Heavy Metals In Wild Rice From Gure, Kagoro And Kaduna, Kaduna State, Nigeria

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ABSTRACT: The whole plants of wild rice were collected from Gure, Kagoro, and Kaduna of Kaduna state in order to determine the concentration of Cu, Mn, Pb and Ni in wild rice plants. HNO_3-H_2O_2 was used for digestion. Flame atomic absorption spectrometry was used for the determination of heavy metals in plants digest. Ni and Co were uniformly distributed in small quantity in all the plant parts. Mn and Cu, were differently distributed in good amount, with the roots recording the highest amount of Cu. The leaves recorded Mn and Pb as the highest. Gure location recorded the highest amount of Ni, Mn, and Pb, while, Cu was recorded as the highest in Kaduna location. ANOVA at 95%confidence level show that there is no significant different in concentration of Cu, Ni and Pb in all the locations and plant parts. But, the concentrations of Mn was significantly different in plant parts and locations at 95% confidence level. The concentration of the metals in grain were compared with other studies as well as WHO/FAO reference standard and most of the metals concentration in grain were within the limit for food quality standard. However, Cu concentration in grain was a little higher than the WHO/FAO reference limit and may pose danger in humans and animals who may consume the grain in the near future.

Key words: Heavymetals and wirld rice

INTRODUCTION

Wild rice in Nigeria is considered as a none cultivated cereal plant[1] of which the seeds are eaten by birds. The leaves and stems are also eaten by other lower animals[2] Wild rice plants in other part of the world like USA is being cultivated in large scale and research [3] has shown that the nutritional value of wild rice is ranked as the highest among other cereal plants cultivated in the same areas. Also from the studies[3], it was indicated that nutritional elements like zinc, copper, manganese and iron are found within the nutritional ranged but insome part of Malaysia and china[4,5] the concentration of iron and manganese was high. Like wise, in Macedonia and Dabaosham [6] mine in China the concentration of lead and cadmium was higher than the World Health Organizatio/Food Agriculture organization(WHO/FAO) reference standard [7,8]. This variation of heavy metals in plant parts depend on many factors, even within the same species of plants , there is great genotypic difference in the effect that heavy metals have on plants as well as their concentration[6] It has been observed[3] in Northern Wisconsin, USA that the toxic metals such as, lead, cadmium, arsenic and mercury were detected at the highest amount in the roots while the nutritional elements such as copper, zinc and magnesium were within the normal range in the seeds.

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In Nigeria and Kaduna state in particular, there is limited studies on wild rice and the ecology of wild rice is not well studied. However, research [1] has shown that the commonest wild rice species found in Kaduna state are Oryza logitaminata and Oryza baitti. These cereal plants growth alone the river banks and on swampy paddy land as uncultivated grasses or with cultivated rice(Oryza sativa) as weeds. Although, the plant is not cultivated in Nigeria, but the aerial parts especially the seeds are eaten by other animals in the ecosystem, and when polluted with heavy metals, this can be transferred to human being. Also as cereal plant, its bio-accumulation and distribution of heavy metals can be of economic important or pollution control and these, necessitated this study. There for, the aim of this study was to determine the level of heavy metals(coper (CU), manganese(Mn), lead(Pb) and nickel (Ni) in the roots, 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 north west of Nigeria. Karimbo in Gure sample area is in lere local Government area of Northern geographical zone in Kaduna state. The wild rice there is grown as a weed with paddy cultivated rice at about 100m from rocky mountains. Kagoro sample area is a farm land situated at about 4km away from kagoro hill from southern geographical zone while Unguwan Barde is in Kaduna metropolis, situated in Kaduna south industrial area and is about 3km away from Nigerian National peotroleum corperation in central geographical zone. The wild rice there is grown alone the stream bank as uncultivated weed. (**figure** 1)

Samples

The samples of wild rice plants were selected and harvested on November 2009, from the three locations (Gure, Kagoro and Kaduna), then pooled together to form a composite sample for a given location. The roots of the plants harvested were washed with clean water to remove the soil, and the plants were separated into four parts (seeds, leaves, stems and roots). The samples were dried at room temperature for seven days and stored in a labeled polyethene bags, then brought to the laboratory for preparation and analysis.

Method
In the laboratory, the samples were thoroughly washed with de- ionized water and oven-dried at constant weight at 70^0c for 2hrs. The seeds were de-hulled with ceramic pestle and mortar, then, each samples of the roots, stem, leaves and grain 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 [9] for 24hrs, then, finally digested by heating at 100^0c for about 2hrs. Tshe mean concentration of the metals within the plant parts and locations were used to statistically analyze the variance using the fixed model analyses of variance. The data of four elements in the four plant parts and three locations were correlated to determine the interaction among the elements. Quality assurance programs were conducted by carrying out recovery studies and preparation of blank solutions.

RESULTS AND DISCUSSION

Distribution of heavy metals within the wild rice plants parts

Table 1 mean concentration of heavy metals according to plant parts($mgkg^{-1}$) and ANOVA(95% confidence limit)

	Cu	Mn	Ni	Pb
Grain	2.617	8.333	0.033	0.183
Leaves	1.883	14.900	0.067	0.750
Stems	1.733	5.913	0.090	0.717
Roots	4.533	10.900	0.040s	0.467
ANOVA F- value	4.225	9.721	0.035	0.496

In Table 1, its show that, Copper was detected abundantly in roots. Also in paddy rice in Malaysia it was observed [5] that, copper was detected in a significant amounts in the roots of paddy rice. These observations are in agreement with the pot experiment conducted [10] on the uptake of copper by Cultivar Xiayangbai and Celery (Apium graveolens plants) which indicated that the plants stored 80% of copper metals in roots while the remaining 20% was distributed to the stem and other parts of the plants. However, studies has shown that [11] the most important path way of which the plant uptake of these heavy metals is via the plant roots. The distribution of heavy metals in plants is associated with many factors which include, the plant species and ionic potential [5]. That, elements with high ionic potential precipitate rather than migrating to the stem or leaves. For example, barium (Be) with ionic potential of 5.9 has the greater tendency of precipitating while cadmium with smaller ionic potential of 2.0 easily migrate. This observation may account for one of the reasons why most of the element are abundantly found in the roots. Also in Table 1 the concentration of manganese was recorded in leaves and stem in good quantities. It has been observed [12] that manganese is an essential elements required for the formation of chlorophyll which is very important in photosynthesis. This account is probably the reason of its abundance in leaves and stem. Lead, although, not an essential element in plants and animals. Its highest concentration was recorded in leaves as indicated in Tables 1. In the past, studies conducted by Bennette in Northern Wisconsin[3], it shows that lead concentration was recorded in significant quantity in the leaves. Lead (Pb) compounds are volatiles and are found in the atmosphere either through natural processes or through human activities. The atmospheric particles from the natural sources account for various proportion of lead[13]. The anthropogenic processes like mining, human and industrial activities also released lead to the atmosphere. These volatile metal or its compounds can be transported to a far distance and could be deposited on the aerial parts of the plants. When deposited, it will be absorbed directly into the plant [13] Nickel was found higher in stem and leaves as indicates in table 1. Its vitality as a compound might have contributed to its higher amount in the air and probably it concentration in the leaves and stem. The distribution of Cu and Mn were different in plant parts while Pb and Ni were evenly distributed in small amount within the plant parts as indicated in ANOVA at 95% confidence level in table 1)

Distribution of heavy metals within the locations

Table 2. Mean concentration of heavy metals according to locations $mgkg^{-1}$and the ANOV(95% confidence limit)

	Cu	Mn	Ni	Pb
Gure	2.600	13.975	0.100	0.663
Kagoro	2.313	11.225	0.000	0.163
Kaduna	3.163	4.835	O.070	0.750
ANOVA F – Value	0.451	25.336	0.054	1.183

Gure location recorded the highest amount of manganese (Mn), and nickel(Ni) (Table 2). Although this location is a far remote farm land but research[13] has shown that heavy metals can be transported to a along distance through air or water and be distributed on land. Also Gure location as a farmland where agrochemical like fertilizer and pesticides which contain trace of heavy metals as impurities might have contributed to this high content of these heavy metals[11]. It is also right to suggest that the rocks that surround this farm land contributed to the amount of these heavy metals. Kaduna location recorded the highest amount of copper(Cu) and lead(Pb) as indicated in Table 2. This location is within the metropolis of Kaduna where so many industrial and human activities are common. This industries discharge heavy metals which are either used as catalyst or as ingredient in the manufacturing processes[14]. This industrial discharge and domestic utensils which are component of some of this heavy metals are thrown into our environment as solid waste contributes to this quantity of heavy metals in this location. The high contain of Pb in this location also suggested to be as a result of high traffic in Kaduna town and the burning of fuel through the generator and other heavy duties machine in the industries [15]. Kagoro location did not recorded any good amount of heavy metals as compared with other locations. There were variation in the distribution of Mn and Cu in all the locations. The concentration of Pb and Ni were evenly distributed within the locations as indicated in ANOVA result at 95% confidence levelin table 2)

Table 3. Correlation of metals Within the Plant parts

	Cu	Mn	Ni	Pb
Cu	1	0.1052	0.7579	-0.6903
Mn	0.1052	1	0.1009	0.4927
Ni	0.7579	0.1009	1	0.9069
Pb	-0.6903	0.4927	0.9069	1

Correlation of heavy metals concentration between metals in plant parts

In table 3, there was strong positive correlation between copper and nickel, like wise between lead and nickel. However, copper and lead correlated negatively. More elements related positively with other elements. This, shows that there is a good interaction between elements in plant parts. Many factors are responsible for mobility of metals within the plant parts which include: the metals potential, ionic radii and plant species. Studies was shown [5] that cadmium (Cd) has distributing potential on all the plants of the Paddy plant which was suggested to be its small ionic potential. Sharman and Sharman [11] also observed that there is a close relationship between the ionic radii of metals and their individual correlation coefficient as bio available specie

Table 4. Correlation of metals in plant parts within the location

	Cu	**Mn**	**Ni**	**Pb**
Cu	**1**	**-0.8046**	**0.9433**	**0.0269**
Mn	**-0.8046**	**1**	**0-9560**	**0.6153**
Ni	**0.9433**	**-0.9560**	**1**	**0.3571**
Pb	**-0.029**	**0.6153**	**-0.3571**	**1**

Correlation of heavy metals in plant parts within the locations

In table 4, the correlation between copper and nickel was positive, but there was strong negative correlation between copper and manganese like wise between nickel and manganese. Most elements related more negatively with other elements. The uptake of metals from the soil depend on many factors such as: soil factors (pH, bioavailability of organic matter, availability of metals), plant species, [16]. However, it is not surprising to observe negative correlation of metals concentration in plants with different locations, since each location may have different soil properties.

concentration of heavy metals in wild rice grain and its dietary and health implication

Copper(Cu) and manganese (Mn), are essential elements required in a small quantities for various activities and growth in plants and animals, however, at a higher concentration, they are toxic to the body. Other element like lead (Pb) is very toxic even at a lower concentration and therefore, not considered as essential elements [17]. Manganese concentration in wild rice grain in this study was 3.125mgkg$^{-1.}$ This was lower than the concentration of 1.529mgkg^{-1} in rice grain from Malaysia [5]. Although manganese is very necessary in plants for photosynthesis and in animal, trace amount of it is require for metabolic activities in the body. Copper concentration in wild rice grain from the studies area was 2.617mgkg^{-1} . This concentration was a little higher than the WHO/FAO recommended unit of 2.42mgkg^{-1}[8], but lower than the concentration (5.27mgkg^{-1}) recorded in wild rice grain at Northern Wisconsin of USA[3]. It has been observed[18] that the excess amount of copper especially in animal can cause mental illness. The concentration of nickel in wild rice grain from this study was 0.003mgkg^{-1}. The WHO/FAO recommended limit of 0.54mgkg^{-1}[8] and the value 0.19mgkg^{-1} observed[19] in Japan is higher than the detected value. Nickel is require in small quantity to maintain good metabolic activities in animals but lack of it has not been discovered to affect animals or plant. However, the Department of Health and Human Services(DHHS) has determined that nickel and nickel compounds may reasonably be anticipated to be carcinogens[18] Lead concentration of 0.182mgkg^{-1} was observed in wild rice from this study to be lower than the WHO/FAO limit of 0.430 [8] and 10times lower than the value 0.960mgkg^{-1}observed in wild rice grain from Northern Wisconsin in USA [3]. Lead as a toxic element does not require for nutritional value and its has adverse health implication. It has been observed [18] that excess amount of lead in our body can cause damage to the delicate organs like ,liver, kidney heart, male gonad even immune and neurological system. The excess amount of lead in our food crops could have damaging effect on the delicate organs such as kidney, heart, brain etc in human when ingested[18]. Although, there were variations on the amount of each heavy metal in the grain of wild rice in this study, most metals concentrations were within the limit of WHO/FAO nutritional standard and limit, however, copper s concentration was a little higher and might have health implication in future

CONCLUSION.

In this study, Pb and Ni were uniformly distributed in a small quantity in the plant parts. Cu and Mn although differently distributed in a higher concentration, the roots and the leaves recorded a significant amount of Mn. Gure location recorded higher amounts of Mn and Ni while Kaduna recorded high amounts of Pb and Cu. Most elements concentration were within the normal range of dietary intake in grain with the exception of Cu that was a little above that of WHO/FOA reference standard. The ANOVA and correlation studies showed that, there was correlation among geological characteristics and the elements in the plants. Therefore, the data obtained could be used as a base line studies for possible use of wild rice species as a tracer or environmental monitoring effect

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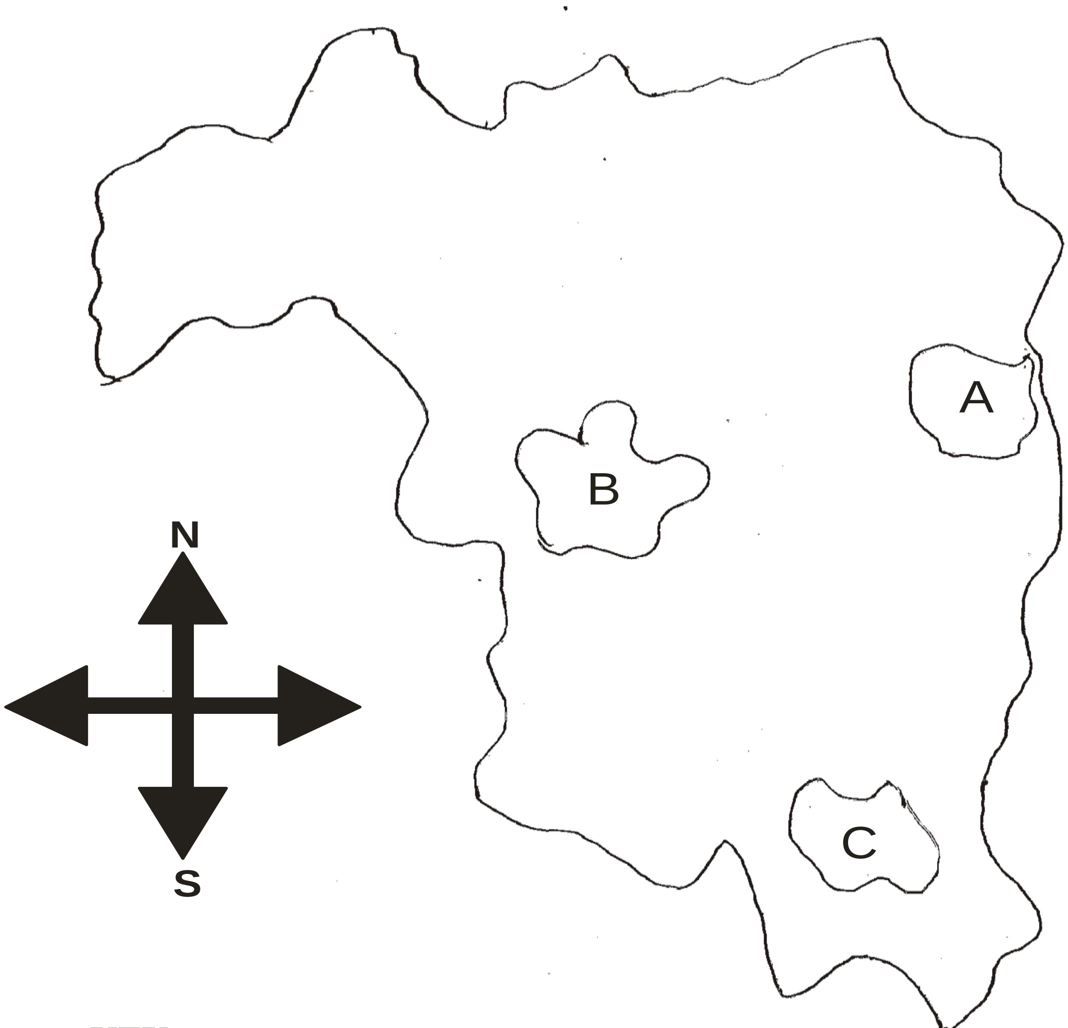
Fig I. **The map of Kaduna state and the study Areas for Sampling**



KEY

A. Gure / Karimbo (Lere Local Government) Northern Zone
B. U/Barde/ Kaduna Metropolis (Chikun Local Government) Central Zone
C. Kagoro (Kaura Local Government) Southern Zone

Fig 2. Map of Nigeria showing Kaduna state