



Research Article

Determination of Heavy Metals in Boreholes, Hand Dug Wells and Surface Water in some Selected Areas of Mubi North Local Government Area Adamawa State, Nigeria.

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Drinking water Quality is one of the most important concerns. The heavy metals level up to ppb levels in drinking water quality may cause severe health problems. In this study attempt was made to determine the concentrations of eight heavy metals in water samples taken in August 2016 from boreholes, hand dug wells and streams in some selected areas of Mubi North local government Adamawa state. These samples were subjected to analysis for eight elements (Zn, Fe, Ca, Na, Mg, Mn, Pb and Cd using Atomic Absorption Spectrophotometer (AAS). The concentrations of these metals in the study areas were compared with drinking water quality limits given by the World Health Organization (WHO). Na, Mg, Fe, Mn, Zn and Ca concentrations were found to range from 4.80-5.0, 0.06-2.6, 0.03-3.05, 0.04-0.80, 0.02-0.17, 20.49-35.6Mg/L respectively. The concentrations of Na, Mg, Ca, and Zn found in this study were lower than the permissible limit of WHO. While that of Fe in water sample from stream were found to be higher as compared with the WHO standard. Similarly the concentration of Mn in stream and borehole water samples were also higher. Cd and Pb were not detected in all the samples.

Key Words: Water, Heavy metals, Determination, Mubi, Adamawa, Nigeria.

INTRODUCTION

Ground Water (boreholes, hand dug wells) and Surface Water is an important and major source of drinking water in both urban and rural areas in Mubi. Determination of water quality is one of the most important aspects in studies (Valipour 2012; Valipour 2013a,b,c; Valipour 2017a,b,c).

Safe drinking water is a basic need for good health and it is also a basic right of humans. Fresh water is already a limiting resource in many parts of the world (Voica *et al.*, 2012). In the next century, it will become even more limiting due to increased population, urbanization and climate change (Ayoola, 2008). Thereby there is an urgent need to educate the people about the judicious uses of

water as a natural resources and the water bodies may be the natural or the man made. The water is in day today households, academic, industries, transports and others. So the water users must take care for avoiding casual attitude towards use of water and leaving water bodies uncared.

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Unfortunately, in developing countries (i.e. Nigeria) the drinking water quality is continuously being contaminated and hazardous for human use due to high growth of population, expansion in industries, throwing away of waste water and chemical effluents in to canals and other water sources (Muhammad *et al.*, 2013).

Groundwater is highly valued because of certain properties not possessed by surface water (Prasad and Reddy, 2011; Omolayo *et al.*, 2010). People around the world have used groundwater as a source of drinking water, even today more than half the world's population depends on groundwater for survival. The value of groundwater lies not only in its widespread occurrence and availability, but also in its consistent good quality, which makes it an ideal source of drinking water. In recent times, increasing focus is being given to studies on groundwater contamination. Since groundwater is directly in contact with soil, rocks, and plants, the constituents of these sources might contaminate the groundwater (Nardi *et al.*, 2009; UNESCO 2000; Hamanuman *et al.*, 2012).

The main source of heavy metals in drinking-water is contamination of surface and ground waters by industrial sewage and agricultural run-off. In the areas that the water distribution network is made of alloys containing heavy metals, some people may not afford bottled- or mineral water with controlled heavy metal concentrations and they consume tap water, therefore the possibility of contamination of drinking-water with heavy metals greatly increases (Mishra *et al.*, 2010). Therefore, quality control in drinking-water and detection of its heavy metals is extremely critical issue in maintaining the human health. Along with this the purest water globally is being used as standard liquid for calibrating several academic and industrially equipment and after use is being drained out rather than recycling and reusing. The essential measures must also be initiated like survismeter (Singh 2006) where the use of water must be recycled and reused even in scientific measurements in academics as well as in industries.

Many trace metals are natural constituents of the environment. Some of them are even necessary for the biological functions of organisms. At high concentration levels, however, all metals have negative impact, as they are easily accumulated (Vickackaite *et al.*, 2006). High concentrations of trace elements are dangerous because they tend to bio-accumulate resulting in heavy metal poisoning. Extreme concentrations of naturally occurring substances has been reported as being harmful to living organisms (Offem and Ayotunde, 2008; Hornung *et al.*, 2009; Ayotunde *et al.*, 2011; Ayoola and Ajani 2008; Jiraungkoonskul *et al.*, 2002; 2003; Idodo-Umeh, and Oronseye, 2006).

Heavy metals are chemical elements with a specific gravity that is at least four to five times the specific gravity of water

at the same temperature and pressure (Garbarino *et al.*, 1995; Duruibe *et al.*, 2007). Metal elements are those with positive valances and occupy group I to III in the periodic table (Fedalis 2012).

Millions of people around the world get exposed to high levels of heavy metals in the drinking-water. People may be exposed to heavy metals over the course of their lifetime (Mishra *et al.*, 2010; Mudgal *et al.*, 2010). Heavy metal exposure to human occurs through three primary routes namely inhalation, ingestion and skin absorption (APHA, 2005). The threat that heavy metals pose to human and animal health is aggravated by their low environmental mobility, even under high precipitations, and their long term persistence in the environment (Muhammad *et al.*, 2013). There are a lot of water reserves but people are not educated to make best use and keep contaminating and thronging the contaminated water uncared.

Also, human exposure has risen dramatically as a result of an exponential increase of their use in several industries, agricultural, domestic and technological applications (Ayuotunde 2008). Thereby currently the greener approaches are gaining the attention world over for saving the resources by making best uses in a most careful manner (Mahdavinia *et al.*, 2015).

All metals are toxic at higher concentrations (Chronopoulos *et al.*, 1997). Excessive levels can be damaging to the organism. Other heavy metals such as mercury, plutonium, and lead are toxic metals that have no known vital or beneficial effect on organisms, and their accumulation over time in the bodies of animals can cause serious illness. Certain elements that are normally toxic are for certain organisms or under certain conditions, beneficial. Examples include vanadium, tungsten, and even cadmium (Lane *et al.* 2011).

Although individual metals exhibit specific signs of their toxicity, the followings have been reported as general signs associated with cadmium, lead, iron, zinc, and copper poisoning: gastrointestinal (GI) disorders, diarrhoea, stomatitis, tremor, hemoglobinuria causing a rust-red colour to stool, ataxia, paralysis, vomiting and convulsion (Duruibe *et al.* 2007). Depression, and pneumonia when volatile vapours and fumes are in-haled.

The nature of effects can be toxic (acute, chronic or sub-chronic), neurotoxic, carcinogenic, muta-genic or teratogenic (Ayotunde 2012).

In Mubi -North Local Government Area of Adamawa State, there is no documented information on heavy metal in surface and ground water.

The purpose of the study is to determine the level of concentration of these heavy metals in drinking water in the study area and compare it with the world health organization limits for safe drinking water quality.

MATERIALS AND METHODS

Sample Collection

Three water samples were collected from streams (surface water), Boreholes and Hand dug wells in three replicates in Mubi North local Government area. Standard methods were adapted for the analysis of various heavy metals. 1 litter polythene bottles were washed with dilute acid followed by distilled water and were dried before using it to collect the water samples for the analysis of the heavy metals. At each sampling location, water samples were collected in three polyethylene bottles. Before taking final water samples, the bottles were rinsed three times with the water to be collected. Three litters of each sample was collected and homogeneous sample is prepared for analysis of heavy metals.

Samples were collected from various water sources (Table 1):

Sample – 1: Stream (surface water)

Sample – 2: Bore hole

Sample – 3: Hand dug well.

Quality assurance Procedure

Special precautions were taken during sampling and analysis of trace elements. Before collecting the samples, the sample containers were soaked overnight in 2% nitric acid and washed with double distilled water. All the samples were collected in polythene containers.

Analytical Methodology

Heavy metals were analysed by using Atomic absorption spectrophotometer (AAS) as adopted by Barbes *et al.*, (2014).

Table 1 Shows the number of samples taken with their corresponding locations and sources

Sample number	Sample locations	Sources of water
1	Barama	Stream Bore hole Hand dug well
2	Lokuwa	Stream Bore hole Hand dug well
3	Federal Polytechnic	Stream Bore hole Hand dug well

RESULTS AND DISCUSSION

The results of the concentration of heavy metal from the various water sample source from Barama is presented in Table 2. While that of federal Ploytechnic and Lokuwa are

in Tables 3 and 4 respectively. Table 5 shows the mean concentration for the study area. Figures 1 to 6 shows the level of concentration of each heavy metals (Na, Mg, Ca, Fe, Mn and Zn respectively) in the water samples from each source.

Table 2 Results of the concentration (Mg/L) of heavy metals from the various source of water in Barama

Sources of water	Heavy metal							
	Na	Mg	Ca	Fe	Mn	Zn	Cd	Pb
Stream	5.00	1.79	19.09	4.02	1.01	0.04	ND	ND
Bore hole	5.3	2.00	37.4	0.02	0.11	0.15	ND	ND
Hand dug well	5.00	0.05	29.30	0.07	0.06	0.020	ND	ND

Where:

ND is no data (metal not detected)

Table 3 Results of the concentration (Mg/L) of heavy metals from the various source of water in Lokuwa

Sources of water	Heavy metal							
	Na	Mg	Ca	Fe	Mn	Zn	Cd	Pb
Stream	4.79	2.00	21.9	4.60	0.76	0.07	ND	ND
Bore hole	6.00	2.9	36.77	0.03	0.18	0.13	ND	ND
Hand dug well	5.20	0.07	32.30	0.08	0.04	0.03	ND	ND

Where:

ND is no data (metal not detected)

Table 4 Results of the concentration (Mg/L) of heavy metals from the various source of water in Federal Polytechnic

Sources of water	Heavy metal							
	Na	Mg	Ca	Fe	Mn	Zn	Cd	Pb
Stream	4.80	2.6	20.49	3.05	0.80	0.06	ND	ND
Bore hole	5.00	2.05	35.6	0.03	0.16	0.17	ND	ND
Hand dug well	5.00	0.06	29.30	0.07	0.041	0.02	ND	ND

Where:

ND is no data (metal not detected)

Table 5 Results of the mean concentration (Mg/L) of heavy metals from the various source of water in the study area

Sources of water	Heavy metal							
	Na	Mg	Ca	Fe	Mn	Zn	Cd	Pb
Stream	4.80	2.6	20.49	3.05	0.80	0.06	ND	ND
Bore hole	5.00	2.05	35.6	0.03	0.16	0.17	ND	ND
Hand dug well	5.00	0.06	29.30	0.07	0.04	0.02	ND	ND

Where:

ND is no data (metal not detected)

Sodium (Na) is a silver white metallic element and found in less quantity in water. Proper quantity of sodium in human body protects many fatal diseases like kidney damages, hypertension, headache etc. In most of the countries, majority of water supply bears less than 20Mg/L while in some countries the sodium quantity in water exceeded 250Mg/L (WHO 1984).

According to WHO standard, concentration of sodium in drinking water is 200Mg/L. The findings of this study shows

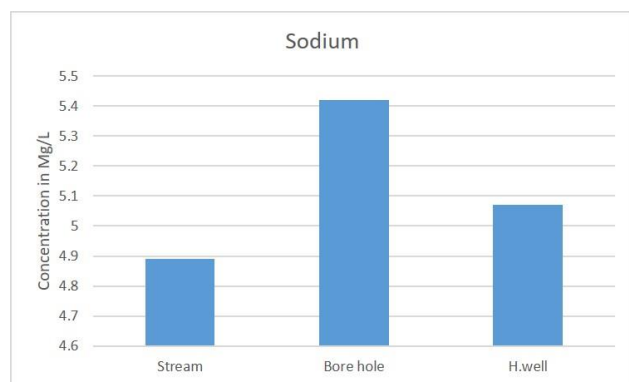


Figure 1: shows the level of concentration of Sodium in the water samples from each source in the study area.

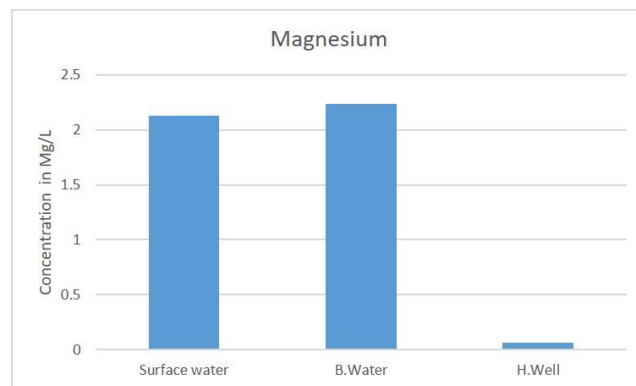


Figure 2: shows the level of concentration of Magnesium in the water Samples from each source in the study area.

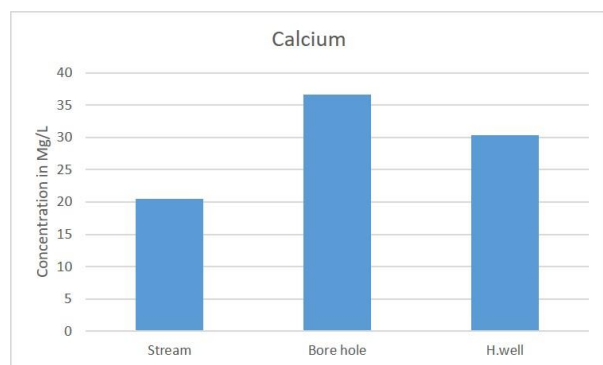


Figure 3: shows the level of concentration of Calcium in the water samples from each source in the study area.

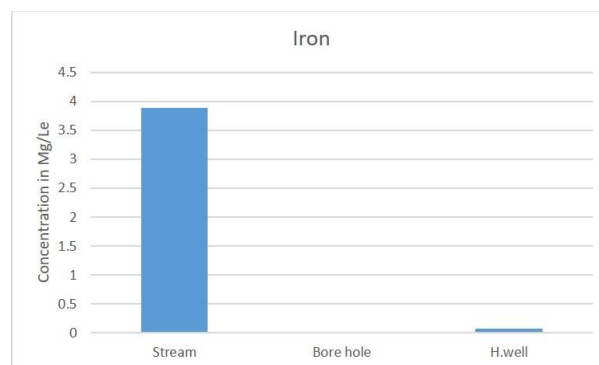


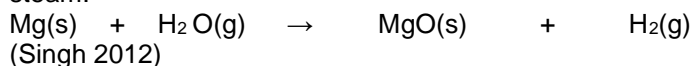
Figure 4 Shows the level of concentration of Iron in the water samples from each source in the study area.

that sodium concentration ranges from 4.80 to 5.0 Mg/L (Table 5, Figure1). Sodium quantity in the water samples in the study area is low compared to WHO standard (200Mg/L) which could be harmful for the health of local inhabitants. Hard water consumes too much water with no efficiency of in washing clothes therefore the wash ability of the wettability of the water sample before used for washing be ensured by making measurements using survismeter at the local point only. The survismeter is a simple and accurate device which does not need any additional resources except water sample. Laundries industries consume gallons of water globally and hence data of wash ability of water sample is inevitable (Singh 2012).

Magnesium (Mg) is the 8th most abundant element on the earth crust and natural constituent of water. It is essential for proper functioning of living organisms and found in minerals like dolomite, magnesite etc. Human body contains about 25g of magnesium 60% in bones and 40% in muscles and tissues (Fasae and Omolaja 2014).

According to WHO standard the permissible range of magnesium in water could be 30Mg/L. The concentration of magnesium (ranges from 0.06 to 2.6Mg/L) is low in all the water samples from the various source in the study area (Table 5, Figure.2) as compared to WHO's limit. Such a low concentration somewhat affects health of residents as it is essential for human body.

Magnesium reacts slowly with cold water and more with steam.



Calcium is the fifth most abundant element on the earth crust and is very important for human cell physiology and bones. About 95% calcium in human body is stored in the bone and teeth. The high deficiency of calcium in human may cause rickets, poor blood clothing, bone fracture, etc. and the exceeding limit of calcium produced cardiovascular diseases.

According to WHO (1996) standard its permissible range in drinking water is 75 Mg/L. However, an adult require 100Mg/day to work properly. The concentration of calcium from this study ranges from 20.49 to 35.60Mg/L (Table 5, Figure 3) which did not exceed the standard limit of WHO.

The concentration of Iron in water samples taken from Hand dug well was found to be 0.07Mg/L which is higher than WHO standard (0.03Mg/L). While that of Stream (3.05 Mg/L) is very high (Table 5 and Figure4) when compared to the stipulated value for drinking water.

The first concern is that high iron in drinking water may reduce palatability and therefore reduce the amount of rate of intake. The values observed for the water samples with high concentration are expected because it has been

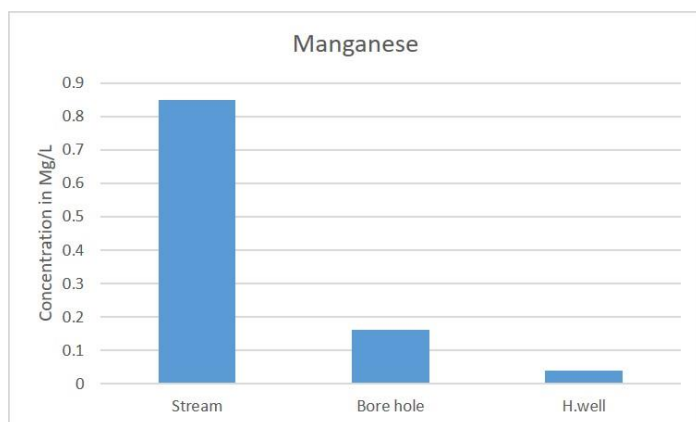


Figure 5: Shows the level of concentration of Manganese in the water samples from each source in the study area.

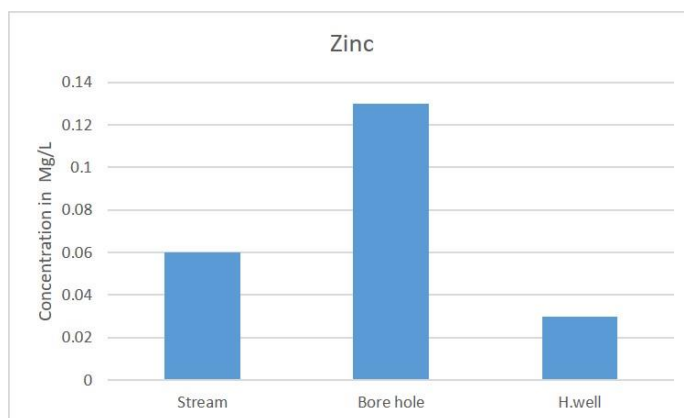


Figure 6: Shows the level of concentration of Zn in the water samples from each source in the study area.

reported that iron occurs at high concentration in Nigerian soil (Nwajei and Gagophien,2000; Asaolu and Olaofe,2004). However, the values obtained in this study corroborates the reports of Abulude (2006) for higher content of iron in water. The high iron concentration observed in stream water might be due to the runoff water from iron containing materials and acid rain which result from thermal power plants, industries and other sources release thousands of tonnes of oxides of nitrogen and sulphur in to the atmosphere every day. These gasses undergo transformation in the atmosphere and form nitrates, sulphates, nitric acid or sulphuric acid droplets. Some of these pollutants, especially the oxides of sulphur can travel 200-300Kms in a day. Thus, the compounds emitted at a place may be carried hundreds of kilometres by the wind and deposited on ground or on vegetation directly as acid rain. $\text{H}_2\text{O} + \text{SO}_2 \rightarrow \text{H}_2\text{SO}_3 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{SO}_4$ (Lande,1997; Singh 2012).

The concentration of Manganese was observed to be 0.04Mg/L (Table 5, Figure.5) for hand dug well which is less than the value of WHO (0.05Mg/L). However, for stream and borehole water the values are 0.80 and 0.16Mg/L respectively which are higher than the WHO standard.

The concentration of Zinc in this study ranges from 0.02 to 0.17Mg/L as shown in Table 5 and Figure 6 which is lower than permissible limit of WHO (5.00Mg/L). Similar thing was observed by Fedelis *et al.*, (2012).

Cadmium

Cadmium (Cd) is a heavy metal of considerable environmental and occupational concern. It is widely distributed in the earth crust at an average concentration of about 0.1Mg/L. The highest level of Cadmium compounds in the environment is accumulated in the sedimentary rocks and marine phosphates contains about 15Mg Cadmium/Kg. Cadmium compounds are classified as human carcinogens by several regulatory agencies. Cadmium is frequently used in various industrial activities.

The major industrial application of Cadmium include the production of alloys, pigments and batteries (Paul *et al.*, 2014). Though in this study the concentration of Cadmium was not detected.

Lead

Lead (Pb) is a naturally occurring bluish-gray metal present in small amounts in the earth crust. Although lead occurs naturally in the environment, anthropogenic activities such as fossil fuel burning, mining and manufacturing contribute to the release of high concentrations.

Lead is a soft metal that has been known to have many applications over the years. During this investigation, lead metal was not detected in all the samples. The permissible limit recommended by WHO for drinking water is 0.01Mg/l. The possible source of lead are combustion of gasoline, its uses in alloys, old lead pipe line from which water is supplied (although lead does not react with either water or steam), idol immersion activities, uses of lead arsenate as pesticides as well as its uses in paints, pigments and storage batteries.

CONCLUSION

Ground and Surface water samples were taken from Barama, Lokuwa and Federal Polytechnic in Mubi North local government area of Adamawa State, Nigeria in August 2016 for determination of Na, Mg, Fe, Mn, Zn, Ca, Cd and Pb using AAS. The concentration of Na, Mg, Fe, Mn, Zn, and Ca were found to range from 4.80-5.0, 0.06-2.6, 0.03-3.05, 0.04-0.80, 0.02-0.17, 20.49-35.6Mg/L respectively. While Cd and Pb were not detected in all the samples. The concentrations of Na, Mg, Ca and Zn were lower than WHO limit for drinking water in all the samples. Both Fe and Mn in water samples from stream as well as Mn from Borehole exceeded WHO limit for drinking water.

The result from this study revealed that water from hand dug well was of good quality, while that from Borehole and

stream were fair for drinking purpose. Quality control in drinking-water and detection of its heavy metals is extremely critical issue in maintaining the human health. Therefore, some treatment technology should be employed to treat Borehole and stream water in the study areas for it to be safe drinking water for the public.

Certain water recycling and reusing as pure water saving measures like survismeter for checking wash ability of water to be used in laundry and other green chemistry application of water like NOSIA are suggested.

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