Ilorin Journal of Science
Volume 1, Number 2, 2014, pp. 289–300 (Printed in Nigeria)
ISSN: 2408 – 4840 © 2014 Faculty of Physical Sciences, University of Ilorin
https://doi.org/10.54908/iljs.2014.01.02.005

ILORIN
JOURNAL OF SCEINCE

ILJS-14-020

Status of some trace elements in water samples from University of Ilorin Campus

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Abstract

This study was carried out to monitor the quality of the drinking water in University of Ilorin (UNILORIN) main Campus. Water samples were collected from seven different sources within the University Main Campus, which include a ground water (borehole), untreated surface water and tap water (treated surface water). The metals investigated were Copper (Cu), Manganese (Mn), Zinc (Zn), Iron (Fe) and Lead (Pb). Total Cu concentration ranged from 0-0.04 mg/L, total iron concentration from 0.12-3 mg/L and Zinc concentration from 0.02-35 mg/L. Manganese concentration was within the range of 0.2-3.8 mg/L. No trace of Lead was discovered in the water samples. The Zn value for most samples was below WHO and the Nigerian Standards of 3 mg/L. The ground water sample was found to be the least polluted, thereby making it suitable for drinking. The treated water samples were also within the laid down limits, with a minimal level of pollution while the untreated surface water sample was recorded as the most polluted water sample and unfit for drinking.

Keywords: Heavy metals; drinking water; Unilorin dam, pollution.

1. Introduction

The trace contaminants are the pollutants that occur in minute quantities. Their concentrations usually is in the order of 0.1 mg/L. Trace elements do have a high tendency for causing terrible health effects and thus pose a high threat to public health (Mane et al., 2013). Pollution in surface and groundwater system through human activities and natural processes enter easily into reservoir water. In order to make safe the best use of water resources, it has become imperative to carry out an assessment and analysis of their magnitude, distribution, and moreover their scopes of utilization (Kataric and Singh, 2006).

Dams are important structures from the environmental effects point of view. It has been proven that sediments entering a dam reservoir contain materials from neighbouring geological formations and organic substances from plants and animal decomposed in water

(Barretto *et al*., 2008).

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In aquatic environments, metal pollution has been a serious problem and this can be attributed to both natural and anthropogenic factors (Forstner *et al*., 1990; Hart *et al.*, 1991; Schuurmairn and Market, 1998). Thus, investigation of water quality is important to evaluate metal concentration, since it provides useful information on pollution level in reservoir. Similar work has been carried out on dam reservoirs by various researchers including Priju and Narayara (2007), Opuene *et al*. (2008), Al-Juboury (2009), Kho *et al*. (2009) and Taghinia Hejabi *et al.* (2010).

The aim of this study is to determine the concentrations of Cu, Mn, Zn, Fe and Pb in ground water (borehole), an untreated surface water and tap water (treated surface water) in University of Ilorin in order to evaluate the quality of the water to ascertain whether the obtained concentrations are within the acceptable standard limits.

2. Materials and Methods

Chemical and reagents

All chemicals and reagents used in this research were of analytical grade and all glass wares were thoroughly pre-treated and washed with deionised water before use. The standard solutions were prepared and kept in the refrigerator prior to analysis.

Study Area

The University of Ilorin is one of the institutions of higher learning established by a decree of the Federal military government in August 1975. It is situated in Ilorin, Kwara State, North Central Nigeria. The University campus, which is about 15,000 hectares, is located within latitude $8°30^1$N and longitude $4°35^1$ E and altitude 307.5 m. The sample collection sites are listed below and can be traced out in the University road map shown in Figure 1. Location A: Rising Main (pipe carrying raw water from the dam to the treatment site).

This is located within the University of Ilorin water treatment station. Location B: Booster plant. This is also located within the premises of University of Ilorin water treatment station. Tap water were collected from the following locations; Location C: Village II Female Hostel; Location D: Male Hostel; Location E: School Clinic; Location F: Chemistry Department; Location G: Borehole (beside the Senate Building).

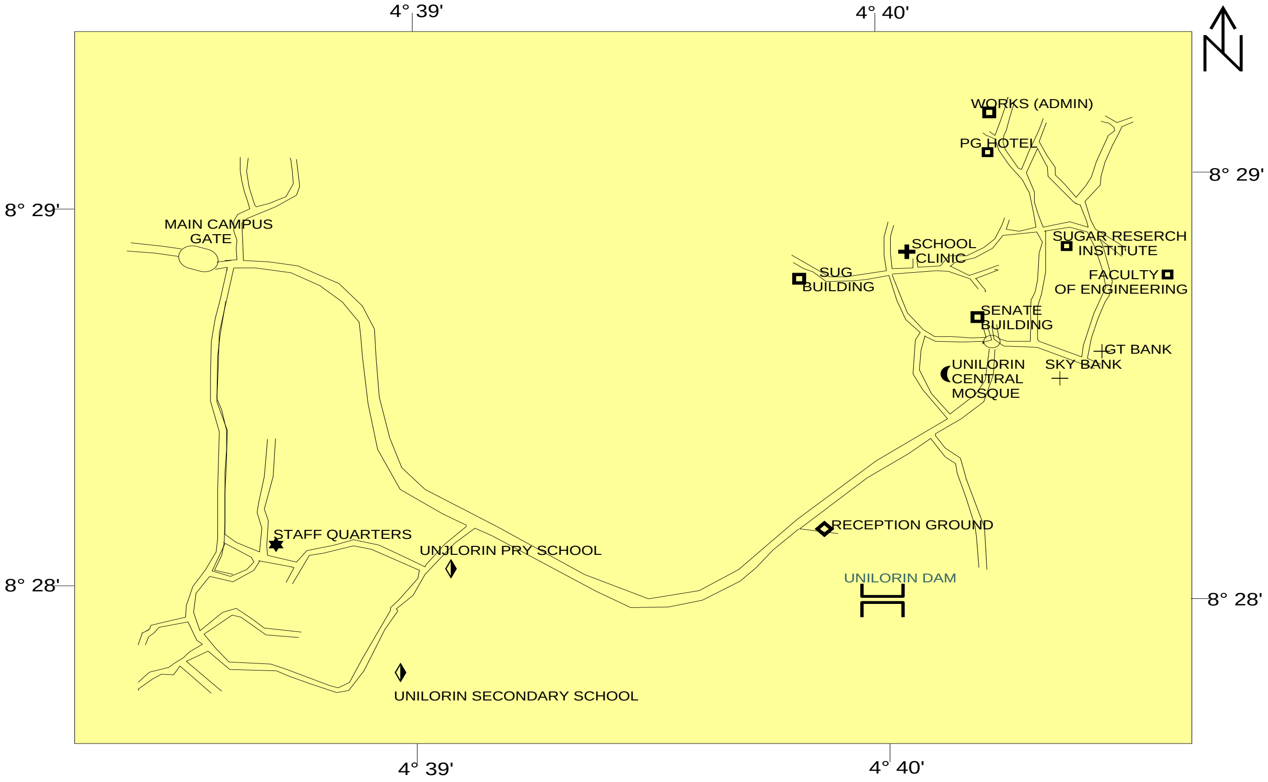

Fig. 1.0: A Road Map of Unilorin showing the sample collection points

Sample Collection

Twenty one samples were collected from seven different locations within University of Ilorin, campus at specific intervals (February, April and May) to check their seasonal variations. The samples were collected in polyethylene bottles previously washed with detergent, rinsed with distilled water, dilute nitric acid and finally with distilled water. (Soylak *et al.*, 2002) Before each sample was taken, the tap was allowed to run for about two to three minutes to remove possible impurities in water flowing through the pipes (Krishna, 2012). The bottles were rinsed with the water sample before the actual water sample was collected.

Determination of trace metals

100 ml of well mixed water sample was measured into a beaker. 2 ml of concentrated nitric acid (HNO_3) and 5 ml of concentrated hydrochloric acid (HCl) were added respectively. The sample was covered with a watch glass and heated on a hot plate till the final volume was about 15 to 20 ml. The remaining content of the beaker was filtered into a 100 ml standard

volumetric flask and it was made up to 100 ml with distilled water (Okoro, 2012) the concentration of the trace metals was then determined with Atomic Absorption Spectrophotometer (AAS).

3. Results and Discussion

The results of the trace metal analysis of the water samples taken within the months of February to May, 2013 in University of Ilorin (Unilorin) Campus are presented below. The metals analysed were Fe, Cu, Pb, Mn and Zn respectively. High level of lead causes health problems like cancer, anaemia, interference with Vitamin D metabolism. It affects mental development in infants and is toxic to the central and peripheral nervous systems etc. (National Academy of Science, 2009). It was not detected at all in this present study. High values of lead in river water samples may be caused by run-off water from residential areas or waste from domestic work like paints. However, most of the water samples used for this present study is treated, except the untreated surface water from the dam. Convectional water treatment procedures remove a significant amount of lead.

Iron is the most abundant element by weight in the crust, it occurs in water in its ferric and ferrous states, particularly in well-aerated conditions (USEPA, 2004). The EPA standards for drinking water classified Fe and Mn presence under the Secondary Maximum Contaminant (SMCL) Standards. According to Adekola *et al*. (2013), the Secondary Standards are based on taste, odour, colour, corrosive foaming and staining properties of water. The SMCL for iron in drinking water are 0.2 mg/L and 0.05 mg/L.

The Nigerian standard for Fe and Mn are 0.2 mg/L and 0.3 mg/L respectively. The Fe concentration in the untreated surface water sample collected in February, April and May are 3.0 mg/L, 0.95 mg/L and 7.02 mg/L respectively, while the ranges of the Fe concentration for the treated surface water are 0.25-0.4 mg/L, 0.14-0.64 mg/L and 0.32-2.36 mg/L respectively for the same period. The Fe concentration for the ground water samples collected in February, April and May are 0.39 mg/L, 0.12 mg/L and 0.41 mg/L respectively. The level of deviation of Fe in all the samples is very high compared with EPA standard (0.3 mg/s). This may be due to Fe coming from the leaching of underlying bedrock which is mainly ferromanganese mineral. The Fe concentration of the water samples collected in early February, April and May are represented in Table 2.0 and Figure 2.0 respectively.

Table 1.0: Drinking water standard and health effects of metals investigated

Metals	SDWR 2012	SON 2007	WHO 2006	HEALTH EFFECT
Iron	0.3	0.3	0.3	Hemochromatosis
Manganese	0.05	0.2	-	Neurological disorder
Zinc	5	3.0	0.5	Zinc overloads reduce body's immune function, and reduce HDL (good cholesterol) level.
Copper	1.0	1.0	0.05-1.50	Gastrointestinal disorders

Table 2.0: Iron ion concentration for water samples collected within Unilorin Campus in early February, April and May 2013

Samples	February (mg/L)	April (mg/L)	May (mg/L)
SW	3.00	0.95	7.02
GW	0.39	0.12	0.41
TW1	0.28	0.14	0.53
TW2	0.25	0.38	0.4
TW3	0.40	0.23	0.32
TW4	0.28	0.17	0.54
TW5	0.31	0.64	2.36

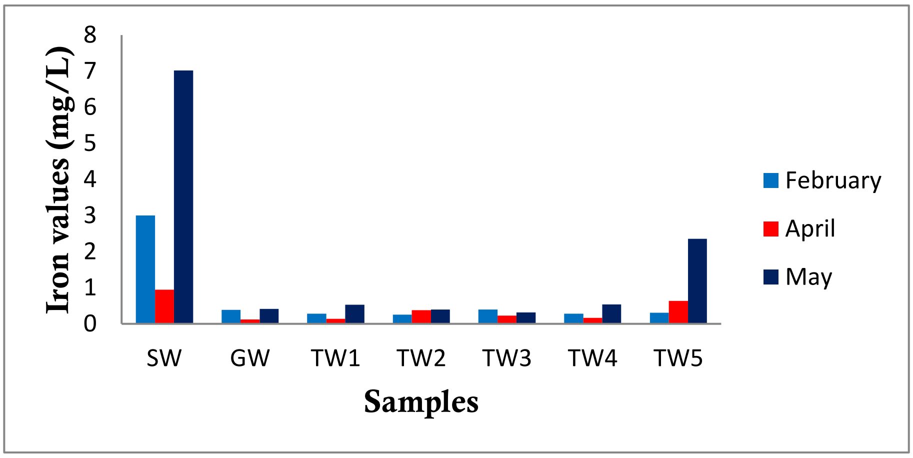

Fig 2.0: Distribution of Fe in the water samples collected within Unilorin main Campus in early February, April and May, 2013 respectively.

The health impact of drinking water with high Mn concentration is the incidence of neurological disorder (National Academy of Science, 2009) The Mn concentration in the untreated surface water sample collected in February, April and May are 1.2 mg/L, 1.64 mg/L and 1.72 mg/L, respectively. The ranges of the Mn concentration for the treated surface water are 1.1-3.8 mg/L, 0.37-1.41 mg/L and 1.53-2.84 mg/L respectively, while the Mn concentration for the ground water samples are 0.2 mg/L, 0.21 mg/L and 0.31 mg/L respectively for the same period. Highest Mn level was recorded in May while the lowest Mn level was recorded in February.

The Mn concentration levels for the ground water samples agree with the Nigerian standard for Mn in drinking water except for the samples collected in May which was found to be 0.3 mg/L. Among all the samples analysed, only the ground water samples agree with SON (2007) specification. In a similar study carried out by Adekola *et al*. (2013) on the level of Mn in treated and untreated dam water, the concentration of Mn recorded in February for treated dam water was 0.048 mg/L and 0.064 mg/L for untreated dam water in that order, these values are a bit lower than the values recorded in this study. The Mn content of almost all the water samples in all the three months under study were above the prescribed drinking water standards. USEPA has recently indicated that there is a health concern with high levels of manganese in drinking water (Technical report, 2008).

Mn may affect neurological and muscle functions in humans. In additions, values above the acceptable limit may cause objectionable and tenacious stain to laundry and plumbing fixtures. When compared with the results obtained from the assessment of heavy metal contamination of ground water in Ilorin (0.08-0.48 mg/L) by Okoro *et al*. (2012), the values recorded in this present study fall within the acceptable limit of 0.2-0.31 mg/L set by Environmental Health (2010). The Mn concentration of the water samples collected in early February, April and May are represented in Figure 3.0

Table 3.0: Manganese ion concentration for water samples collected within Unilorin Campus in early February, April and May 2013

Samples	February (mg/L)	April (mg/L)	May (mg/L)
SW	1.20	1.64	1.72
GW	0.20	0.21	0.31
TW1	1.10	1.24	2.24
TW2	1.40	1.41	1.82
TW3	3.80	0.82	2.57
TW4	1.20	1.01	1.53
TW5	1.60	0.37	2.84

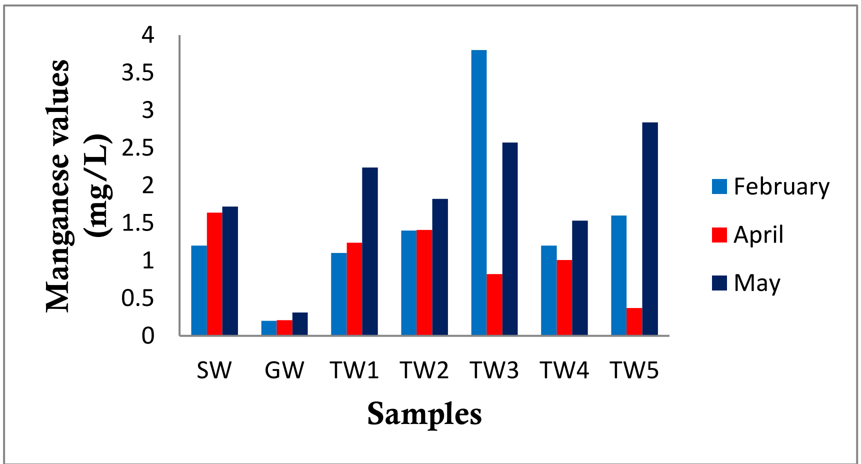

Fig 3.0: Distribution of Mn in the water samples collected within Unilorin Campus in early February, April and May, 2013.

The Zn concentration recorded for the untreated surface water samples collected in February, April and May are 0.35 mg/L, 0.16 mg/L and 0.08 mg/L respectively. The Zn concentration recorded for the treated surface water samples are 0.025-0.34 mg/L, 0.07-0.22 mg/L and 0.05-1.62 mg/L while the Zn concentration for the ground water samples are 0.019 mg/L, 0.04 mg/L and 0.11 mg/L respectively. All of them complied with the water standards (SON, SDWR). The results obtained from this present study (0.019-0.11 mg/L) was comparable with that of the assessment of heavy metals in ground water done by Okoro *et al.* (2012), which fall within the acceptable guideline limit of 0.05-0.63 mg/L set by Environmental Health, 2010. This study, when compared with Adekola *et al.* (2013), showed that the Zn level recorded in February for treated dam water was lower than the values recorded in the related study by Adekola and his co-workers. The zinc level for the water is good. There's no health impact recorded for zinc. The Zn concentration of the water samples collected in early February, April and May are represented in Table 4.0 and Figure 4.0 respectively.

Table 4.0: Zinc ion concentration for water samples collected within Unilorin Campus in early February, April and May 2013

Samples	February (mg/L)	April (mg/L)	May (mg/L)
SW	0.35	0.16	0.08
GW	0.02	0.04	0.11
TW1	0.02	0.09	0.67
TW2	0.34	0.15	0.15
TW3	0.03	0.07	0.12
TW4	0.30	0.22	1.62
TW5	0.04	0..08	0.05

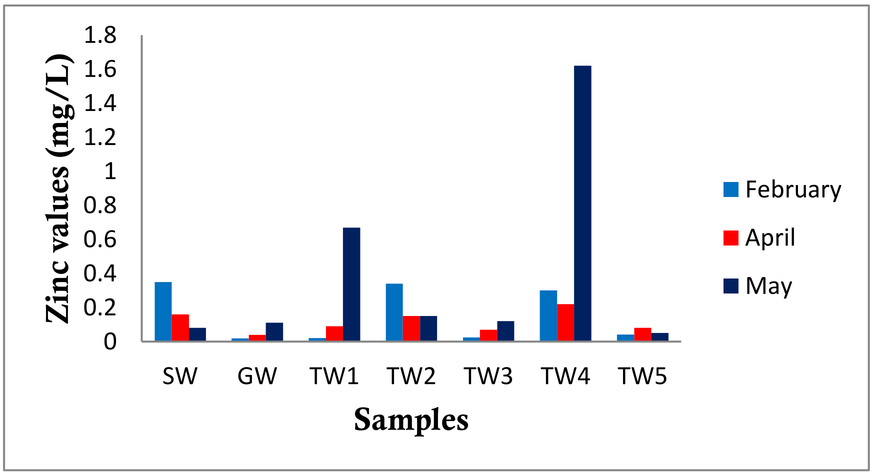

Fig 4.0: Distribution of Zn in the water samples collected within Unilorin Campus in early February, April and May, 2013.

The concentration of Cu in the untreated surface water samples collected in February, April and May are 0.024 mg/L, 0.04 mg/L and 0.03 mg/L, respectively. For the treated water samples, the ranges of Cu concentrations are 0.017-0.02 mg/L for February, 0.01-0.02 mg/L for April and 0-0.03 mg/L in May. The Cu concentration for the ground water samples collected in February, April and May are 0.029 mg/L, 0.01 mg/L and 0 mg/L respectively. These values are all below the maximum limits specified by WHO, SDWR and SON (1.50, 1.0 and 1.0 mg/L respectively). High level of Cu concentration in drinking water causes gastrointestinal disorders (National Academy of Science, 2009).

In a related study carried out by Eze *et al.* (2012), higher values were recorded for Cu which ranged between 0.02- 0.88 mg/L when compared with the values obtained in this study (0-0.04 mg/L), this could be attributed to either natural or manmade factors. The Cu concentration of the water samples collected in early February, April and May are represented in Table 5.0 and Figure 5.0.

Table 5.0: Copper ion concentration for water samples collected within Unilorin Campus in early February, April and May 2013

Samples	February (mg/L)	April (mg/L)	May (mg/L)
SW	0.024	0.040	0.030
GW	0.029	0.010	ND
TW1	0.026	0.010	ND
TW2	0.017	0.020	0.030
TW3	0.017	0.020	0.010
TW4	0.020	0.020	0.030
TW5	0.028	0.020	0.010

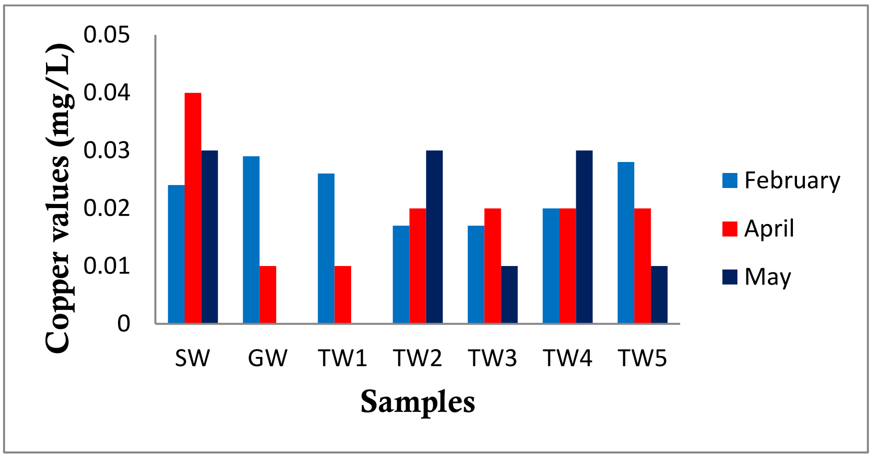

Fig 5.0: Distribution of Cu in the water samples collected within Unilorin Campus in early February, April and May, 2013.

4. Conclusion

The results obtained from the trace metal analysis reveal that the ground water (borehole water) is the least polluted drinking water sample in University of Ilorin main Campus. It was also discovered that the untreated dam water has the highest level of pollution. The ground water sample, being the least polluted, is the most suitable for drinking. The treated water samples were also within the laid down limits, while the untreated surface water sample was recorded as the most polluted water sample and unfit for drinking.

The water samples are free of copper contaminants. This also makes them good for drinking. The level of deviation of iron in all the samples is very high compared with EPA standard. The source of pollution may be due to anthropogenic factors. The Mn content of almost all the water samples in all the three months under study were above the prescribed drinking water standards. The levels of Mn recorded in this study were a bit higher than the values recorded by Adekola and co-workers in 2013. Therefore, the drinking water needs to be properly monitored especially at the locations where we have high Mn concentration recorded.

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