Bacteriological Analyses of Groundwater Quality in Gombe Metropolis, Gombe state Nigeria

Maina Benjamin, Kollos Ngune Paul, Sule Samuel

Abstract— Bacteriological analyses of groundwater were investigated in six (6) selected Communities of Gombe Metropolis with the aim of examine impact of sewage on groundwater quality using culture media. One way analysis of variance was employed to test the spatial variation in the concentration of tested bacteria among low, medium and high density areas, afterward T- Test was also used compared the result obtained with WHO water quality acceptable standards. Samples were collected from boreholes and hand dug wells water. Culture media laboratory result indicates the present of bacteria in the entire water sample collected from all locations and confirmatory test reveals the types of bacteria as coliform bacteria. Analysis of variance conducted which shows that the concentration of the coliform bacteria varies significantly across low, medium and high density areas of the study area, whereas T-test shows that concentration of bacteria in all sampled areas exceeded WHO permissible standard.

As the water in question indicated the presence of coliform bacteria, the situation can lead to outbreak of water borne diseases like Cholera, hepatitis, dysentery, giadiasis, typhoid fever to mention but a few. It is therefore, essential to treat water from this kind of groundwater sources to make it fit for both drinking and domestic use. It is Paramount important for government to embark on regular environmental sanitation exercises within the study area and also provide refuse disposal vehicle to populace of the study area to lessen indiscriminate sewage disposal in the area, on the other hand populace in the study area need to intensified effort on personnel hygiene This will improve the general health care and well being of the public in the study area.

Index Terms— Bacteria, Culture media, Ground water, Water Quality

1 Introduction

Water is an excellent natural resource in the entire ecosystem, the critical bond to all spheres. It can be made to serve various functions such as domestic, industrial, agricultural, transportation and other uses. It's also a universal solvent which can neither be created no destroyed on the surface of the earth. Man cannot survive very long without water neither can plant or animals live without water. Water that is meant for drinking should be of high quality [1].Groundwater which is located beneath the earth's surface in soil pore space and in the fracture of rock formations, It's the major source of water to most people living in developing economy, but unfortunately groundwater in both urban and rural areas can be polluted as a result of human activities [2]. Today 1.1 billion people live without access to qualitative sources of water and 2.4 billion people without access to sanitation [3]. Similarly this situation is not different from what is currently obtainable in Nigeria and Africa, United Nation Children Education Fund (UNICEF) Joint Monitoring Programme for Water Supply and Sanitation reported that only 58 percent of Nigerian population has access to improved drinking water supply and sanitation coverage stands at only about 32 per cent [4]. Nigeria with an estimated population of about 160 million, about 64 million people are without access to improved drinking water and over 100 million people do not have access to improved sanitation this situation forced many people to drink polluted water obtained from other unsafe available sources thereby exposing them to hazardous chemicals and infectious agents [3]. Bacteria are microorganism's form as a result of fermentation or nitrogen fixation, responsible for many plant and animal diseases.

Gombe metropolis in recent time has experience sudden increase in population, combined with the problem of insurgency in the north eastern Nigeria, the metropolis is serving as destination to large number of immigrant especially internally displace people (IDP) from the neighboring state such as, Borno, Yobe and Adamawa states, consequently resulting to pressure on the available social amenities.

Because of the abovementioned problem, the existing pipe borne water is insufficient for the teaming population, leading to water shortage in the metropolis, forcing most of the urban communities to drink untreated water obtained from traditional hand dug well and boreholes. Most often the well and the boreholes are dug not too far from their pit toilets and poor drained bathrooms sewage system with an open air dumped sites at the backyards. This kind of the aforementioned situation may result to contamination of their

- *Maina Benjamin is currently pursuing his PhD in environmental Resources and Planning in University of Jos , Nigeria, and he is a Lecture with Department of Geography Faculty of Science Gombe State University, Nigeria E-mail: benmaina82@gsu.edu.ng*
- *Kollos Ngune Paul is currently pursuing masters degree program in Geography in University of Ibadan, Nigeria and he is a Lecture with Department of Geography Faculty of Science Gombe State University, Nigeria. E-mail:ngune82@gmail.com*
- *Sule Samuel. Lecture with Department of Geogaphy Faculty of Science Gombe State University, Nigeria E-mail.ssule36@yahoo.com*

major source of water and it can expose people to hazardous bacteria's and infections their by resulting to outbreak of water bone diseases. Therefore there is a great need for the analysis of the water in Gombe metropolis, in order to ascertain the quality of the water in question for drinking and other domestic uses.

2 THE STUDY PROBLEM

According to the United Nations report on developing nations access to safe drinking water and sanitation estimated that, at least 2.5 billion people in these countries lack adequate sanitation, and that about half of the populace lack access to clean drinking water compared with that of developed nations estimate where 90 percent of the people have adequate (safe) sewage disposal, and 95 percent have clean drinking water [5]. In Nigeria, the rate of urbanization characterized by high population concentration, increasing industrial, agricultural activities coupled with environmental pollution/degradation and indiscriminate disposal of all kinds of wastes are perceived to pose serious pollution threats with all its concomitant health hazards on groundwater quality especially urban areas [6]. This concern has attracted scholars on the field of environmental pollution to embark on surface and ground water pollution studies. Ocheri 2006, in his study revealed that municipal water supply is largely inaccessible to a large proportion of urban dwellers, and even where it is available, the supply is highly inadequate, unreliable and irregular, Consequently, there is high dependency on untreated groundwater abstracted through hand dug wells and borehole systems [7]. Omofonwman and Esigbe (2009) and Omoisi et-al (2012) examined the impact of municipal wastes on the quality of groundwater in Benin City and found concentration levels of physicochemical and bacteriological loading higher in wells close to dumpsite than those far away [8]. In a related study, Ahmed (2003) investigated the effect of sanitation on groundwater in Kaduna, noted high peak values of sanitation pollution indicators such as coliform and nitrate, similarly hands dug wells located close to pit latrine and soak-away have higher concentration of these pollution bacteria. In addition unclean water along with poor sanitation kills over 12 million people early in developing countries [9]. The WHO has a clear guidelines or water quality standard set to control the level of contamination.

Therefore against this backdrop this study will carry out bacteriological analysis of groundwater quality in Gombe metropolis.

3 THE STUDY PROBLEM AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to assess the bacterial status of groundwater source from boreholes and hand dug wells in Gombe metropolis, with a view to determining the portability of the water.

The specific objectives of the study are;

i. To analyze bacterial status of groundwater in Gombe metropolis.
ii. To relate the bacterial status of groundwater in Gombe metropolis with the general standard for coliform bacteria acceptable limit.
iii. To compare result obtained among low, medium and hidensity area

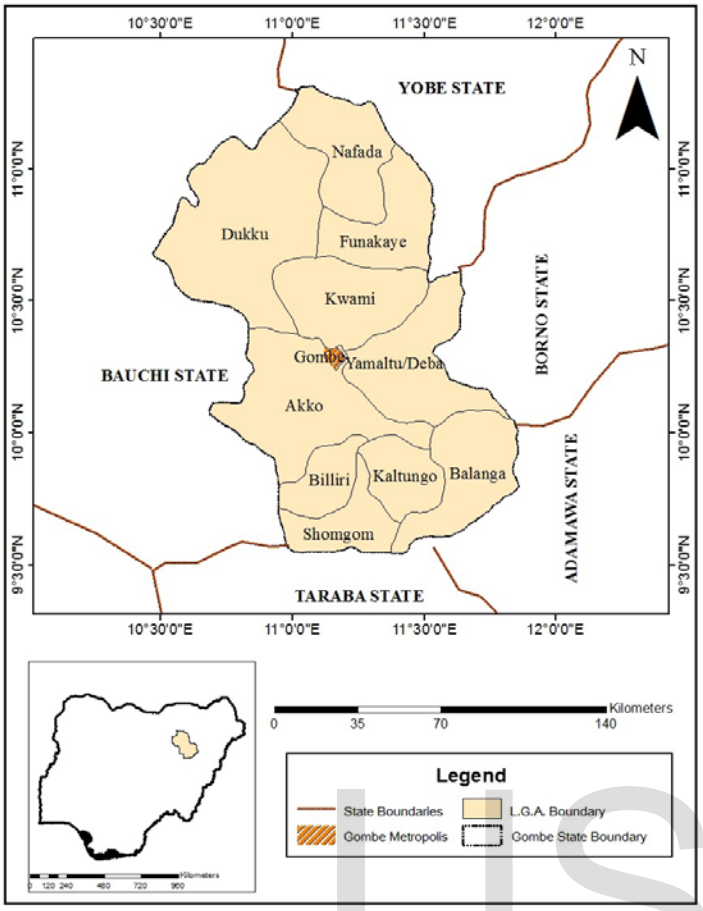
4 RESEARCH HYPOTHESIS

The following hypotheses are formulated for the purpose of this study.

i. There is no significant relationship between the concentrations of bacteria in the study area with the general standard for coliform bacteria acceptable limit.
ii. The concentration of bacteria in the study area does not vary among low, medium and high density of the study areas.

5 THE STUDY AREA

Gombe metropolis is located in the north-eastern part of Nigeria, it is situated at the latitude 10°17' 13.97" N and 11° 9' 58.45" E, longitude (see figure: 1) Gombe metropolis shares common boundary with Akko Local Government Authority in the South and West; Yamaltu-Deba to the East and Kwami to the North, Occupying an area of about 45km^2. The metropolis is divided in wards and each the ward can be regarded as community, serving as the seat of admiration of Gombe State as well as the State headquarters [10].



Historical development and associated landmark event of the metropolis enhanced its further growth as a town in both population size and it cosmopolitan composition. The relief of Gombe developed on complex geologic crystalline bedrock. Although, much of the area is underlain by the ancient crystalline basement complex, sedimentary formation during the late cretaceous period has influenced the topography. Prominent land form of Gombe metropolis is Liji hills, which falls within a stretch of Benue Trough Known as Zambuk ridge. Many rivers truncate the older part of the town flowing eastward from their source at Akko escarpment. Gombe metropolis is located within the sub-Sudan climate zone. It is characterized by a tropical climate with two distinct seasons, dry season (Nov- March) and a wet season (April-October). The vegetation of Gombe metropolis can be best described as Sudan savannah with open grass land which dries up during the dry season [10]. According National Population Commission, Gombe metropolis has a population of 319,875, as it was reported in 2006 census [11]. Location of Gombe metropolis at the centre of the north eastern State gives it an advantage of being the commercial nerve center of north eastern part of Nigeria. More also the Sub-Sudan savannah region makes it productive farming area, producing large farm produced.

6 METHODOLOGY

The stated purpose of the study is to analyzed bacterial status of groundwater in Gombe metropolis and it requires preliminary information from field through reconnaissance survey, field observation and field interview. Laboratory analyses were also used to source first hand information in the study area. Visual survey of the study area was carryout by the researcher to source background information on then study area and samples point, locations, method of working, were also identified during the survey. Purposive sampling techniques were employed to collect sampled from low, medium and high density areas. Observation survey was conducted by the researcher in order to identify various sources of water available in the study area. In other to drive information on the common illnesses within the study area, informal interview were used across the study area. Culture media methods were employed to determining bacterial load in the groundwater. Student T-Test and ANOVA analysis of variance were the statistical method used to calculate the data from the laboratory result.

7 LIRETURE REWIEW

Water occupies more than 70 percent of the earth's surface. It fills the oceans, seas, rivers and lakes, it is in the ground and in the air we breathe in. Our demand for water is constantly increasing every year because there are more people on earth [12]. Furthermore people settle where water is plentiful.

Urban expansion can have negative impact on soils, surface water bodies and aquifer. The most visible evidence of this is the serious human health problems associated with discharge of pathogens into drinking water sources. Olokesusi, 2005 in his studies explained that as a result of urbanisation and industrialisation, there is increase demand for goods, land, services, thereby leading to irreversible changes in physical landscape. He further stressed that construction of roads, houses, and industrial buildings causes environmental problems such as flood and pollution [13]. The expansion of concreted surfaces in cities and the resultant heightened volume and velocity of runoff that is thereby generated have tended to make many Nigerian cities increasingly susceptible to flash floods, Yusuf, 2007, in his studies of the quality of the Bauchi ground waters undertaken to determine the variationsin physical and chemical concentrations, reported that, as a result of over stressed sewage system, most of the canal are often little better than open sewers. In addition, the improper disposal of solid and liquid wastes near residential areas, poor wastes collection and handling and the state of physical infrastructure contribute to sewage problems [14]. In all these cases, it is expected that direct input of organic species of biological origin, major and minor in organic species and bacterial will occur in aquifer. Similarly Sabo A 2012, research work on Assessment of Wash-Borehole Water Quality

in Gombe metropolis, Gombe State, North-Eastern Nigeria investigated to ascertain its quality status and suitability for drinking and domestic uses in three different wards of the metropolis and find out that faecal coliform were within the permissible limits recommended by the Nigerian Standard for Drinking Water Quality (NSDWQ) and also, the World Health Organization (WHO) standards with the exception of nitrate (NO_3^-) He recommended that wash-borehole water in Gombe Metropolis should only be used for bathing and washing. The study therefore, stresses on the need for the study arose from the fact that there are not much done in the study area. Furthermore, the significance of this study lies in the fact that Gombe Metropolis is still a commercial nerve center of all the north east state of Nigeria and no current study on the bacteriological characteristics of groundwater in the Metropolis has ever been carried out. Hence, the data will serve as a reference point to assess any progress that would be made in future when it comes to management of the state's Environmentally-based natural and infrastructural resources. Such apart, to monitor the trend and spatial distribution of these contaminants in this environmental compartment and thus, it is essential to obtain and maintain a data base of the proportion of the contaminants in the water which plays host to chemical and many disease causing pathogens.

.

4 RESULT AND DISCUTION

Table 1.Locations and Result of Culture Media Analysi

Per 100ml	Locations					
	High Density Areas		Medium Density Areas		Low Density Areas	
	Pantami	Herwagana	Nasasrawo	Barunde	Hamadukafi	GRA
Bacteria colony after 24 hours	5200	7000	3800	4100	3100	2800
Bacteria Colony after 48 hours	10400	14400	7800	8400	3500	3200
Total	**15600**	**21300**	**11600**	**12500**	**6600**	**6000**

Source: Author's Analysis, 2015

Base on the laboratory analysis of culture media conducted, indicate the present of bacteria in all the water samples collected, and a confirmatory test was perform to determined the type of bacteria present in the water, sample water turn acid turn to yellow indicate coliform bacteria.

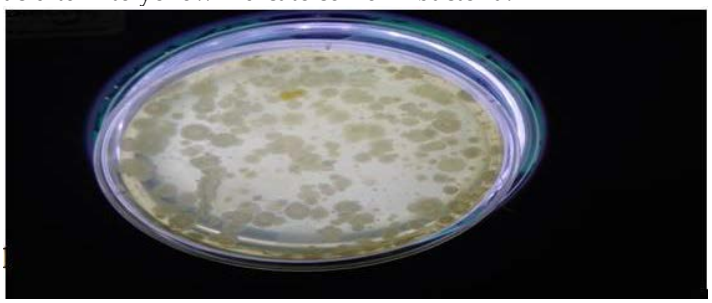


Plate 1:Slide Bacteria colony in high density area.

Furthermore the total coliform bacteria in the watersample exceeded general standard for coliform bacteria acceptable limit of <1 colony per 100ml.

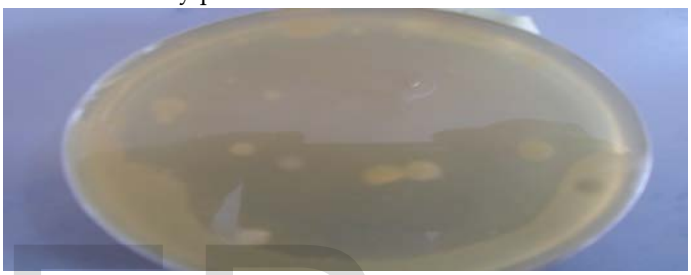


Plate 2:Slide bacteria colony in low density

See appendix 1 and plate 1 and 2.

Hypothesis Number (1) testing relationship between bacteria concentration in the study area with the general standard for coliform bacteria acceptable limit, One sample statistics (T-Test) was also used to examine if there is significant relationship between bacteria concentration in the study area with the general standard for coliform bacteria acceptable limit. The result shows that after 24 hours the coliform bacteria concentration is significantly different general standard for coliform bacteria acceptable limit of [0.99] concentration per 100 ml/g; Mean of bacteria after 24 hours, mean difference = [4332.343] and [P = 0.01]; since P> 0.05, alternative hypothesis is accepted, Which stated that there is no significant relationship between the concentration of coliform bacteria in all the water samples in the study area with the general standard for coliform bacteria acceptable limit. At 48 hours, mean difference = [7515.677] and [P = 0.03]; since P> 0.05, alternative hypothesis is accepted, Which stated that there is no significant relationship between the concentration of coliform bacteria in all the water samples in the study area varies with the general standard for coliform bacteria acceptable limit of [0.99] concentration per 100 ml/g. While the total indicate mean difference = [121.677] and [P = 0.003]; since P> 0.05, alternative hypothesis is accepted, Which stated that there is no significant relationship between the concentration of coliform bacteria in all the water samples in the study area

with the general standard for coliform bacteria acceptable limit. See table 2

Table .2. One-Sample Test AT 95% Confidence level

Table .2. One-Sample Test AT 95% Confidence level

Bacteria Concentration per 100ml	Test Value=WHO Standard = 0.99 of <1 coliform per 100/ mlg					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Bacteria Concentration after 24 hours	6.829	5	.001	4332.343	2701.60	5963.08
Bacteria Concentration after 48 hours	5.514	5	.003	7515.677	4012.12	11019.23
Total Bacteria Concentration	5.195	5	.003	121.677	61.47	181.89

Source: Author's Analysis, 2015

ANOVA

Bacteria concentration		Sum of Squares	df	Mean Square	F	Sig.
Total Bacteria Concentration	Between Groups	14776.333	2	7388.167	13.170	.033
	Within Groups	1683.000	3	561.000		
	Total	16459.333	5			
Bacteria Concentration after 24 hours	Between Groups	1036.333	2	518.167	9.091	.053
	Within Groups	171.000	3	57.000		
	Total	1207.333	5			
Bacteria Concentration after 48 hours	Between Groups	5504.333	2	2752.167	120.533	.001
	Within Groups	68.500	3	22.833		
	Total	5572.833	5			

Source: Author's Analysis, 2015

Hypothesis Number (2) testing variation in the concentration of coliform bacteria among low, medium and high density area of Gombe metropolis

One way Analysis of Variance (ANOVA) was used toexamine if there is significant spatial variation in the concentrations of the coliform bacteria between the low medium and high density areas of the study area. Result obtained indicate that the Coliform bacteria concentration after 24 hours and 48 hours varies significantly at P.24= [.053] and P.48 [.001], since the calculated value is less than table value of P< 0.05.

We therefore reject alternative hypothesis which stated that the concentration of coliform bacteria does not varies between low, medium and high density of the study areas. See table 3.

Table.3.Comparison of the mean difference of bacteria Concentration among low, medium and high density areas

5 Conclusion and Recommendation

Base on the laboratory analysis of culture media conducted, indicate the present of bacteria in all the water samples collected, See Plate 1 and. 2 and a confirmatory test was perform to determined the type of bacteria present in the water, result indicate present of coliform bacteria. In addition the total coliform bacteria in the water sample exceeded general standard for coliform bacteria acceptable limit of <1 colony per 100ml. One sample statistics (T-Test) conducted indicate no significant relationship between bacteria concentration in the study area with general standard for coliform bacteria acceptable limit while Analysis of Variance (ANOVA) conducted indicate that the concentrations of coliform bacteria varies significantly among the low medium and high density areas of the study area. As the water in

question indicated the presence of coliform bacteria, this situation may lead to outbreak of water borne diseases like Cholera, hepatitis, dysentery, giadiasis, typhoid fever. Another important factor that can result to this condition is the indiscriminate dumping of sewage and location of boreholes close to sewage as seen in most locations in the study area. Most of the high density area doesn't enough toilet conveniences. It is therefore, essential to treat water from this kind of ground water sources to make it fit for both drinking and domestic use. It is also central for government to embark on regular environmental sanitation exercises within the study area and also provide refuse disposal vehicle to populace of the study area to lessen indiscriminate sewage disposal in the area. This will improve the general health care and well being of the public in the study area.

REFERENCES

[1] Eziashi, A.C., (1995). Analysis and classification of natural river channels on the Jos Plateau. Ph.D. Thesis, Department of Geography and Planning, University of Jos

[2] Cornelia Muntean, Petru Negrea, Mihaela Ciopec, Lavinia Lupa, Ioan Ursoiu, Giannin Mosoarca and Ramona Ghiga (2006): Studies Regarding the Ground water Pollution in a Rural Area,Chem. Bull,Vol.51 (65), 1-2, Pp.75-78.

[3] Jidauna, G.G., D.D. Dabi, J.B. Saidu, B. Abaje and C. Ndabula, (2013) Assessment of well water quality in sleceted location in Jos, Plateau State, Nigeria.

[4] World Health Organisation and UNICEF. (2005). Water for Life: Making it happen.WHO Press, Geneva, Switzerland, p.4.

[5] Cunnigham W.P and Saigo B. W. (1999). Environmental Science: A Global Concern, Fifth Edition. McGraw-Hill Companies pp. 515-517.

[6] Kehinde M.O. (1998). The impact of Industrial growth on groundwater quality and availability in Osuntokun, A(eds) Current Issues in Nigerian Environment, Ibadan Danidan Press.

[7] Ocheri, M.I. C(2006).Analysis of water consumption pattern in Makurdi metropolis .Journal of Geography and development, Vol. 1, No.1, pp. 141-146.

[8] Omofonmwan, S.I., and Esigbe J.O. (2009).Effect of solid waste on the quality of groundwater in Benin metropolis, Nigeria. Journal of Human Ecology, Vol. 26 (2), pp. 99-105.

[9] Ahmed H. (2003). Effect of sanitation on groundwater quality. International Conference on Towards the Millennium Development Goal, pp. 183-185.

[10] Maina Benjamin (2009) Household solid waste management in Gombe Metropolis, Gombe state Nigeria, Bsc Thesis, Department of Geography Gombe state University.

[11] National Population Commission: Federal Republic of NigeriaOfficial Gazette: Legal Notice on publication of 2006 Census Report, p.185. 2007

[12] Leopold, L.B.(2000). The contribution the article on water Research on Hydrology of the(1961). Management prospects. Journal of the Earth and Environmental Science. Vol.7

[13] Olokesusi, A. (2005). Appraisal of characteristic environmental problems and management prospects in Nigeria. Journal of the Earth and Environmental Science. Vol.7 No.1,pp 55-60

[14] Yusuf, (2007), Water Quality Index: a fuzzy river pollution decision support expert system. J. Water Resource Plan. Manage. 133, 95-105.

APPENDICES

General standard for coliform bacteria acceptable limit

Contaminant	**Acceptable limit**	**Sources / Uses**	**Potential Health Effect at High Concentration**
Total Coliform	<1 coliform/100 ml	possible bacterial or viral contamination from human sewage or animal manure	diarrheal diseases, constant high level exposure can lead to cholera and hepatitis

Source: College of Agricultural Sciences, Peen State. (2013)