Assessment of Heavy Metal Content of Njere River in Umuakam, Okaiuga Nkwoegwu, Umuahia North L.G.A

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Authors' contributions

This work was carried out in collaboration between all authors. Authors IAO and DA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors UM and IAO managed the analyses of the study. Author DA managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Aims: To assess the heavy metal content of water from Njere river in Umuakam Okaiuga Nkwoegwu autonomous community in Umuahia North L.G.A of Abia State.
Study Design: Purposive sampling was employed for sample collection.
Place and Duration of Study: Department of Chemistry, Michael Okpara University of Agriculture, Umudike from June 2009 to December 2009.
Methodology: Water samples were collected from upstream, midstream and downstream locations of the Njere river. From each location, water was collected from three different points and combined to form a composite. The total, soluble and exchangeable metal ions were estimated by the use of Atomic absorption spectrophotometer.
Results: Total Nickel, cadmium and zinc ion content exceeded the WHO standard in all the locations. Water soluble zinc ion was higher than the standard for all the samples. Exchangeable metal ions exceeded the standard for Ni, Cd, Zn and Pb.
Conclusion: The water from the Njere river is not completely safe for domestic and agricultural activities.

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1. INTRODUCTION

Water is an essential commodity needed by all life forms. It is derived naturally from surface water (lakes, rivers, streams, etc.) or ground water (borehole water and well water) [1]. Most rivers are used for both domestic and irrigation purposes [2]. Fishing activities in rivers serve as source of income for the people. However, people find it easy to dump wastes into rivers because they are easily accessible [3]. Effluents from domestic wastes, industries, traffic, fossil fuels and so on pollute water making it unsafe for human consumption and agricultural activities [4-6]. Some of these pollutants include: suspended solids, heavy metals and various chemical compounds.

Heavy metal contamination of water may be from anthropogenic sources as well as lithogenic [7]. The dumping of domestic waste into water bodies has been identified as the primary source of heavy metal contamination [8]. Heavy metals are toxic even at low concentrations. They cause damage to both aquatic organisms, plants and man [9,10]. Heavy metals can be introduced into the food chain by bio-accumulating different parts of aquatic life like fishes. There is need to protect rivers from environmental contamination to ensure its usability.

Njere River is located in Umuakam, Okaiuga Nkwoegwu, Umuahia North L.G.A of Abia state (N 05°34'24.3''; E 007°27'52.0''; Elevation 90 m). It has been the major source of water for drinking and other domestic purposes. Fishing activities are predominantly prohibited in the river, including bathing and washing in the river to avoid contamination. The aim of this research is to evaluate the heavy metal content of the Njere River collected from different location to ascertain its safety and use for human consumption.

2. MATERIALS AND METHODS

2.1 Sample Collection

The water sample was collected at three different sites namely: Upstream (US), midstream (MS) and downstream (DS). The water samples were scooped using a small clean plastic bucket from three different points on each site of collection. Thereafter, it was poured into sample kegs. Few drops of hydrogen tetraoxosulphate VI acid were also added to preserve the metals in the water samples. The kegs were well labeled according to location. The samples were collected once in June, 2009.

2.2 Determination of Total Metal Concentration

To 20 mls of water sample in a conical flask were added 15 mls of HNO_3 and 10 mls of HCl. The conical flask and its content were heated at 100°C in a fume cupboard for thirty minutes. Thereafter, 25 mls of deionized water was added and the heating continued for 90 minutes. The digested sample was allowed to cool, filtered into 50 mls volumetric flask and made up to mark with distilled water. An aliquot of 10 mls was collected into clean labeled sample bottle for determination of Pb, Zn, Fe, Cd and Ni using Atomic Absorption Spectrophotometer (AAS 240 FS Agilent Technologies).

2.3 Determination of Water Soluble Metal Concentration

This was determined by measuring 20 mls of water sample into a conical flask, allowed to stand and filtered using whatmann no 1 filter paper. It was made up to mark with deionized water. Ten milliliters (10 mls) of the filtered sample was taken from the 50 ml volumetric flask into a clean labeled sample bottle for Atomic Absorption Spectrometer (AAS) analysis.

2.4 Determination of Exchangeable Metal Fraction

To twenty mls of water sample in a conical flask was added 20 mls of 1M solution of $MgCl_2$. The pH was adjusted using potassium phosphate buffer. The conical flask and its content were put in a fume chamber and heated for 60 minutes at ambient temperature. Thereafter, the conical flask content was filtered into a 50 ml volumetric flask using whatmann no 1 and made up to mark with deionized water. Ten mls of the resulting solution was measured into clean labeled bottle for determination of exchangeable metal fraction.

3. RESULTS AND DISCUSSION

Table 1 shows the result of the total metal ions concentration in the water samples compared to the WHO (World Health Organization) standard.

The concentration of Nickel, Cadmium and zinc concentrations for all the locations were all above the WHO standard. In the upstream sample, the Fe concentration was more than the WHO standard. The water from the upstream and downstream locations had Pb values above that of WHO.

Table 1. Total metal ions concentration

Type of metal ion	Sample location	Mean metal ion conc (ppm)	WHO standard (ppm)
Ni	upstream	0.041	0.02
Ni	midstream	0.03	0.02
Ni	downstream	0.04	0.02
Cd	upstream	0.29	0.003
Cd	midstream	0.15	0.003
Cd	downstream	0.12	0.003
Fe	upstream	3.54	0.2
Fe	midstream	0.02	0.2
Fe	downstream	0.48	0.2
Zn	upstream	0.48	0.1
Zn	midstream	0.14	0.1
Zn	downstream	0.21	0.1
Pb	upstream	0.25	0.01
Pb	midstream	0.01	0.01
Pb	downstream	0.01	0.01

Values are means of duplicate determinations

Table 2. Water soluble metal ions

Type of metal ion	Sample location	Mean metal ion conc (ppm)	WHO standard (ppm)
Ni	Upstream	ND	0.02
Ni	Midstream	0.03	0.02
Ni	Downstream	0.03	0.02
Cd	Upstream	0.43	0.003
Cd	Midstream	ND	0.003
Cd	Downstream	0.004	0.003
fe	Upstream	0.06	0.2
fe	Midstream	ND	0.2
fe	Downstream	ND	0.2
Zn	Upstream	0.24	0.1
Zn	Midstream	0.16	0.1
Zn	Downstream	0.2	0.1
Pb	Upstream	0.003	0.01
Pb	Midstream	ND	0.01
Pb	Downstream	0.01	0.01

Values are means of duplicate determinations

Table 2 above shows the concentration of water soluble metal ions from different locations compared to the WHO standard. Nickel was not detected in the water from the upstream location.

The concentration of Ni in the midstream and downstream locations were greater than the WHO standard, however it was not detected in the upstream sample. Cadmium level exceeded the WHO standard in the upstream water. Fe was not detected in the midstream sample. Zn levels were generally higher than the standard for all the samples. Pb was not detected in the midstream sample.

Table 3 shows the concentration of exchangeable metal fraction ions compared to WHO standard. Nickel, cadmium, zinc and lead levels exceeded the WHO standard for all the samples. Fe levels were within the WHO standard.

Table 3. Exchangeable metal ions

Type of metal ion	Sample location	Mean metal ion conc (ppm)	WHO Standard (ppm)
Ni	Upstream	0.14	0.02
Ni	Midstream	0.12	0.02
Ni	Downstream	0.11	0.02
Cd	Upstream	0.24	0.003
Cd	Midstream	0.39	0.003
Cd	Downstream	0.39	0.003
Fe	Upstream	0.12	0.2
Fe	Midstream	0.08	0.2
Fe	Downstream	0.04	0.2
Zn	Upstream	0.16	0.1
Zn	Midstream	0.12	0.1
Zn	Downstream	0.11	0.1
Pb	Upstream	0.04	0.01
Pb	Midstream	0.03	0.01
Pb	Downstream	0.03	0.01

Values are means of duplicate determinations

Ni is majorly introduced into water bodies through disposed domestic wastes. It causes oxidative stress, cell membrane disruption and inhibits the activities of some enzymes [11-13]. Cd is a non-essential element and is highly toxic to aquatic organism [14] It has the potential to damage biomolecules like proteins ad nucleic acids [15]. Pb is a very toxic, non-essential element in water. Its presence in water usually confers danger even at low concentrations. Pd causes denaturation of DNA [16]. Iron is the fourth most abundant element. Though an essential element, and component of haemoglobin, myoglobin and many enzymes, its overload can lead to several health challenges like cancer, diabetes, heart disease and infertility. High concentrations of iron in water lead to

change in colour, taste or odour [17]. Zinc has important physiological functions but is affects most metabolic processes when in excess amount [17]. The high levels of Ni, Cd and Pd in this water samples suggest that the water may not be fit for drinking.

These heavy metals may have arisen form run-offs or erosion, weathering or anthropogenic sources. It could also be due to practice of discharging various wastes into the river which accumulates the concentration of heavy metals over time.

4. CONCLUSION

The study revealed that water sample from the Njere river is not completely safe for drinking purpose. There is need for purification to make it safe for consumption and survival of aquatic life. The heavy metal contaminants in the Njere river could have been from run-off into the river.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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