TETFUND TERTIARY EDUCATION TRUST FUND

CHEMICAL SCIENCES

PRELIMINARY ASSESSMENT OF HEAVY METALS AND WATER QUALITY OF SELECTED WELLS IN TALATA MAFARA, ZAMFARA STATE, NIGERIA

[1]Zubairu, A.Y. , [1]Mukhtar, M., Sokoto, A.M. [2]Zubairu, A. and [3] Ladifa, H.M.
[1]Department of Pure and Applied Chemistry, Usmanu Danfodiyo University, P.M.B, 2346, Sokoto, Nigeria.
[2]Department of Biochemistry, Kebbi State University of Science and Technology, P.M.B. 1144, Aleru, Nigeria.
[3]Department of Pure and Industrial Chemistry, Bayaro University, P.M.B. 3011, Kano, Nigeria.

Corresponding Email: aminuyakubuzubairu@gmail.com

Manuscript received:18/11/2016 Accepted: 30/12/2016 Published: December, 2016

ABSTRACT

Contamination of drinking water source by pollutants is one of the major problems affecting rural areas in developing countries like Nigeria. Accessibility of high-quality water is necessary for preventing diseases and improvingquality of life. Well water is the main source of drinking water in Talata Mafara, Zamfara State, Nigeria.Well water samples collected from two major locations, Tashar Kali (TKM) and Yarkurna area (YAM)ofTalata Mafara metropolis of Zamfara State, Nigeria were assessed for heavy metal concentration using atomic absorption spectroscopy (AAS). Also, a physicochemical analysis was carried out using standard procedure of water analysis approved by Association of Analytical Chemist and American Public Health Association. The results obtained revealed that both samples have neutral pH of 6.8, Turbidity of (3.23 and 5.46 NTU), electric conductivity of (29.5 and 29.6μ/cm), Phosphate (0.12 and 0.13mg/L), Temperature (21 and 21^{O}C), TDS (1.5 and 1.7ppt), B.O.D (0.1 and 0.3mg/L), C.O.D (2.397 and 3.196mg/L) and D.O (4.0 and 2.0mg/L). The concentrations of heavy metals obtained were Cd 219μg/ml and ND, Cr 0.954 and 0.587μg/ml, Fe 1.948μg/ml and ND, Pb 0.587 and 0.158μg/ml, Mn 0.159 and 0.052μg/ml, Ni 6.620 and 3.104μg/ml, more over Cu, Se,and Zn were not detected in the both samples respectively. the results obtained are compared with the National standard (NSDWQ 2007) and International standard (WHO 2011), The research recommended that the Government should provide some water treatment agencies in the study areas to reduce the level of heavy metals in the water for safety purpose in terms of drinking and domestic uses.

Keywords: *Heavy metal; Talata Mafara; Tashar kali; Water pollution;Well water; Yarkurna.*

INTRODUCTION

Water is an important factor for survival of any human being and animals. Globally quality of portable water is major concerns for environmental, public health and domestic used (Maria *et al.*, 2016).

The ecological circumstances within water bodies are frequently altered as a result of differences in nature and anthropogenically persuaded dynamics. Moreover water superiority is definitely exaggerated from the origin of the water, rate of movement, proximate composition and population of algae. Additional features like sewage and agricultural run offs, different harmful chemicals and natural contaminants like (animal faeces) contact the natural origins of water bodies and as well pollute the ground water. Heavy metals are believed to be the major source of water pollution as they are non-biodegradable andcan destroy human and animal organs(Elsayed *et al.*, 2015).

Almost all the sources of water are surrounded by heavy metals.N Heavy metals from anthropogenic behavior may possibly roam or penetrate into aquifers and mingle with groundwater (Fahad, 2015).

Heavy metal pollution within human organs have turned out to be a critical hazardsince they are non-biodegradable and can cause contemporary health challenges like environmental tumors. Metalshave been organized and moved into food webs due to the leaching from waste deposits, contaminated soils and water. The metals enhance in absorption within each stage of food chain and are moved to the subsequently advanced stage, an event described as bio-magnification. The pollution of water through matters that contain serious consequences to human beings, animal and plant is called water pollution(Khairia, 2015).

Water pollution is a global crisis also to organize such problem has developed addicted to progressively more vital in current years. Urban or industrialized runoff extravagances by waste water management plants include many quantities of organic matter and contaminants counting metals like Cu, Zn, Cd and Pb etc. The uptake of metals by sludge flocks is among critical consequence in pollution control (Khairia, 2015).

Almost the entire forms of water are surrounded by heavy metals; numerous of this occurs as result of the natural weathering of the globe. Additionally, wastewater utilized for irrigation land, as well as runoff from city sewage and industrialized wastewater, possibly will considerably influence water purity. Heavy metals from anthropogenic behavior may possibly roam or penetrate into aquifers and mingle with groundwater (Fahad, 2015).

Nickel (Ni) is generally used in recent industry. Its more expose in human beings cause inflame considerable effects as well as the lung, cardiovascular and kidney illness. Additional consideration been paying attention on the toxicity of Ni since it can proceed to allergic reactions and its positives compounds could be carcinogenic. Ni and various heavy metals go into in water bodies by the means of natural process from dissolution of rocks and soils, biological cycles, atmospheric fallout, mainly from industrial practices and disposal of waste batteries produce from Ni–Cd and pigments, electronic products, deposit electrode and at the same time as catalyst involve in hydrogenation reactions, which may boost the correlation of this element (Naeemullah *et al.*, 2014).

Iron and copper are vital bioelements, moreover there are important to their biological function and there are essential elements for body growth and besides there areharmless when found in excess than the standard limit require in the body (Jamal 2012).

Cadmium and lead are also recognizedwith highly poisonous consequence moreover is not considered as important element for human being and identified to be element injurious organs like kidneys, liver, and lungs. It is already identified that cadmium gathers in liver and kidneys and the small of this element in human body is within one and four decades,in contact to lagerquantity of cadmium can effect destroyed to the central nervous and immune systems as well as to infertility confusion and rate of unusual cancer categories (Sezgin *et al.*, 2013).

Chromium is highly toxic which was released into the environment in a hugeamountmostly from metal finishing industry, petroleum refinery, leather tanning, iron and steel industries,which led to serious risk to human health. Nearly every one of the industrial wastes contains chromium which is current in hexavalent form as chromate (CrO_4^{2-}) and dichromate ($(Cr_2O_7^{-2})_2$. This species is very toxic to plant and animal. Therefore drinking contaminated water with Cr (iv) causes lung cancer, respiratory problems, bronchitis and various cause on body immunity system (Vinuth *et al.*, 2015).

Lead is very toxic heavy metal, its affect organs like bones, brain, blood, kidneys, and thyroid glands. Existence of lead within release and poisonous nature proceed to additional difficult problems on receiving waters in aquatic system. Even at very little concentration of heavy metals in water is extremely toxic to aquatic life. The main origin of lead and cadmium in water are the waste matter of processing industries like electroplating, paint, pigment, basic steel work, textile industries, metal finishing and electric accumulators' batteries (Khairia 2015).

As a result of the harmful and poisonous effects of iron, copper, lead and cadmium, it is essential to determine and observe their content in water nowadays (Jamal 2012).

Heavy metals pollution corresponds to a critical difficulty as these metals leach into ground water or soil, which isharmful to human health. Ground water pollution is an outcome of numerous activities like chemical manufacturing, painting and coating and mining. Metals apply a toxic effect on fauna and flora of lakes andstreams (Hanuman *et al*., 2012).

Due to high toxicity of heavy metal in our source of water, which led to serious havoc to human health as well as affecting the environmental sustainability in any given society,thus, aimedto preliminary investigation of heavy metal in well water samples of Talata Mafara which was one of the major source of water for drinking and domestic used in the area.

MATERIALS AND METHODS

The samples of well water were obtained from two major locations of Talata Mafara metropolisof Zamfara State, Nigeria. These were collected in four polyethylene bottles each containing two liters.All samples were collected at the same time; the bottles were earlier washed with 10% HNO_3 for 48h before collecting the samples in order to avoid loss of metals. The rubber bottles were labeled instantly as sample TKM and sample YAM.

Where

- *TKM = water sample collect from well at Tashar Kali behind Model Primary School TalataMafara.*
- *YAM = water sample collect from Yarkurna area TalataMafara.*

50 cm^3 of each water sample was transfer into evaporating dish, 10cm^3 conc. Nitric acid (HNO_3) were added for each sample, the samples were place on stem bath to evaporate 25 cm^3, the samples were transfer to sample bottle, follow by addition of distilled water up to 50cm^3 mark the preparesamples were taking to an AAS machine for analysis or determination (Fahad 2015)

Heavy metals were analysis using a Perkin Elmer model 306 Atomic Absorption spectrophotometer at Usman Danfodiyo University Central laboratory.

All the physicochemical analysis were carried out according to standard analytical methodsof analysis approved byAssociation of Analytical Chemist (AOAC 2005) and Standard methods for the examination of water and waste water approved by American Public Health Association APHA (2005).

The pH, of the samples were measured immediately after sample collection using pH meter, while Analysis for total dissolved solid (TDS) and turbidity were determined using model 1000 TDS scanner and model 2100p turbidity meter HACH, USA(AOAC 2005).

Temperature of water samples were also measured at the support of collection using thermometer (AOAC, 2005).

The phosphate was determined using the following process, after the preparations of the samples were poured into cubed and inserting into spectrophotometer to take the absorbance at 660 wavelengths. The percentage of phosphate was calculated using the equation reported by AOAC (2005)and APHA (2005) In Lawal *et al*., (2015).

Chemical oxygen demands (C.O.D) were determined using appropriate procedure reported by winklers and calculated using the equationin Lawal *et al*., (2015) (AOAC 2005).

Dissolved oxygen (DO) was determinedinitially and finally after 5-days incubation at 25^oC, using the model 2002 filter HACH, which ledto the computed of biochemical oxygen demand (BOD) from the relation between them, this was achieved using procedure reported by winklers, AOAC (2005) In Lawal *et al*., (2015).

RESULTS AND DISCUSSION

Table 1: Results of Physicochemical Analysis

Parameters	Result (TKM)	Result (YAM)	WHO Guidelines for drinking 2011
B.O.D (mg/L)	0.1	0.3<5	
C.O.D (mg/L)	2.397	3.196	5.0
E.C (μ/cm)	29.5	29.6	1400
D.O (mg/L)	4.0	2.0	<5
Temperature (^OC)	21	21	273
TDS (ppt)	1.5	1.7	500
Turbidity (NTU)	3.23	5.46	1000
pH	6.86.8	6.5-9.5	
Phosphate (mg/L)	0.12	0.13	50

Table 2:Results of AAS Analysis

Element	Symbol	Result (TKM)	Result (YAM)	WHO Guidelines for drinking 2011
Cadmium	Cd	0.219	ND	0.05
Copper	Cu	ND	ND	0.05
Chromium	Cr	0.954	0.587	0.05
Iron	Fe	1.948	ND	0.3
Manganese	Mn	0.159	0.052	0.1
Nickel	Ni	6.620	3.104	0.07
Lead	Pb	0.587	0.158	0.01
Selenium	Se	ND	ND	0.04
Zinc	Zn	ND	ND	5.00

The results are compared with NSDWQ 2007 and WHO 2011.

Keys: **NSDWQ** *= Nigerian Standard for Drinking Water quality 2007*
WHO *= World Health Organization 2011*
Unit of concentration = μg/ml.

The biological oxygen demand (BOD) were found to be 0.1mg/l and 0.3mg/l for sample TKM and YAM, all results where bellow the maximum allowable limit (MAL<5mg/l) required by (WHO 2011) and (NSDWQ 2007). The result BOD where compute from the relationship between initial dissolved oxygen (DO0) and final dissolved oxygen (DO1).The biological oxygen demand (BOD) is used to measure ecological organics.

Chemical oxygen demand (COD)were found to be 2.397mg/l and 3.96mg/l for sample TKM and YAM which are lower than the maximum allowable limit (MAL 5.0mg/l) required by (WHO 2011)and (NSDWQ 2007).

The dissolved oxygen (DO) were obtained to be4.2 and 2.6, sample TKM and YAM, all results where bellow the maximum allowable limit (MAL<5mg/l) required by (WHO 2011)and (NSDWQ 2007).

In general dissolved oxygen, biochemical oxygen demand and chemical oxygen demand are essential parameters which assist environmental scientists and engineers to make vital decisions about how to handle the treatment of waste water generally.

Electrical conductivity (EC) were obtained to be 29.5(μ/cm) and 29.6(μ/cm) for sample TKM and YAM, the results were obtained bellow the maximum allowable limit(MAL 1400μ/cm) required by (WHO 2011) and (NSDWQ 2007).

Temperature was observed to be 21 and 21 for sample A and B, the results are below the maximum allowable limit (MAL273^{O}C) required by (WHO 2011) and (NSDWQ 2007).

Total dissolved solids (TDS) was observed to be.5mg/l and 1.7mg/l for sample TKM and YAMthe results were found bellow the maximum allowable limit (1000mg/l) required by (WHO 2011)and (NSDWQ 2007).

Turbidity was 3.23NTU and 5.46NTUfor samples TKM and YAM andthe results were found to be below the maximum allowable limit (25NTU) required by (WHO 2011)and (NSDWQ 2007).

The pH valueswas found to be 6.8 and 6.8 for sample TKM and YAM were within the maximum allowable limit (6.5-9.5) required by (WHO 2011)and (NSDWQ 2007).

All the physicochemical analysis were obtained within the maximum allowable limit for water quality index approved by Word Health Organization (2011) and benchmark of Nigerian Standard for Drinking Water Quality (2007).

The concentrations of Cadmium Cd in the water samples obtained are presented in Table 2.The levels of cadmium found in sample (TKM) was found to be 0.219μg/ml this was above the detection limit approved by (WHO 2011)and (NSDWQ 2007) while in sample (YAM) was found no any amount of cadmium concentration.Cadmium is a poisonous and carcinogenic metal. The main sources of cadmium publicity are cigarette smoke, food intake (shellfish, offal and certain vegetables), and ambient air, mostly in urban areas and in the surrounding area of industrial settings as well as those found in surface water (Jamal, 2012).The high concentration of cadmium found (0.219μg/ml) in sample (TKM) found above the required limit, when drink without undergoing any special treatment will lead to injurious of organs e.g. (kidneys, liver, and lungs) and other (Sezgin *et al.*, 2013).

Copper was found not detected in all water samples,this indicate that there is no any copper infectivity in the samples. Copperare important to several physiological processes(Rita et al., 2015).

Chromium (Cr) was foundto be higher in all samples,0.954μg/ml and 0.589μg/ml founds in sample TKM and (YAM) were above the maximum allowable limit(MAL 0.05μg/ml) required for drinking purpose by (WHO 2011)and (NSDWQ 2007).Even do chromium Cr species with oxidation state (+3) is an important biological metal that participate in plants and animals metabolism (Vinuth *et al.*, 2015), but higher concentration of chromium insample can affect the human health as well as environment (Vinuth *et al.*, 2015).

Iron (Fe) was found not detected (ND) in sample YAM but, 1.948μg/ml was found in sample TKM, this was above the maximum allowable limit(MAL 0.3μg/ml) approved by (WHO 2011)and (NSDWQ 2007).

Manganese (Mn) was obtained to be 0.05μg/ml for sample YAM within the range (MAL 0.1μg/ml) approved by (WHO 2011) and (NSDWQ 2007), while 0.159μg/ml found higher in sample TKM of well water which was above the maximum allowable limit (MAL 0.1μg/ml) approved by (WHO 2011)and (NSDWQ 2007).

Nickel (Ni) was found to be 6.620μg/ml and 3.104μg/ml for sample TKM and YAM the results were founds abovethe maximum allowable limit (MAL 0.07μg/ml) approved by (WHO 2011)and (NSDWQ 2007).It has been reported that Nickel (Ni) is generally used in present industry. Its more publicity in human beings can inflame considerable effects as well as the lung, cardiovascular and kidney diseases (Naeemullahet al., 2014).

Lead (Ph) was found to be high in all samples 0.587μg/ml and 0.158μg/ml for sample TKM and YAMthe results exceeds the maximum allowable limit (MAL 0.01μg/ml) approved by (WHO 2011) and (NSDWQ 2007), high toxicity of lead in water sample can destroyed nervous links, particularly in young children's and cause high blood pressure and brain disarrays (Jamal 2012).

Selenium(Se) was not detected (ND) in all samples. The maximum allowable concentration of Selenium(Se) is (MAL 0.04µg/ml) approved by (WHO 2011)and (NSDWQ 2007).

Zinc (Zn) was not detected (ND) in all samples. The maximum allowable limit ofZinc (Zn)(MAL 5.00µg/ml) required by (WHO 2011)and (NSDWQ 2007).

Although, such heavy metals as manganese, zinc and copper in small amount are essential for the physiological functions of living tissue and control many biochemical processes (Fahad 2015).

CONCLUSION

From the results obtained in this research, high concentration ofCadmium Cd, Chromium (Cr), Iron (Fe), Manganese (Mn),Nickel (Ni) and Lead (Pb) were available in the samples. The heavy metals are known to promote pollution of the water. It istherefore worth noting that the well water is not a good source of drinking water or for domestic use even thoughthe physicochemical analysis was moderate. The Government should promote the establishment of some water treatment agency in the study areas to control the level of heavy metals in the water.

It is recommended that further research to be carried out in the area of study, in order to determine the presence of other heavy metals such as Mercury (Hg), Cobalt (Co), Arsenic (As) or Silver (Ag),which have been reported to be among the heavy metals that pollute the environment and negatively affect human health.

ACKNOWLEDGEMENT

We acknowledgement the efforts ofProf. Abdullahi Abdu Zuru and Prof. Sani Muhammad Dangoggo of the Department of Pure and Applied Chemistry, Usmanu Danfodiyo University, Sokoto, Nigeria for their support throughout the research.

REFERENCES

AOAC,(2005). *Official method of analysis*.15th edition, Association of analytical Chemist,Washington DC. 11-14.

APHA,(2005). *Standard methods for the examination of water and waste water.* 21stediton,American Public Health Association, Washington DC, USA.

Elsayed, M. Y., Nasser A. A., Abdel-Wahab A. A., and Abdullah A. A.,(2015). Seasonal Variations in the Body Composition and Bioaccumulation of Heavy Metals in Nile Tilapia Collected From Drainage Canals in Al-Ahsa. Saudi Arabia. *Saudi Journal of Biological Sciences*. 22: 443–447.

Fahad, N. A.,(2015). Assessment of the Levels of Some Heavy Metals in Water in Alahsa Oasis Farms, Saudi Arabia, with Analysis by Atomic Absorption Spectrophotometry. *Arabian Journal of Chemistry*. 8: 240–245.

FEPA,(2003). Guideline and Standards for Environmental Pollution and Control in Nigeria. Federal Environmental Protection Agency, Nigeria.

Hanuman, R. V., Prasad, P. M. N., Ramana, R. A. V. and Rami, R. Y. V.,(2012). Determination of Heavy Metals in Surface and Ground Water in and Around Tirupati, Chittoor (Di), and Hra Pradesh, India. *Der Pharma Chemica*. 4(6): 2442-2448.

Jamal, A. M.,(2012). Determination of Iron, Copper, Lead and Cadmium Concentrations in Rain Water Tanks in Misurata Libya. *Journal of Science and Technology.* 2(8): 7225-7217.

Khairia M. A.,(2015). Water Purification Using Different Waste Fruit Cortex for Heavy Metals Removal. *Journal of Taibah University Science*. 15: 1-24.

Lawal, A. M., Galadima A., Mukhtar, M., Zubairu, A. Y., Saidu, I., Isa, Z. I.and Nasiru, Y.,(2015). Evaluation of Heavy Metals Concentration in Borehole Water from Talata Mafara Metropolis, Zamfara State, Nigeria. *International Journal of Science for Global Sustainability.* 1(1): 69-74.

Maria, J. W., Chad, T. J. and Loring, F. N.,(2016). The assessment of water use and reuse through reported data: A US case study. *Science of the Total Environment*,539: 70-77.

Naeemullah, Tasneem, G. K., Hassan I. A., Faheem, S., Sadaf, S. A., Kapil, D. B., Jamshed, A., and Mariam, S. A.,(2014). Simultaneous determination of silver and other heavy metals in aquatic environment receiving wastewater from industrial area, applying an enrichment method. *Arabian Journal of Chemistry.* 8: 1878-5352.

NRC,(2012). National Research Council. Water Reuse: Potential for Expanding the Nation's Water Supply through Reuse of Municipal Wastewater. The National Academies Press.

NSDWQ,(2007). Nigerian Standard for Drinking Water Quality. Nigerian Industrial Standard NIS 554. *Standard Organization of Nigeria.* Pp: 30.

Rita, M., Sara, B. P., Marianna, M., Rui, F., Arlete, S., Caroline, A. E., Roberto, D. P., Phillip, C. W and Paula, T., (2015). Effects of heavy metals on Cyanothece sp. CCY 0110 Growth, Extracellular Polymeric Substances (EPS) production, Ultrastructure and Protein Profiles. *Journal of Proteomics*. 120: 75-94.

Sawyer, C. N., McCarty, P. L., and Parkin, G. F.,(2006). *Chemistry for Environmental Engineering and Science*, 5th Edition, Tata McGraw-Hill Put. Coy. Ltd, New Delhi.

Sezgin, B., Tolga, Y., Nihan, T., Mehmet, D., Kemal, A. F., Onur, M., and Abdullah, K.,(2013). Determination of As, Cd, and Pb in Tap Water and Bottled Water Samples by Using Optimized GFAAS System with Pd-Mg and Ni as Matrix Modifiers. 2013: 7.

Tommy, M. P. and Alfonds, A. M.(2015). Heavy Metals in Water of Stream Near an Amalgamation Tailing Ponds in Talawaan-Tatelu Gold Mining, North Sulawesi, Indonesia. *Procedia Chemistry.* 14: 428-436.

UNWater,(2007). *Coping with water scarcity*.Challenge of the twenty-first century.

UNESCO,(2000). *Ground Water Pollution*. International Hydrological Programme. Guidelines for drinking water quality, 4th edition, WHO, 2011.

USEPA, (2012). *IRIS US Environmental Protection Agency*. Intergrated Risk Information System, Environmental Protection Agency Region I, Washington DC 20460. Accessible on line at http://www.epa.gov/iris/

USEPA,(2015). United State Environmental Protection Agency, 2012b. Discharge Monitoring Report (DMR) Pollutant Loading Tool. Accessed 17 August 2015 at http://cfpub.epa.gov/dmr/.

USEPA,(1995). *Method* 1638: Determination of Trace Metals in Ambient Waters by Inductively Coupled Plasma-Mass Spectrometry, EPA 821-R-95031. Washington, DC.

USNWIS, (2015).*United State National Water Information System*, 2002. NWISWeb, New Site for the Nation's Water Data. U.S. Dept. of the Interior, U.S. Geological Survey, Reston, Accessed 17 August 2015 at http://waterdata.usgs.gov/nwis

Vinuth, M., Bhojy-naik, H. S., Chandra-sekhar, K., Manjanna, J., and Vinoda, B. M.,(2015). Environmental Remediation of Hexavalent Chromium in Aqueous Medium Using Fe (II) – Montmorillonite as Reductant. *Procedia Earth and Planetary Science*. 11: 275-283.

WHO,(2008). Guideline for Drinking-water Quality. 3rd edition. Incorporating 1stand 2nd Agenda, Recommendations. Geneva, 1: 668.

WWD 2015. World Water Day. Accessed 12 February 2015 athttp://www.fao.org/nr/water/docs/escarcity.pdf.

Yang, C. L., Guo, R. P., Yue, Q. L., Zhou, K., and Wu, Z. F., (2013). Environmental Quality Assessment and Spatial Pattern of Potentially Toxic Elements in Soils of Guangdong Province, China. *Environ. Earth Sc*. 70: 1903-1910.