

## Heavy Metals Evaluated In Some Well-Water Obtained From Almajiri Schools In Sokoto East, Nigeria

Yusuf Sarkingobir<sup>1</sup>, A.I. Umar<sup>2</sup>, Syed A. Waheed<sup>3</sup>, Yusuf Yahaya Miya<sup>4</sup>, Rose Livinus<sup>4</sup>,  
Mustapha Sahabi<sup>5</sup>, Nura Maiakwai Salah<sup>6</sup>

<sup>1</sup>Department of Environmental Education, Shehu Shagari University of Education, Sokoto,  
Nigeria

<sup>2</sup>Department of Biochemistry, Sokoto State University, Sokoto, Nigeria

<sup>3</sup>University of Okara, Pakistan

<sup>4</sup>Federal School of Medical Laboratory Technology Jos, Plateau State, Nigeria

<sup>5</sup>Department of Biology Shehu Shagari University of Education Sokoto, Nigeria

<sup>6</sup> Department of General Studies, College of Agriculture and Animal Science Wurno, Sokoto  
state, Nigeria

\* Corresponding Author. E-mail: [superoxidedismiutase594@gmail.com](mailto:superoxidedismiutase594@gmail.com)

### ABSTRACTS

**Introduction:** Heavy metals in water are due to pollution and are nowadays threat. The standard methods were utilized (including the atomic absorption spectroscopy) to determine the levels of Fe, Ni, Mn, Cr, Pb, and Cd in water collected from Almajiri schools in sokoto East, Nigeria. The levels of iron, nickel, and manganese in well water in Almajiri schools in Sokoto East, Nigeria. The ranges of the metals determined for iron, nickel, and manganese are respectively as follows:  $3.110 \pm 0.001$ -  $3.100 \pm 0.001$  mg/dm<sup>3</sup>,  $0.051 \pm 0.001$ - $0.662 \pm 0.001$  mg/dm<sup>3</sup>, and  $0.001 \pm 0.0001$ - $0.021 \pm 0.001$  mg/dm<sup>3</sup> respectively. The highest element found was the iron, then nickel, and lastly manganese. The lead, chromium, and cadmium ranges are as follows:  $0.005 \pm 0.0002$ - $0.06 \pm 0.005$  mg/dm<sup>3</sup>,  $0.101 \pm 0.001$ - $0.231 \pm 0.003$  mg/dm<sup>3</sup>, and  $0.0072 \pm 0.0001$ - $0.0213 \pm 0.001$  mg/dm<sup>3</sup> respectively; therein, the higher element evaluated was chromium, then cadmium, and lastly lead. Evaluated Pb, Cr, and Cd were higher than the WHO limits. It was found that, the levels of metals (Fe, Mn, Ni, Cr, Pb, and Cd) were elevated and could pose great risk to the children consumers by causing detrimental effects to health (including the nervous system defects) and poor academic performances.

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## 1. Introduction

In the initial history of Islam, Prophet Muhammad was sent by the Almighty God through an inspiration to convey the message of God to the humanity. However, Muhammad was sent away from his native city of Makkah by the oppositions to his message. He then migrated to Madina in order to preach and teach. Therefore, his entourage were regarded in Arabic as “Almuhajirun” meaning emigrants. Here emigrants refer to people that abandoned their native place to the other for the sake of Islam, learning or relations (Mohammed et al., 2022). From the forgone it has depicted the significance of teaching and learning since the initial time of Islam, Muslims were enjoined to seek for knowledge (Mohammed & Danjuma, 2015).

Consequently, Almajiri schools were famous in Hausland and nearby as a system that is relayed to emigration that occur during the antecedents of Islam and Muslims. These schools are meant to mold child in the course of religious and worldly knowledge. The child in Almajiri school is called Almajiri. It is a Hausa language word that relates Almuhajirun or Almuhajir derived from Arabic. Almajiri is a child or person who travelled from his home to attend an Islamic boarding school for the cause of learning Islamic knowledge. The Almajiri leave his home for many months or years just to search for knowledge. In Muslim societies such as Ghana, and Mali also practice the system as well. It is a successful ancient practice over the years that was shouldered by the authorities and the public. However, the colonials have shifted attention to Western schools and abandoned the system to its fate of languish (Abdulmalik et al., 2009; Abdullateef et al., 2017).

Consequently, the Almajiri schools are presently in deplorable states, likewise the teachers and students (Almajiri); therewith, children of four or more years are forced to seek for their daily living and study via the practice begging, or other unworthy forms of labor. Thus, they are vulnerable to many forms abuse and the begging and other bad practices in the system are contrary to the ideals of Islam and the initial foundations of Almajiri system because Islam gives children the rights to health, the right to be nurtured in an appropriate and conducive manner, and good environment. They must be educated in a socially acceptable way (Sarkingobir et al., 2020). Unfortunately, the system is now a devastating thing; some Almajiri to sleeps on the bare floor in the school or street; some are not well-fed or well-clothed contrary to the past, but he has to engage in various odd labors like begging, domestic work and street work (Bello et al., 2021).

Unfortunately, in the Almajiri schools no organized boarding facilities are available, albeit before the exception of colonial masters the schools were good and better of education. Nowadays, piecemeal school charges are paid at will or at the will of scholars, thus; the school or students are depending on the bounties paid by wealthy individuals and alms givers for clothing, shelter, food and other basic needs for the Mallam and the Almajiri. This system has made students (small boys) weak, and vulnerable to some forms of abuse by miscreants in the society. The students are suffering from care from their wards and in turn feeling emotional and physical distress over their stay at Almajiri school in most of the cases. The lack of care from their families can affect the students psychologically; and leave at the mercy of the negative minds in the society (Sarkingobir et al., 2019; Sarkingobir et al., 2020; Bello et al., 2021).

Meanwhile, education is of utmost importance to the life individual and groups and cannot be overemphasized as a tool to attaining an organized society. A society stays in order and

stability based on the importance it attached to its educational system. In fact, the philosophy behinds education is diverse in emphasis and benefits and is a rationale for the moral up-brought of humans to have an ultimately better society (Mohammed et al., 2022). In the Article 24 of the 1948 Universal Declaration of Human Rights, it was echoed “everyone has the right to education”. In turn, at global stage, a known portend of the Sustainable Development Goals (SDGs) is shown in the provision of quality education to citizens irrespective of their affiliations. Indeed, quality education provision is listed 4th item of the "Envision 2030" document. Thus, the government of Nigeria added the right to education in the folds of the 1999 Constitution and highlighted that "Government is indebted to channeled policies that ensure equal, and adequate education to all " (Maigari et al., 2017). To yield the policy of equal and quality education to all, the Nigeria government has concluded diverse attempts to support all in the quest for education. Parable, in the year 2004 an education policy was made, stressing the right of every Nigerian child to have education of better quality (Mohammed et al., 2022).

The system of Almajiri education is certainly deemed to address the rising number of out-of-school children in the country (that is about 13 million, and mostly from the ten northern states that give about 8 million out-of-school children). Thus, Almajiri educational school is specialized in intervening to tackle the nature of the menace of Almajiri culture/ syndrome in the parts of the country. Nowadays, Nigeria Almajiri is called described as a time bomb waiting to explode when time comes (Maigari et al., 2017). An olden education practice initially formed to give qualitative and accessible education to all children children such as orphans, children of poor families, children of ethnic minorities, broken-home wards derived from the northern parts of Nigeria and relation Almajiri education is shoulder the teaching of education needs of more than 9.5 million Almajiri children (Mohammed et al., 2022). It is to imperative implement to the Nigerian Child Right Act, which enjoins that: "Education is the birth right of every Nigerian child, and should be brought close to the environment of 1 3 Education and Information Technologies the child". It is fully mandated that the Act of present day Almajiri education, drafted and signed as a law as far back as 2012, was objected to the Almajiri schools for ensuring that Almajiris students are accorded with rights to access basic education (Mohammed et al., 2022).

Nevertheless, Almajiri schools suffered from all phases including shortage of water supply, and pollution of drinking water. Water is essential component of human body and has to be taken through the environment. However, nowadays anthropogenic processes had expunged metals from their natural stores and make air, water, and soil very susceptible to pollution until proven otherwise (Yahaya et al., 2019; Mathew et al., 2021; Sarkingobir et al., 2022; Wali et al., 2022). A group of metals called heavy metals that are elevated in weight, toxic at little amount, and cause diverse effects on humans and other biologicals are rampant pollutants that need to be monitored in water (Radu-Rusu et al., 2013; Uba et al., 2016; Teke et al., 2020; Umar et al., 2022). Iron, nickel, and manganese are heavy metals that are useful to life, but very poisonous when exceeding some limits (Quds et al., 2021); therewith, excess iron exposure is either fatal or often negative to health (Garba et al., 2013), nickel excesses lead to concern and other adversities (Iwuoha et al., 2013), and low or high manganese is also a factor linked with adverse effects including poor academic performances (Allen et al., 2018). Other forms of heavy metals termed as non-essential such as lead, chromium, and cadmium because no known biological role is found about them (Rahman et al., 2019; Quds et al., 2021); and their little uptake by the human body elicits toxicity and consequent adverse effects (Saeed et al., 2011;

Balali-mood et al., 2021). Parable, lead damages brain, kidney, elevate blood pressure, causes symptoms such as headache, abdominal pain, irritability, and manifest nervous system symptoms (Iwuoha et al., 2013; Quds et al., 2021). Cd is a causer of obstructive lung disease, renal disease, bone fragility (Duruibe et al., 2007; Iwuoha et al., 2013; Quds et al., 2021). Cr causes dermatitis, cancer of the lung, etc (Iwuoha et al., 2013). Indirect effects in form of biological problems due to metals toxicity causes school/ classes absenteeism that in turn affects education. Likewise, nervous system is emphatic to affect the academics of the exposed children (Farias et al., 2022). However, the toxicity and effects of drinking polluted water containing heavy metals is more critical at early stages of life because of the poorly developed biological system, surface area-to-volume ratio, tendency of children to contact anything they see without caveat etc. The ability of the heavy metals to reach the blood brain bilayer (BBB) instigates toxicity and resultant functional and morphological defects of the body; and more specifically causes neurodevelopment lesions in the affected children, thereby affecting their learning capacity and other behaviors as well (Farias et al., 2022). Therefore, the objective of this paper is to determine the concentration of some heavy metals present in some selected wells of Almajiri schools in Sokoto East The objectives are:

- a) To ascertain the level of heavy metals contaminants in the well water sample in Almajiri schools in Sokoto East, Nigeria.
- b) To ascertain whether the heavy metals concentrations are within the tolerable limit or not.

## 2. Materials and Methods

### 2.1. Sample Collection

The sample was collected from Sokoto East, Nigeria. The sample for this study was collected from 20 different wells in Almajiri schools in Sokoto East.

### 2.2. Procedure for Digestion

50cm<sup>3</sup> of each sample was transferred into a beaker and 5cm<sup>3</sup> of concentrated HNO<sub>3</sub> was added into each beaker. The samples were heated on a hot plate until the solution appears pale yellow colored indicating the digestion was completed. After which solution allowed to cool and transferred to a 50cm<sup>3</sup> volumetric flask and distilled water was added to the mark and transferred into a sample bottle for atomic absorption spectroscopy (Umar et al., 2022).

### 2.3. Principle of Atomic Absorption Spectroscopy

Basically, the Atomic Absorption Analysis is a useful method for analysis of metals, and absorption of light is applied in an instrument popularly dubbed as Atomic Absorption Spectrophotometer. Consequently, a flame system is applied to instigate a dissociation of element away from their chemical bond. The dissociated atoms take in amount of light with a certain wavelength specific to chemical bonds because at ground state, the atoms absorb light at characteristic wavelength. A combination of air and acetylene give out a flame of enough temperature to free most of the atoms of elements. Often nitrous oxide is use instead of air to yield elevated temperature when analyzing some specific elements. Because of the nature in the narrow spectral line of the sample there is need for a line source and as well as high resolution monochrometer of high resolution capacity to prevent an interference from adjacent spectral lines (from divergent species on the sample matrix). AAS and flame atomizer are

utilized to measure exact metals present in a given sample. The presence of a spectrometer carrying a lamp turret induce the measurement of several metals in a sample (Umar et al., 2022).

#### 2.4. Procedure for Atomic Absorption Spectroscopy

After the digestion has been completed, the AAS machine was used to determine the presence and concentration in the sample (carrying the metals of question) is subjected to aspiration with an air-acetylene flame and in turn evaporation of the solvent occurs. Likewise, the conversion of free metals into vapor in a method called atomization occurs. A light source (hallow cathode lamp) that works at the region of Uv-visible is utilized to instigate excitation of metal electrons and consequently, the absorbance is measured using a conventional Uv-visible dispersive spectrometer that possesses photomultiplier detector (Umar et al., 2022).

### 3. Results and Discussion

The results for this study were shown in tables 1 and 2.

**Table 1.** Fe, Ni, and Mn metals evaluated in well-water obtained from Almajiri schools in Sokoto, Nigeria

	Iron (mg/dm <sup>3</sup> )	Nickel (mg/dm <sup>3</sup> )	Manganese (mg/dm <sup>3</sup> )
School A	3.110±0.001	0.310± 0.003	0.021±0.001
School B	1.510±0.002	0.051± 0.001	0.006±0.0002
School C	3.100±0.001	0.662±0.001	0.003±0.0001
School D	2.150±0.005	0.290±0.005	0.001±0.0001
WHO limits	0.3	0.02	0.3

Source: field data, (2023)

Key: values are expressed as mean± standard deviation

Table 1 shows the levels of iron, nickel, and manganese in well-water in Almajiri schools in Sokoto East, Nigeria. The ranges of the metals determined for iron, nickel, and manganese are respectively as follows: 3.110± 0.001- 3.100± 0.001 mg/dm<sup>3</sup>, 0.051± 0.001-0.662± 0.001, and 0.001± 0.0001-0.021±0.001 mg/dm<sup>3</sup> respectively. The result (indicated in table 1) has revealed that, the highest element found was the iron, then nickel, and lastly manganese. Therewith, the Fe level evaluated in well-water obtained from Almajiri schools was very high compared to the WHO permissible limit (0.01 mg/dm<sup>3</sup>). Fe is important in the body of all, let alone the school children. Deficiency of Fe (such as anemia) happens due to lack of iron in the diet and is characterized with signs such as fatigue, weakness, pale skin, chest pain, dizziness, headache, etc. Therewith, these conditions cannot allow the children to learn properly. Many of the affected children had to abstain schools or classes or visit clinics thereby missing classes/ lessons (Ayed et al., 2021). It is well-known that, class/school absenteeism is a factor that causes poor academic performance, school dropout, risky behaviors etc. (Allen et al., 2018). In relations, elsewhere it was deciphered that, iron deficiency in children spurs transmogrification of cognitive performance by causing damage to mitochondria of the brain and in turn poor attention, poor concentration, and poor intelligence (Iqbal et al., 2015; Ayed et al., 2021).

Table 1 shows the levels of Mn in well-water of Almajiri schools were indicated, and found to be below WHO limit. It is worthy to propel that, Mn is an essential element to humans at optimum level, and harmful at excess levels; therewith, low or high levels of Mn affect the

nervous system and consequently the cognitive ability of children and neurodevelopment (Allen et al., 2018). Thus, it is important to monitor Mn levels in drinking water of schools especially the Almajiri children schools that are usually very vulnerable because of their abandonment by all. Excess Mn change the neurobiology of basal ganglia together with the dopaminergic system, cerebral cortex (Farias et al., 2022). Manganese was linked to poor attention, hyperactivity, conduct problems, and other poor behaviors in children. Lack of recall, and negative learning (Heng et al., 2022).

The determined nickel levels in Almajiri schools drinking water were mostly above WHO permissible limits. Nickel excesses might be due to its extensive distribution in air, water, and soil owing to natural and anthropogenic processes. Exposure to the metal can elicits allergy, kidney diseases, cardiovascular diseases, lung fibrosis, and cancer of the nose and lung. All of the effects due to lead can cause hospitalization and in turn a child has to avoid classes or school and in turn militating academics (Genchi et al., 2020). Albeit, the nickel is significant in plants, and some microbes; in animal it instigates mitochondrial damage by impairing the mitochondrial membrane potential, and annihilation of its DNA. Thereby, interfering with electron transport chain, and increasing reactive oxygen species (Zhang et al., 2019; Genchi et al., 2020).

**Table 2.** Showing evaluated heavy metals determined in well-water obtained from secondary schools in Sokoto, Nigeria

	Lead (mg/dm <sup>3</sup> )	Chromium (mg/dm <sup>3</sup> )	Cadmium (mg/dm <sup>3</sup> )
School A	ND	0.231± 0.003	0.0121±0.001
School B	0.005±0.0002	0.132± 0.001	0.0212±0.0002
School C	ND	0.101±0.001	0.0072±0.0001
School D	0.06± 0.005	0.135±0.005	0.0213±0.001
WHO limits	0.01	0.05	0.05

Source: field data, (2023)

Key: values are expressed as mean± standard deviation

Table 2 indicates the levels of heavy metals (Pb, Cr, and Cd) in well-drinking water in Almajiri schools in Sokoto East, Nigeria. The lead, chromium, and cadmium ranges are as follows: 0.005± 0.0002-0.06± 0.005 mg/dm<sup>3</sup>, 0.101± 0.001-0.231± 0.003 mg/dm<sup>3</sup>, and 0.0072± 0.0001-0.0213±0.001 mg/dm<sup>3</sup> respectively; therein, the higher element evaluated was chromium, then cadmium, and lastly lead. Evaluated Pb, Cr, and Cd were higher than the WHO limits.

Pb is a poisonous metal at low level in food, water, and relations. The lead found (in table 2) was higher than WHO limit (0.01) and more harmful to school children because the body is still developing. It elicits a lot of discomfort that makes children sick and have to abstains school or classes and in turn affecting their academics; likewise, lead is directly associated with poor academic performance, low intelligence, and poor behavior (Evens et al., 2015; Heng et al., 2022; Kowalska et al., 2022). In the other hand, lead incites low weight, which is a predictor of academic performances; therefore, early childhood exposure to lead can have a negative effect on academic performance of victims (Evens et al., 2015; Allen et al., 2018).

From table 2, it was indicated that the water in the observed Almajiri schools is contaminated with cadmium. Cd is poisonous, it forms complexes with several organic compounds that are harmful to the body, let alone in children. It mechanistically, affects the

body by affecting cell proliferation, differentiation, and programmed cell death; in turn compromising DNA repair, apoptosis, and formation of reactive oxygen species (ROS). It in turn affects DNA, availability of glutathione, antioxidant enzymes (like catalases, superoxide dismutase) (Rafati Rahimzadeh et al., 2017).

As indicated in table 2, the chromium found in Almajiri school water was higher than the WHO limit and concern in drinking water utilized by children, because the metal is of concern to health. The chromium has ability to cause toxicity, allergy, and cancer (Sughis et al., 2012; Caparros-gonzalez et al., 2019); an experience that causes hospitalization, leaving school, and consequent academic backwardness (Caparros-gonzalez et al., 2019). On the other hand, early life exposure to toxic metals such as chromium were found to be of negative effects on neuropsychology development of children. Thus, the children consuming this water are prone to develop low academic performance at Arabic or any other school involved (Caparros-Gonzalez et al., 2019). This experience might be biochemically due to low cholinergic and dopaminergic neuronal cells, and neurological sequelae spurred by the chromium. Therefore, more hands should be on deck to save the Almajiri child by providing enough and quality water in their schools or integrating them in Almajiri integrated schools that are government funded schools.

#### 4. Conclusions

Water is essential for healthy living in any environment especially to the children at schools. There should be portable water that is enough for proper running of any school and for students to be able to learn properly. Evaluated Pb, Cr, and Cd were higher than the WHO limits. It was found that, the levels of metals (Fe, Mn, Ni, Cr, Pb, and Cd) were elevated and could pose great risk to the children consumers by causing detrimental effects to health (including the nervous system defects) and poor academic performances.

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