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Determination of level of the concentration of some heavy metals in water from Jibiya Dam, Katsina State

Abstract

The physical parameters of water from Jibiya dam such as (pH, temperature and electrical conductivity) were determined by the use of standard analytical techniques. The values were found to be 7.02±0.22, 28.97±1.89 and 65.04±2.05 respectively. The concentration of the heavy metals; Fe, Cd, Ni, and Pb determined by the use of atomic absorption spectroscopy AAS were found to be 0.75±0.23, 0.24±0.09, 0.11±0.56, and 0.096±0.03 respectively. The physical parameters were all found to be within the standard WHO recommended values but the concentration of the metals was all found to be above the recommended WHO values.

Keywords: water, contaminants, heavy metals, physical parameters

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Introduction

Water is the essential for life on earth because of its importance in various fields. The pattern of human settlement throughout history has often been determined by availability of water Mahmoud et al.[1] Water is the most important substance for human existence after oxygen.[2] Water is the most abundant substance on the earth's surface that is essential for the survival of all known forms of life. Water plays an important role in the world economy, as it functions as a solvent for wide variety of chemical substances, industrial cooling, transportation and agriculture. More than 70% of fresh water is consumed for agriculture Borini et al.[3] Safe drinking water is a human birthright as much as its birthright for clean air. As a matter of fact, in most of the developing countries, even in relatively advanced countries such as India, safe drinking water is not easily available. Of the 6billion people on earth, more than one billion lack accesses to safe drinking water and about 2.5billion do not have access to adequate sanitation service (TWAS, 2002). Fresh water that is available for human consumption comes from rivers, lakes and subsurface aquifers. These sources account for only one (1%) of the entire water on the earth. Today 31countries representing 2.8billion people including Nigeria, Kenya, and china, India, Peru and Ethiopia confront chronic problems. Within a generation the world's population will climb to an estimated 8 billion people, yet the amount of water will remain the same Bishno et al.[4]

Contaminants such as Bactria, heavy metals, nitrates and salt have found their way into water supplies due to inadequate treatment and disposal of waste from human and livestock and overused of limited water resources Singh et al.[5] Even if no source of anthropogenic contamination exist, natural sources are also equally potential to contribute higher of some metals and other chemicals that can harm human health Anawara et al.[6] Uptake of heavy metals by plant and subsequent accumulation along food chain is a potential threat to animal and human health Borini et al.[3]

Statement of the problem

Human being has been exposed to heavy metals for an immeasurable time. Rapid increase in population, coupled with other factors such as urbanization, rapid industrial development, mining and agriculture etc, result in huge accumulation of waste and pollutants which end up in water bodies such as rivers, streams and lakes thereby polluting them Duruibe et al.[3] Heavy metals also present in virtually every area of modern consumerism such as rivers construction materials, cosmetics, medicines, processed food, fuel source, personal care products, etc. it is very difficult for everyone to avoid exposure to any of the heavy metals In our environment. Heavy metals toxicity represents an uncommon, yet clinical significant medical condition. If recognized or inappropriately treated, heavy metal toxicity can result in significant morbidity and mortality Bishno et al.[4]

Aim and objectives

The aim of this research is to assess the level of some physical parameter and some heavy metals in Jibiya Dam, Katsina State of Nigeria.

Objectives

To determine the concentration of some heavy metals; lead, iron, nickel and cadmium in the water samples from Jibiya Dam, Katsina state, to compare the concentration of the heavy metals analyzed in the water sample of Jibiya Dam with the World Health Organization standard for drinking water and see if it certify the limit for drinking water and irrigation purpose and to determine some of the physical properties of water samples such as pH, temperature and electrical conductivity.[7]

Scope of the research

The study was designed to cover only within Jibiya dam in Katsina state, nine water samples were collected at different time of the day within the dam. The study intents only to assess the concentration of some heavy metals of the raw water in the study area. The concentration of the metals tested in this study was lead, iron, nickel and cadmium. In spite of the limitations, it is hoped that the data generated will provide reasonable background for further studies.[8]

Justification of the study

The rationale behind this study is that in accessibility to qualitatively water supply in the study sample has worsened the wide spread of water borne diseases. The problem of drinking water with high concentration of lead and other heavy metals affect human and animal health, because drinking such water poses so many health problem and hazard to environment. It is widely known and accepted that quality water improves and enhances the social, health, and economically wellbeing of the people. This makes `the provision of portable water in abundance in the study area within the frame work of integrated development imperative. The needs to identify the factors affecting the quality of water supply and demand that in turn constitute a number of the study area makes this research inevitable.[9]

Methodology

Experimental procedure

a. Cleaning of apparatus

b. Collection of sample

c. Determination of some physical parameter

d. Sample digestion

Cleaning apparatus

Apparatus such as plastic containers (for water sampling) and glassware were washed with tap water using detergent followed by dilute nitric acid and finally rinsed with deionized water. The glassware were dried in oven and kept in dust-free atmosphere until used analysis.

Collection of sample

Polyethylene bottles were used for the collection of sample. The containers were thoroughly washed with detergent, rinsed with water and then distilled water before soaking in 5% HNO_3, containers were finally rinsed with doubled distilled water before being used for sampling. The method employed by an environmental protection agency as reported by Gregoriadou et al.[10] was adopted for the collection of water sample, that the samples were collected in the bank of the river.

Determination of some physical parameters

The samples were analyzed for different parameters as described below. The temperature of water samples were measured on-sites with a mercury thermometer (0-100°C). The pH of water sample was determined using potentiometric method using pH meter already standardized by using buffer solution of known pH value before analyzed. Electrical conductivity was determined using conductivity meter that has been calibrated with standard conductivity buffer solution.[11]

Sample digestion

100ml of each of the representative water samples were transferred into Pyrex and 10ml of concentration HNO_3 was added. The samples were boiled slowly and then evaporated on a hot plate to the lowest possible volume (about 20ml). The beakers were allowed to cool and another 5ml of concentrated HNO_3 was added. Heating was continued with adding of conc. HNO_3 as necessary until digestion was complete. The sample was evaporated again to dryness and the beakers were cooled followed by addition of 5ml HCl solution. The solution was then warmed and 5ml of 5M NaOH was added and then filtered. The filtrates were transferred to 100ml conical flask and diluted to the mark with distilled water. These solutions were then used for the elemental analysis. I.e. ATOMIC ABSORPTION SPECTROSCOPY.[12,13]

Results and discussion

Statistical analysis was performed using SPSS 22 (Statistical Package for Social Sciences version 22) table shows the concentration of metal in sample against WHO 2014 standard limit. Concentrations of the various heavy metals as well as pH values varied at different sites (Table 1). The water samples had an average pH mean values varied from 7.02±0.22. The temperature was found around the WHO limit of 30°C-35°C since it was found to be 28.97±1.89, the electrical conductivity was found to be far less than the WHO limit of 1000us since the average mean electrical conductivity for water samples analyzed was found to be 65.04±2.05.[14] In the analyses, the concentrations of household and industrial activity-originated Fe, Cd, Ni and Pb heavy metals were determined from Water obtained from Jibia Dam in Katsina State, Nigeria, and mean heavy metal concentrations were found as follows: Fe 0.75±0.23mg/kg, Cd 0.24±0.09mg/kg, Ni 0.11±0.5mg/kg and Pb 0.10±0.03mg/kg. The concentrations within the WHO accepted limits for Fe, Cd, Ni and Pb are 0.30mg/kg or less, 0.01mg/kg or less, 0.02mg/kg or less and 0.01mg/kg or less respectively.[15] Concentrations were usually high and indicated that the water obtained from Jibia Dam which is used for both domestic and agricultural use is polluted in the present. The presence of heavy metals with moderate high concentrations in the water samples indicate that there can be a chance of damage to water and animal kingdom including human beings. Hence continual assessment and enlightenment is highly essential. The results of the study was in disagreement with Ibrahim et al.[16] shows that the waters were within the limits of WHO and NAFDAC for potable water and therefore safe for human and animal consumption, subsequently there is need for regular checking of these parameters to ensure the health and safely of the populace and subsequently reduce diseases caused by poor water quality. When the values obtained in the study were compared with the literature, Kanat et al.[17] could conclude that the bed dredging works in the Jibia Dam, the channels established around the estuary to prevent wastewater discharge, building of wastewater treatment plants, and the closure of the existing factories improved the rehabilitation of heavy metal levels in the water. However, contaminants that were concentrated in the water are harmful to life even if the pollutant discharge to the water environment is reduced or even prevented. To prevent pollution in the Jibia Dam, all uncontrolled discharges from land, air and water sources should be identified and prevented. Industrial organizations located around the Jibia should be prevented from conducting illegal discharges by regular inspections, and treatment plant effluents complying with the discharge standards should be controlled (Table 2).

Table 1 Concentration of physical parameters

S\N	Parameter	Mean±Std. dev.	W.H.O limit
1	pH	7.02±0.22	7.0-8.5
2	Temperature	28.97±1.89	30°C-35°C
3	Electrical conductivity	65.04±2.05	1000us

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Table 2 Concentration heavy metals in raw water of Jibiya Dam of Katsina State

S/N	Metal	Mean ±Std. dev.	W.H.O limit
1	Iron (Fe)	0.75±0.23	0.30 or less
2	Cadmium (Cd)	0.24±0.09	0.01 or less
3	Nickel (Ni)	0.11±0.56	0.02 or less
4	Lead (Pb)	0.1±0.03	0.01 or less

Conclusion

The physical parameters of raw water of Jibiya Dam of Katsina state were analyzed and result found fall between the range of recommended value of world health organization for survival, metabolism and physiology of aquatic organism. The concentration of the metals (lead, cadmium, nickel and iron) has been also determined by flame of atomic absorption spectrometry. Analysis of the physical parameter measured and metals in the raw water of Jibiya is very important as the water used for various purposed by the community which has health implication. The present study revealed that open beaker digestion was reliable method for quantitative determination of metals in the raw water. The result of recovery test as found in the rejected range for the analyzed metals i.e. the concentration of the all metals is much higher from recommended WHO limit. According to WHO guideline the result obtained indicate that the raw water of Jibiya dam is not safe for drinking unless it is treated to control the concentration of the metals.

Recommendations

i. This study, therefore, recommended the government of Katsina state and other responsible authorities to introduce relevant drinking water treatment techniques which can reduce the current the current level of metals (Pb, Cd, Ni, Fe), to the accepted level current results indicate that their concentration are above limit guideline.

ii. There is also need to create awareness as people of Jibiya usually depend on that dam for irrigation farming for them to know the dangerous stage they engaged in.

iii. Finally further studies should focus on too compare the level of the metals in raw and treated water of that dam and to determine the level of more metals.

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None.

Conflicts of interest

Authors declare that there is no conflicts of interest.

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