Monitoring of Drinking Water quality in Regional Laboratory Gombe Nigeria

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ABSTRACT: Drinking Water Quality control by the Regional laboratory Gombe Nigeria was investigated. The aim of this study is to investigate the quality of analysis done in drinking water control in the regional laboratory in terms of the kinds of analytical instruments used, the technology employed for the control and the kind of contaminants analyzed. Four analyses were carried out between June to December 2008 for four different samples. For each sample, 25 parameters were tested. The results obtained were analyzed using the Nigerian Drinking water standards. The results showed good agreements with the Nigerian standards, 90% of the results values were much below the maximum allowed limits. Nevertheless, good as the result may look there are many parameters that are not measured by this laboratory. In the Nigerian Drinking water standards there are so many inorganic parameters with very low maximum allowed limits, parameters like Arsenic with 0.01mg/l, cyanide 0.01mg/l, lead 0.01mg/l, etc. These low limits show how important it is to make sure such pollutants are not found in drinking water, but most of them are not been tested in the research laboratory. Therefore, if these pollutants were found in the water in this region, consumed by human beings and animals it would be to the detriment of their health. The results of this study showed that, the regional laboratory Gombe meets the Nigerian maximum allowed limits to a large extent but need to test for some vital contaminants that pose as health risk in drinking water if present even at a very low concentration. The analytical instruments used in this regional laboratory are simple basic instruments and some tests were not carried out for lack of more robust and reliable analytical instruments.

Key words; water quality, contaminants, drinking water standards, parameters.

INTRODUCTION

The regional laboratory in Gombe is one of the four regional laboratories established by the Federal Ministry of Water Resources. The aim of these laboratories is to monitor pollution in these regions of the country, pollutions due to human and industrial activities. They are also to carry out quality control in the regions, for both raw and portable water. They are expected also to periodically monitor drinking water to ensure the treated water meets specifications. Gombe regional laboratory is responsible for monitoring pollution in about eleven states. One outstanding industry in this region is Savannah Sugar Company, which produced a lot of effluent that require treatment before being disposed into any water body; the regional laboratory monitors their effluent periodically. For any successful monitoring and policing of environmental pollution, excellent methods and instruments for assessment are needed. Therefore the aim of this study is to investigate in detail the methods and instruments used in Gombe regional laboratory to monitor water quality in the region. The kind of contaminants analyzed or not analyzed was examined and results compared with the Nigerian drinking water standard to see how good and efficient the water quality control is being done in the regional laboratory.

MATERIALS AND METHODS

The water samples were collected directly from sources in Gombe and analyzed by the laboratory staff the same day. Methods used for analysis were: Color Filtration, Sensory Organs, Thermometer, pH Meter, Conductivity meter, Turbidity meter, Dissolved Oxygen (DO) Meter, Diethyl-p-Phenylendiamine (DPD) Method, Nitra Ver 5 Reagent Powder Pillow (RPP), Nitri Ver 2 RPP, Sulfa Ver 4 RPP, Phos Ver 3 RPP, Spands method, Calmagite, Ascorbic acid, Ferro Mo/DR890, Oxidation, Comparison, and Membrane filtration. These results were collected and analyzed by comparison with the Nigerian standard for drinking water.

RESULTS AND DISCUSSION

The results obtained in the regional laboratory Gombe are showed in Table 1 to 2 below

Comparing this with the standard, the results are mostly below the standard. But looking at the contaminants analyzed, it can be seen that only few contaminants are analyzed compared for example with contaminants given in WHO drinking water standard or that of some developed countries, a comprehensive comparison has already been described (Danja, 2010). The reason for failure to analyze many contaminants is lack of analytical instruments. The common analytical instruments found in this laboratory are basic ones like pH meter, conductivity meter, total solid meter, turbidity meter. Some few standard instruments were found in the laboratory, examples are spectrophotometer, gas chromatography, flame photometer, etc, but they were not in used. A critical component of environmental monitoring especially for drinking water quality control is the type of analytical instruments used to analyze samples. Normally the choice of these analytical instruments is dictated by the environment monitored, the parameters of interest and the data quality requirements; one must therefore select a scientifically sound method, approved by a regulatory agency. Gombe regional laboratory just use instruments that are available and not so much dictated by the regulatory agency nor the environment or parameters to be monitored (Danja, 2010). This is an unfortunate situation because analytical measurements are the foundation for determining pollutants and their effects in the environment and to ultimately formulate appropriate risk management policies and laws, therefore analytical instruments should be chosen carefully following procedures described in literature (Gillian, 2007).

Table 1 Water Quality Analytical Results from Gombe Regional Laboratory

Parameter	Unit	Method used	Result 29.06.08	Result 15.07.08	Nigeria STD.	Remarks
Appearance	-	Visual	Clear	Clear	Un-Obj	O.K
Color	Pt-co	Color Filtration	0.0	30.0	15.0	Not OK
Odor	NT	Sensory Organs	Un-Obj	Un-Obj	Un-Obj	O.K
Taste	-	Sensory Organs	Un-Obj	Un-Obj	Un-Obj	O.K
Temperature	O^C	Thermometer	29.8	28.8	Ambient	O.K
PH-Value	pH	pH Meter	7.35	6.65	6.5 -8.5	O.K
Conductivity	µS/cm	Conductivity meter	180	440	1000	O.K
Turbidity	NTU	Turbidity meter	11.29	13.70	5.0	Not O.K
TDS	Mg/l	Conductivity meter	90.0	220	500	O.K
DO	Mg/l	DO Meter	4.36	0.85	7.0	O.K
Chlorine (Free)	Mg/l	DPD Method	-	-	0.25	-
Chloride	Mg/l	DPD Method	-	-	250	-
Nitrate (NO_3)	Mg/l	Nitra Ver 5 RPP	22.3	24.30	50	O.K
Nitrite (NO_2)	Mg/l	Nitri Ver 2 RPP	-	-	0.2	-
Sulfate (SO_4)	Mg/l	Sulfa Ver 4 RPP	33.0	15.0	100	O.K
Phosphate(PO_4)	Mg/l	Phos Ver 3 RPP	0.25	0.46	5.0	O.K
Fluoride	Mg/l	Spands method	0.125	0.19	1.5	O.K
Hardness	Mg/l	Calmagite	-	-	150	-
Aluminum	Mg/l	Ascorbic acid	0.02	0.02	0.2	O.K
Iron (Total)	Mg/l	Ferro Mo/DR890	0.01	0.82	0.3	O.K/NOT
Copper (Cu^{2+})	Mg/l	-	-	-	1.0	-
Manganese(Mn^{2+})	Mg/l	Oxidation	0.019	0.13	0.2	O.K
Arsenic	Mg/l	Comparison	-	-	0.01	-
Total Coli Form	Cfu/100 ml	Membrane filtration	0.0	0.0	0/100ml	O.K
E.Coli		Membrane filtration	0.0	0.0	0/100ml	O.K

Sample: Borehole water from Gombe (STD = Standard)

Table 2 Water Quality Analytical Results from Gombe Regional Laboratory

Parameter	Unit	Method Used	Result 06.08.08	Result 02.12.08	Nigerian STD.	Remarks
Appearance	-	Visual	brown	Clear	Un-Obj	Not O.K
Color	Pt-co	Color Filtration	10.0	90.0	15.0	Not O.K
Odor	NT	Sensory Organs	-	Un-Obj	Un-Obj	Not O.K
Taste	-	Sensory Organs	S.Salty	Slightly salty	Un-Obj	Not O.K

Temperature	O^C	Thermometer	26.8	29.0	Ambient	O.K
PH-Value	pH	pH Meter	6.77	6.77	6.5 -8.5	O.K
Conductivity	µS/cm	Conductivity meter	7680	680	1000	(Not) O.K
Turbidity	NTU	Turbidity meter	412.85	57.3	5.0	Not O.K
TDS	Mg/l	Conductivity meter	3930	340	500	(Not) O.K
DO	Mg/l	DO Meter	0.12	3.40	7.0	O.K
Chlorine (Free)	Mg/l	DPD Method	-	-	0.25	-
Chloride	Mg/l	DPD Method	-	-	250	-
Nitrate (NO_3)	Mg/l	Nitra Ver 5 RPP	24.3	7.40	50	O.K
Nitrite (NO_2)	Mg/l	Nitri Ver 2 RPP	-	1.68	0.2	Not O.K
Sulfate (SO_4)	Mg/l	Sulfa Ver 4 RPP	80	47.0	100	O.K
Phosphate (PO_4)	Mg/l	Phos Ver 3 RPP	0.11	0.16	5.0	O.K
Fluoride	Mg/l	Spands method	1.26	0.25	1.5	O.K
Hardness ($CaCO_3$)	Mg/l	Calmagite	-	2.40	150	O.K
Aluminum	Mg/l	Ascorbic acid		0.05	0.2	O.K
Iron (Total)	Mg/l	Ferro Mo/DR890		-	0.3	-
Copper (Cu^{2+})	Mg/l	-	-	0.008	1.0	O.K
Manganese (Mn^{2+})	Mg/l	Oxidation	0.004	-	0.2	O.K
Arsenic	Mg/l	Comparison	-	0.0	0.01	O.K
Total Coli Form	Cfu/100ml	Membrane filtration	0.0	0.0	0/100ml	O.K
E.Coli		Membrane filtration	0.0		0/100ml	O.K

Sample: Borehole water from Gombe

Gombe regional laboratory lack most of classical analytical instruments found in literature, talk less of some high technology ones described in literature (GodeJohan et al 1997, Speight 2005). With such serious lack of analytical instruments, the monitoring of pollutants by this laboratory can not be done efficiently. Contamination of water by toxic metals is one of the most visible water pollution, referred to as heavy metal pollution, as it occurred in Minamata Japan (Singh, 2004, Allchin, Kugler, 2004), but metals like lead, mercury are not monitored in this laboratory. In Figure 1 below comparison of the Gombe Regional Laboratory result is made with the Nigerian Standard for Drinking Water (Nigerian Industrial Standard NIS 554, 2007). The results showed good agreements with the standards because the results' values except for nitrite are much below the maximum allowed limits. In Table 2 where the result compared here is taken, one can see that the laboratory personnel made a comment that this value is not okay, this means the high value is actually from the sample and not a failure from the instruments. But good as this result may look like; there are many parameters that are not measured by this laboratory. In the Drinking Water Standard (Nigerian Industrial Standard NIS 554, 2007) many inorganic constituents are given and most of them have very low limits, parameters like Arsenic 0.01- mg/l, Barium 0.7mg/l, Chromium 0.05mg/l, Cyanide 0.01mg/l, Lead 0.0-1 mg/l, Hydrogen Sulfide 0.05mg/l, etc.

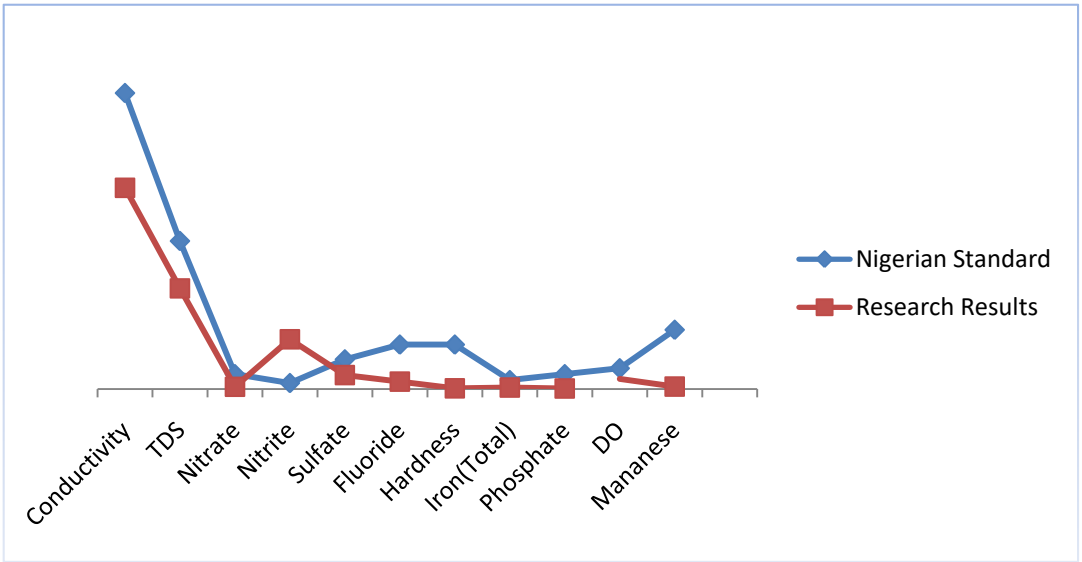

FIGURE 1 RESEARCH RESULTS COMPARED WITH NIGERIAN DRINKING WATER STANDARD (IN mg/L, EXCEPT CONDUCTIVITY µS/cm)

These low limits shows how important it is to make sure such pollutants are not found in drinking water, but they have not been measured by the Gombe Regional Laboratory. If they are available in such water it means they are being consumed by human beings and animals to the detriment of their health. The reason for not monitoring heavy metals and other pollutants in water is lack of instruments or where they are available they are non functional. There are many classical analytical instruments available for such analysis (Stanley, 2000) and many new ones have been described (Cai et al, 2009, Wen et al, 2009) which can be used for better and accurate determination of such metals and other pollutants in water. The measures for chemical laboratory to established quality management have been described in the literature (Funk.W. et al, 2005), these measures include the facilities and equipments of the laboratory, this is lacking in the research laboratory.

A result of Drinking water analysis done in a laboratory in Germany is described in the literature (http://www.stadtwerke-bad-reichenhall.de/wasser/Anal_2004.pdf). The analyses were made based on specific standards as seen in the table in this literature. These standards do not only give the limit but also the analytical methods to be used, methods of calculations where necessary even formulas to be used. If we compare this with the results obtained from the research laboratory, there was no one quotation of any standard used in the analysis. If results from the Nigerian laboratory will have to meet certain standards, not only the maximum allowed limits should be given but specific analytical methods for specific analysis have to be given in the Nigerian standard or international standard with these specifications will have to be adopted. In the result given in http://www.stadtwerke-bad-reichenhall.de/wasser/Anal_2004.pdf, there were 102 parameters tested, but in the research laboratory drinking water analytical results only 25 parameters were given. This makes only 24.5% of the parameters analyzed in the drinking water in the German example above. A class of pollutants seen in the German drinking water analysis, namely organic pollutants was completely absence in the drinking water research laboratory result. It can be seen that the detection limits of the analytical instruments used for this class of pollutants are very low. This class of pollutants needs advanced or accurate instruments to be able to achieve such low limit of detection e.g. Benzo fluoroethane was measured with an instrument with detection limit of 0.001µg/l (Hermann, 1992).

Some parameters like arsenic, cyanide, lead, mercury, nickel, etc. have very low values in the guidelines compared above which show that they are serious health related parameters which should be carefully controlled, but as already mentioned they were not measured in the regional laboratory results due to lack of analytical instruments. Recently the U.S Center for Diseases Cnotrol and Prevention (CDC) reported 169 deaths from lead poisoning in Nigeria (U.S.CDC, 2010), this case was not in drinking water, but we can not rule out some part of the lead ending up in underground water, this demonstrate how important it is to test for heavy metals like lead. In the Nigerian guidelines itself, (Nigerian Industrial Standard NIS 554, 2007) many parameters are missing such as organic pollutants like benzene, dichloroethene, tetrachloromethanes, and vinyl chloride, if these parameters are not even given in the guidelines, then monitors will not make effort to analyze them. Nigeria uses chlorine in water purification and a lot of pesticides are used in the country, but byproducts from such activities are not included in the guidelines. Nkono et al (1998) used the WHO guideline in their study of trace metals in drinking water in southern part of Nigeria; another study was carried out by Musa et al (2007) they also used the WHO guideline for their study; this confirms that the Nigerian guidelines don't have all the parameters needed for drinking water analysis. In the study carried out by Musa et al (2007) Cd was found in many drinking water samples they collected, but Cd was not amongst parameters measured by the research laboratory. If a regional laboratory does not check for the

presence of Cd in drinking water sample and an academic analysis detected this metal in many water samples, then there is a serious gap left between the quality of water people are drinking and the results the monitoring laboratories are providing.

CONCLUSION

The research laboratory has only few basic analytical instruments, which prevent them from carrying out comprehensive analysis of pollutants. There is a great need for the research laboratory to get more analytical instruments as described in the literatures so as to cover more vital pollutants in their drinking water quality control and monitoring of pollution. The Nigerian standard for drinking water does not cover some vital pollutants like the heavy metals, some organic byproducts, etc.

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