkg^{-1}$ respectively. These values obtained in wild rice plant and grain are lower than the range values 0.28-1.50 , 0.5-2.1 and 0.92-4.14 $mgkg^{-1}$ recorded in Tanzania, India and Saudi Arabia respectively (Charles *et al*., 2011; Rajesh *et al*., 2009; Mohamed *et al*., 2012). The values in wild rice plant and grain are also lower than the recommended value of 0.85 $mgkg^{-1}$ of the dietary reference intake tolerable intake level (WHO. 1993). However, these values obtained in wild rice plant are higher than the value (0.065 $mgkg^{-1}$) obtained from Victoria inland Basin in Tanzania (Machiva, 2010). Also observed by Otitaju *et al*., (2014) was that, the concentration of Cd in locally produced rice in Northern Nigeria was below detectable level. Cadmium is found in rock and other sources such as fertilizer, industrial and human activities. This metal when exposed either in compound or in elemental form, can travel to a far distance and when it falls on the soil it will be taken up by the plant through the roots or absorbed directly by the plant. .

Table 1: Concentration ($mgkg^{-1}$) and standard deviation of some heavy metals in the upper parts of wild rice plant from Gure, Kagoro and Kaduna in Kaduna state

Metals	Locations	Plant parts			Mean
		Grain	Leave	Stem	
Cd	Gure	0.35	0.35	0.75	0.485 ± 0.317
	Kagoro	0.35	ND	0.35	0.233 ± 0.135
	Kaduna	ND	ND	ND	ND
	Mean	0.223 ± 0.135	0.117 ± 0.167	0.367 ± 0.307	0.239 ± 0.074
Co	Gure	ND	0.03	0.02	0.017 ± 0.000
	Kagoro	0.05	0.02	0.02	0.030 ± 0.000
	Kaduna	0.02	0.05	0.03	0.033 ± 0.000
	Mean	0.023 ± 0.000	0.033 ± 0.000	0.023 ± 0.000	0.026 ± 0.000
Fe	Gure	3.00	3.50	2.50	3.000 ± 0.707
	Kagoro	1.01	4.53	3.50	3.013 ± 1.478
	Kaduna	2.00	1.15	2.50	1.883 ± 0.421
	Mean	2.003 ± 0.812	3.050 ± 1.415	2.667±0.500	2.632 ± 0.436
Zn	Gure	12.15	12.00	30.00	17.383 ± 8.485
	Kagoro	21.00	11.00	19.25	17.083 ± 4.360
	Kaduna	24.00	17.00	25.62	22.207±3.745
	Mean	19.050± 3.352	13.333±2.625	24.957±4.415	18.891 ± 4.756

ND=Not detected

Table 2 shows that, the mean concentration of cobalt as recorded in wild rice plant and grain are 0.028 and 0.023 $mgkg^{-1}$respectively. The value recorded in grain is lower than the value 0.04 $mgkg^{-1}$ of WHO/FAO recommended as a reference standard in rice (FAO/WHO. 1998). It is not surprising to record this low amount, because cobalt is not required by plants. However, it is an essential nutrient molecule (part of vitamin B_{12}) in humans.

From the Table, iron concentrations in wild rice plant and grain were 2.947 $mgkg^{-1}$ in the upper parts of the plant and 2.003$mgkg^{-1}$ in grain. These values obtained in wild rice plant is 200times lower than the value (543.2 $mgkg^{-1}$)obtained in leaves vegetables in some cities of kingdom of South Arabia (Mohamed *et al*., 2012). Also, this amount is lower than the value (2.886$mgkg^{-1}$) recorded in rice from Malaysia (Otitaju *et al*., 2014). Iron is among the trace elements found in plants and its roles in biochemical activities especially in oxygen atoms transfer for respiration could be suggested as one of the reasons of these amounts in the wild rice plant parts.

The concentration of zinc in upper parts of wild rice plant and grain as shown in Table 2, are 19.145 and 19.050 $mgkg^{-1}$respectively. These values are lower than the ranged values 18.61-122.88, 29.6-63.3 and 8.29-71.3 $mgkg^{-1}$ reported in Tanzania, India and Saudi Arabian respectively (Charles *et al*., 2011; Rajesh *et al*., 2009; Mohamed *et al*., 2012). The value obtained in grain of wild rice is higher than the value obtained in rice produced in Malaysia (Otitaju *et al*., 2014). However, these values obtained are within the recommended reference standard value (50.00 $mgkg^{-1}$) of WHO/FAO(2002).

Zn is present in biochemical system as a trace metal and it is indispensable for the growth and development of plants and animals. Zinc is very necessary in the synthesis of nucleic acid and the manufacture of their components also as a component of enzymes. (Thakur, 2006). This might have contributed to the amount in the plant and grain in this study.

Table 2: Mean of heavy metals concentration in the upper parts of wild rice from the three locations of Kaduna state.

Metals		Location			Mean
	Plant parts	Gure	Kagoro	Kaduna	
Cd	Leaves & Stem	0.350	0.175	ND	0.242
	Grain	0.350	0.350	ND	0.223
Co	Leaves & Stem	0.025	0.020	0.040	0.028
	Grain	ND	0.050	0.020	0.023
Fe	Leaves & Stem	3.000	4.015	1.825	2.947
	Grain	3.000	1.010	2.000	2.003
Zn	Leaves & Stem	21.000	15.125	21,310	19.145
	Grain	12.150	21,000	24.000	19.050

ND = Not detected

The analysis of heavy metals concentration for possible inter area variation by ANOVA Table 3, showed that Cadmium, Cobalt and iron were not significantly different but Zinc was significantly different at 95% confidence limit within the plant parts in the three locations. The geological characteristics and other factors might have contributed to this variation.

The dietary and health implication of these metals under consideration in this study suggest that, the consumption of this wild rice plant might not cause much health hazard to grazing animals and human being. However, the concentration of cadmium is a little higher than the recommended WHO/FAO reference standard and may be a cause of concern in the future.

Table 3: Analysis of variance(ANOVA) of Heavy metals concentration in Wild rice plant parts at 95% confident limit.

Metals	Source	Sum of Square	Df	Mean square	F value
Cd	Between Within Total	0.057 1.542 1.599	2 6 8	0.033 0.257	0.144
Co	Between Within Total	0.003 0.016 0.019	2 6 8	0.002 0.003	0.667
Fe	Between Within Total	32.615 93.146 125.761	2 6 8	16.307 15.524	1.050
Zn	Between Within Total	216.798 31.074 247.872	2 6 8	108.399 5.179	20.930

CONCLUSION

The concentration of the nutritional elements like Zinc, iron and cobalt in plant parts in the studied areas were within the normal range for animals and human consumption. However, the concentration of Cadmium in grain at Gure location was a little higher than the WHO/FAO reference standard and may be a cause of cancer in the future due to accumulation.

The ANOVA analysis shows that the concentration of most elements were not significantly different within the three locations, but that of Zinc was significantly different within their locations at 95% confidence limit

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