Int. j. adv. multidisc. res. stud. 2022; 2(6):919-922

Received: 26-10-2022
Accepted: 06-12-2022

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Determination of Well Water Quality and Its Effect on the Liver and Kidney of Albino Rat

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Abstract

Heavy metals and other parameters are a major environmental and health concern because even at insignificant levels there are toxic when ingested or accumulate in the body. In this study, atomic absorption spectroscopy and standard tissue sectioning techniques were used to quantify the presence of heavy metals in well water samples and their effects on the vital organs of albino rats. The statistical data analyzed showed the followed mean of physiochemical parameter as; pH (6.36±0.04), temperature (35.47±0.47), DO (63.70±13.64), BOD (2.57±1.36), Ca (246.39±297.96), Mg (248.08±186.70), Na (288.07±381.17), SO_4 (394.35±521.18), Cl (430.10±328.73), TDS (544.033±407.1511) and NO_3 (97.82±72.92). And Cu (0.590±0.3996), Zn (0.84±0.0400), Fe (0.063±0.0404), Pb (0.117±0.1106), Cd (0.077±0.0289) and Cr (0.033±0.0577) heavy metals. Some parameters were found to be below or above the permissible limits set by WHO. Only pH and Copper were obtained within the specified range. The group of albino rats intake with well water for 3 weeks developed kidney mild inflammation of glomerulus exceeding the normal size compared to the control groups (intake distilled water). No dilation of the liver. This justifies these heavy metals and other parameter analyzed accumulating in kidney, causing diseases. Well water in the study area are found polluted with heavy metals and physiochemical parameters that effect the health status of human as time goes on. Governments therefor need to find solutions to deal with these toxic substances that maybe present in ground water.

Keywords: Well Water, Physiochemical Parameters, Heavy Metals, Histopathology

1. Introduction

Water is a resource necessary for the survival and daily wellbeing of all life on earth. All life forms are directly or indirectly dependent on water for health and sustainable development [1]. Portable fresh water advances human civilization by meeting their needs in every country. Since groundwater has been used and known since prehistoric times, nearly 7.5 million of it has been exploited and restored for human subsistence in some parts of the world [2]. In Kebbi state, government reluctance, corruption and human agitations have resulted in scarcity of tap water, leading to the digging of wells as the alternative tap water sources. As groundwater flows through sediments, it dissolves metals such as iron and manganese, many which are later found in high concentrations in water. The application of chemical fertilizers, pesticides or discharge of industrial wastewater into soil directly deteriorated groundwater quality [3, 4]. Water quality problems are partly related to poor hygiene around the water.

Heavy metal effects, especially above standard limit, cause changes in vital organs of humans and other animals [5, 6]. Sufficient amounts of lead, cadmium, nickel, cobalt, copper, zinc and chromium are fatal when ingested [7]. It causes shortness of breath and is carcinogenic [8].

Changes in land use and management practices can have significant impacts on water quality parameters [9]. Therefore, water quality is completely dependent on physico-chemical parameters such as pH, temperature, light, dissolved solids and turbidity [10]. [11] studied the physicochemical properties of the Dukku river. They found monthly variations among the parameters obtained. Others researchers have identified various heavy metal substance in human drinking water [12, 13, 14]. Human activities such as bathing, washing of clothes and washing cars, produce chemicals such as detergents used, oils, and automobile waster that increase toxic substances that seep underground and contaminate water. High concentration of heavy metals (Ph, Cr, Fe) in polluted water accumulate in vital organs such as the kidney and liver causing serious illness [15]. Local well water have been reported t be unfit for human use without proper treatment [16]. Consumption of contaminated water is a major contributor to mortality and chronic sickness, leading to the deaths of 14,000 people every day worldwide [17, 18, 19]. Therefore, this study

aimed to evaluate well water quality and its effect on selected organs of albino rats.

Study Area

Birnin Kebbi is a city situated in northwestern Nigeria at coordinates12^{0}27'13"N, 4^{0}12'01"E. It is the capital city of Kebbi State and headquarters of the Gwandu Emirates. In 2006, the city had an estimated population of 268,420 [20]. Birnin Kebbi lies on the Sokoto River and is connected by road with Argungu (45 km to the northeast), Jega (35 km to the southeast) and Bunza (45 km to the southwest) with the relatively abundant surface water and rivers form. These rivers provide a good source of water for irrigation, domestic use, fishing and transportation. Birnin Kebbi has a tropical continental climate with a rainy season that lasting from April to October in the South and from May to September in the north, with a dry season lasting until the end of the year. Agriculture is the main occupation of the people and includes growing crops, fishing and animal husbandry, especially in rural areas. The annual temperature varies between 21ºC to 38ºC. The soil types found in the area vary from heavy clay in the fadama areas to loamy, sandy loam and sandy soils. Average annual rainfall is about 800mm.

Collection of Water Samples

Well water samples were collected early morning in sterilize 1.5 liters of plastic containers at Gulumbe town within Birnin Kebbi Local Government Area using sampling techniques. All collected samples were taken to the Department of Chemistry Laboratory, UDUS for analysis.

Determination of Physiochemical Properties

Chemical parameters of the collected water samples, such as pH, dissolve oxygen (DO), biological oxygen demand (BOD), sodium, nitrogen, phosphorus, calcium and magnesium, total dissolved solid and chloride were determined using the procedure described by [21] with slightly modification.

Determination of Heavy Metals

Approximately 0.2 ml of wells water samples were mixed with 25ml of aqua-regia in a glass digestion tube and heated with microwave machine at 120^{0}C for 3 hours. The digested substance were filtered into 100 mL beaker and the solution was analyzed using Atomic Absorption Spectrometer (AAS) for the presence of Cu, Zn, Fe, Pb, Cd and Cr metals as adopted and described by [22].

Purchasing of Animals (Albino Rats) and Care

A total of twenty 20 albino rats of both sexes of 3 weeks old were purchased from the Department of Biochemistry Usmanu Danfodio Sokoto, Nigeria. The purchased animals were housed in separate cages, kept in a clean environment with a 12hrs light/12hrs dark cycle and fed with food and water ad libitum. Animals received human care and supervision of Veterinary Doctor in accordance with the guide for care and allowed them to acclimatize in the laboratory condition for 10 days. The ethical approval was sourced from Department of Animal and Environmental Sciences, KSUST, Aliero.

Experimental Protocol and Histopathological Examination

A totally of 20 rats were divided into four groups. Group 1 was given distilled water and served as control, while group 2, 3 and 4 were given well water throughout the experimental period (3 weeks). All experimental animals were weight after 7 days each. On the final day of the experiment all the rats were anesthetized, sacrificed and dissected to obtain liver and kidney tissue. Collected organs samples were fixed in 10 % neutralized formaldehyde, processed by embedded in paraffin wax and then stained with hematoxylin and eosin. The stained sections were examined for changes or dilation under a Zeiss Axio scope A1 microscope. Photomicrographs of the tissue sections were taken at different magnifications.

Statistical Analysis

Water parameters were expressed as mean ± SD by ANOVA using version 21 statistical software package.

2. Results and Discussion

From the obtained results, Table (1) shows the different physiochemical parameters values of the analyzed well water samples from 6.36±0.04 value in pH to 430.10±328.73 of Cl which is the highest. Similar parameters were analyzed in river water of Dukku, Kebbi state [11]. Also, majority of the parameters level recorded in these findings were above the [23] recommended permissible limit. This result is comparable to the work of [24] that observed increases and decreases in several physiochemical concentrations analyzed in the Labana waste influent. The NO_3 and SO_4 detected above the acceptable limit agree with the report of [25] who opined that, mean values NO_3 and SO_4 analyzed from stream were above specified limit set by WHO and SON. The closeness of these results findings is probably due to the fact that some pesticides, chemical fertilizers and landfill wastes are used as fertilizers by farmers in these areas. They contained substances that percolated into the soil and altered the original state of underground well water [26]. Nevertheless, the lower concentration of BOD (Table 1) indicated that the well water analyzed is not safe for human drinking. According to Indian water regulatory authority, the permissible limit for drinking water is < 30mg/l [27]. These parameters help in determine water quality and contamination levels for purpose. Well water collected in the study area was found to be neutral (6.36±0.04) as it is less 7.0. [28] water is neutral if it has a pH below 7 and greater that acidic. This is consistent with the findings of [29] who found well water in Yauri and Zuru were within the specific limits set by WHO. Also, the overall pH measured in these findings is closed to 7 which is the standard value.

Physiochemical Parameters

Table 1: Showing Physiochemical Parameters of the Well water Analyzed

Parameters	Values
pH	6.36±0.04
Temp	35.47±0.47
DO	63.70±13.64
BOD	2.57±1.36
Ca	246.39±297.98
Mg	248.08±186.70
Na	288.07±381.17
SO_4^{2-}	394.35±521.18
Cl^-	430.10±328.73
NO_3^-	97.82±72.92
TDS	544.033±407.1511

Values obtained were expressed as mean ± SD.

Heavy Metals

The highest heavy metal concentrations were obtained in Zn (0.840±0.0400), followed by Cu (0.590±0.3996), Pb (0.117±0.1106), Cd (0.077±0.0289) while Cr (0.033±0.0577) was found lowest as seen in Table 2. The results of the present study are similar to those of [30, 31, 29] who found the maximum concentration of heavy metal concentrations in Zinc in well water. Different heavy metals such as Cu, Zn, Pb and Cr have being determined in underground water [32]. This finding is inconsistent with a work of [33] that observed the presence of iron only in dug well water samples in some selected area of Ethiopia. In additional this inconsistence maybe due to the differences of region and human actions that take place within the surrounding.

Table 2: Heavy metals of well water

Parameters	Values
Cu	0.590±0.3996
Zn	0.840±0.0400
Fe	0.063±0.0404
Pb	0.117±0.1106
Cd	0.077±0.0289
Cr	0.033±0.0577

Values obtained were expressed as mean ± SD

Histology of the Liver and Kidney

Figure A1 and B1 representing control groups of rats intake with distilled water during the experiment, show normal liver architecture of central vein (white arrow) and hepatocyte assembly (black arrow) whereas normal glomerulus (black arrows) and Kidney showing renal tubules (red arrow) H & E X 100. A2 and A3 show depiction of a liver with normal portal triad (red arrow), (white arrow) and hepatocytes arrange in cords (black arrow). Fig. B2 and B3 showed dilation of glomerulus (black arrows) above normal size and normal renal tubules (red arrow). Dilation of glomerulus can lead to cancer and adversely affect the health of other associated organs. It has been reported that, 20% cancer cases worldwide and 70% other human disease are associated with drinking polluted water [34]. Several heavy metals are released into the soil by human anthropological agitations that permeate the soil and contaminated groundwater [35] also adversely affects humans and other animals when drinking. Portable water purified for drinking is a major challenge for human populations, especially those leaving in remotes area due to human anthropological activities, resulting in the contamination of ground and surface waters and the environment as a whole.

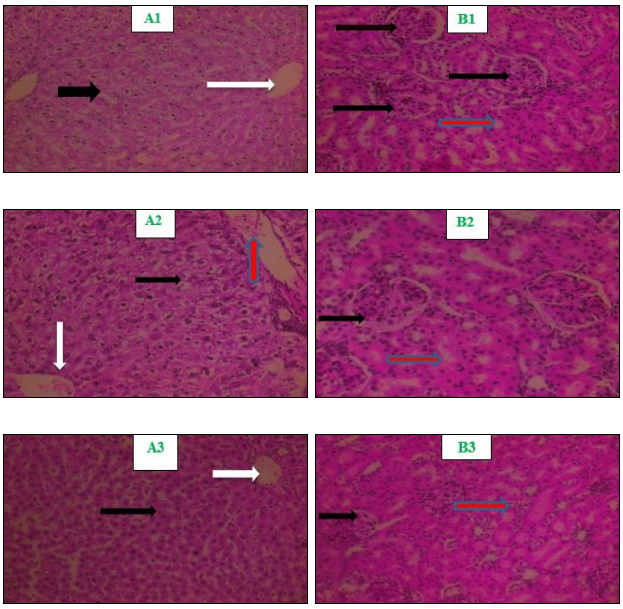

Fig 1: A1 – A3 and B1 – B3 photomicrographs of liver and kidney of experimental animals

3. Conclusion

In conclusion, physiochemical parameters and metals analyzed in well water samples were found above the standard values or below. Also, the photomicrographs show a normal liver condition but the kidney had scarring beyond normal (abnormal condition) which could be due to the accumulation of these parameters. Further studies should be conducted to analyze the vital organs intake with water.

4. References

1. Waghmare TE, Londonkar RL. Study of physicochemical and hematological effects of Bheema river water on Albino rat (Rattus norvegicus). IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT). 2014; 8(5):35-39.
2. APHA. Standard methods for the examination of waste and water, 14th edition. American Public Health Association, Washington D.C, 2012
3. Mico C, Recatala L, Peris M, Sanchez J. Assessing heavy metal sources in agricultural soils of a European Mediterranean area by multivariate analysis. Chemosphere. 2006; 65:863-872.
4. Kidd PS, Dominguez-Rodriguez MJ, Diez J, Monterroso C. Bioavailability and plant accumulation of heavy metals and phosphorus in agricultural soils amended by long-term application of sewage sludge. Chemosphere. 2007; 66:1458-1467.
5. Guala SD, Vega FA, Covelo EF. The dynamics of heavy metals in plant–soil interactions, Ecological Modelling. 2010; 221:8.
6. Muhammad M, Shah T, Khan S. Health risk assessment of heavy metals and their source apportionment in drinking water of Kohistan region, northern Pakistan, Microchemical Journal. 2011; 98:2.
7. Awwad N, El-Zahhar A, Fouda A, Ibrahium H. Removal of heavy metal ions from ground and surface water samples using carbons derived from date pits, Journal of Environmental Chemical Engineering, 2013.

8. Kavcar P, SofuogluA, Sofuoglu SC. A health risk assessment for exposure to trace metals via drinking water ingestion pathway, International journal of hygiene and environmental health. 2009; 212:2.
9. Brainwood MA, Burgin S, Maheshwari B. Temporal variations in water quality of darm dams: impacts of land use and water sources. Agricultural Water Management. 2004; 70:151-175.
10. Verma S, Bourasi SK, Khore N. International Journal of Trend in Scientific Research and Development. 2018; 2: 1107-1110.
11. Abdullahi Muhammad Tilli, Mubarak Aminu, Jibrin Naka Keta, Abdulrahman Sani Kalgo Malik Aminu Imonikhe, Adepoju Oluwaseun Ayobami, Attahiru Muhammad Shagamu. Physicochemical Properties and Diversity of Microalgae in Dukku River, Birnin Kebbi, Kebbi State, Nigeria. International Journal of Scientific Research in Biological Sciences. 2022; 9(2):53-57.
12. Begum A, Krishnas H, Khan I. Analysis of heavy metals in water, sediments and fish Int. J. Environ. Bioener. 2009; 10(2):122-130.
13. Aliyu AK, Birnin Yauri UA, Umar KJ, Isa SA, Nasiru MK. Assessment of physicochemical parameters and heavy metals in ground water from sandy area of Argungu emirate, kebbi state Nigeria. Continental Journal of Applied Science. 2018; 13(1).
14. Musa H, Yakasai IA, Musa HH. Determination of lead concentration in well and borehole water in Zaria, Nigeria. Chemclass Journal, 2004, 14-18.
15. Adelekan BA, Abegunde KD. Heavy Metals Contamination of Soil and Groundwater at Automobile Mechanic Villages in Ibadan, Nigeria**.** International Journal of the Physical Sciences. 2011; 6(5):1045-1058.
16. Machdar E, Van der Steen NP, Rashid-Sally L, Lens PNL. Application of quantitative microbial risk assessment to analyze the public health risk from poor drinking water quality in a low-income area in Accra, Ghana. Science of the Total Environment. 2013; 449:134-142.
17. Adefemi SO, Awokunmi EE. Determination of physico-chemical parameters and heavy metals in water samples from Itaogbolu area of Ondo-State, Nigeria. African Journal of Environmental Science and Technology. 2010; 4(3):145-148.
18. Pink DH. Investing in Tomorrow liquid Gold "Yahoo", 2006.
19. West L. World water Day; A Billion people World Lack Safe Drinking Water, 2006.
20. Statistical Year Book. Research and Statistics Department, Ministry of Budget and Economic Planning, Birnin Kebbi, Kebbi State, 2007, p8.
21. WHO. Guidelines for Drinking Water Quality. Health Criteria and other Supporting Information. 2nd Edition, WHO, Geneva, 1996: p271.
22. Yahaya T, Doherty VF, Akinola OS, Shamsudeen A. Heavy metal profile and microbial counts of selected sachet water brands in Birnin Kebbi. Ife J Sci. 2019; 21(1):229-234.
23. World health organization, guidelines for drinking water quality, world health organization Ganeva, Switzerland, 2008.
24. Yahaya T, Aliero AA, Oladele E, CDO Nathaniel, J., and MZ, A. Concentration and Cytogenotoxicity of Heavy Metals and Microorganisms in Labana Rice Mills Wastewater Birnin Kebbi, Northwestern Nigeria. Nigerian Research Journal of Engineering and Environmental Sciences. 2021; 6(1):216-225. Doi: http://doi.org/10.5281/zenodo.5048285
25. Otone BB, Alfred Ockiya JF, Amadi F. Physicochemical parameters of zooplankton c ommunity structure Okamin stream, Porthacourt, Nigeria. International Journal of Research and Innovation in Applied Science. 2019; 4(10):100-107.
26. Tesfalem N, Tesfamariam A, Okbaslasie A, Tesfay K. Physico-chemical Analysis of Groundwater Around MaiBela, Asmara, Eritrea. American Academic Scientific Research Journal for Engineering, Technology, and Sciences. 2019; 57(1):161-186.
27. B.I.S. Bureau of Indian Standards Drinking water specification, Ist revision, 2012; ISS 10500.
28. Rodier J. The analysis of water" DUNOD. Paris, France. 2009; 1579.
29. Yahaya T, Ologe O, Yaro C, Abdullahi L, Abubakar, H, Gazal, A, *et al*. Quality and Safety Assessment of Water Samples Collected from Wells in Four Emirate Zones of Kebbi State, Nigeria. Iranian (Iranica) Journal of Energy and Environment. 2022; 13(1):79-86.
30. Farimani Raad H, Alireza P, Hamidreza K. Carcibnpgenic and non-carcinogenic health assessment of heavy metals in ground drinking water wells of Bandar Abbas. Pollution. 2021; 7(2):395-404.
31. Yahaya TO, Oladele EO, Fatodu IA, Abudulazeez A, Yeldu YI The concentration and health risk assessment of heavy metals and microorganisms in ground water of Lagos, southwest Nigeria. Journal of environmental health research. 2020; 8:332-342.
32. Dibal, Ishaku J, Odiana S. Water quality assessment of selected boreholes in Biu local government area of borno state, Nigeria. NUAB journal of science and Technology. 2021; 1:166-175.
33. Gebresilasie KS, Berhe GG, Tesfay AH, Gebre SE. Assessment of some physicochemical parameters and heavy metals in hand-dug well water of Kafta Humera Woreda, Tigray Ethiopia. International journal of Analytical chemistry, 2021, 1-9.
34. World Health Organization. Retrieved December 31, 2020, from: https://www.who.int/publications/i/item/9789241549950. 2020
35. Tayebi L, Sobhanardakani S. Analysis of Heavy Metal Contents and Noncarcinogenic Health Risk Assessment through Consumption of Tilapia Fish (*Oreochromis niloticus*). Pollution. 2020; 6(1):59-67.