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An Evaluation of Ground Water Quality along River Ginzo in Urban Katsina, Katsina State, Nigeria

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Abstract: This paper examines the quality of ground water along river Ginzo in Urban Katsina, Katsina State. The area falls within the urban slums with open sewage drains and refuse disposals subjecting it to a high health risk. This triggers the need to assess their major sources of domestic waters which are shallow wells. Groundwater samples were collected from wells systematically sampled across the study are. These were leveled as well A – J. Laboratory tests were conducted on Physiochemical and Bacteriological parameters to ascertain the presence of contaminations or otherwise. All the results obtained were compared with the World Health Organization's (WHO) standards of safe drinking water for logical conclusions. Results shows that turbidity of the water in the study area ranges from a minimum of 0.410 in well F to a maximum of 7.79 in well H. This implies that the Turbidity level can be safely consumed. Only well H is not permissible. pH shows a minimum of 6.57 in well J and a maximum of 7.18 in well F. This reveals that the pH of the water samples from well A to well J are all within the range of the WHO standard of 6.5 to 9.2. TDS shows results all below 1500 of the WHO and is thereby safe for consumption. Total hardness in the water sample also has a maximum of only 1294 across the study area, so is consumable regarding the standard of WHO (1500). The results of total Coliform obtained shows that the water sample from wells B, D, F, G, and J fall below the WHO permissible limit of 5, whereas wells C, E and H have values of 5, 8 and 13 respectively which is above the WHO permissible limit of 5 which indicate presence of excess coliform. The study concludes that the physiochemical parameters studied are within the permissible limits set for safe drinking water except for few locations. Yet there is excess amount of total coliform presence in the water. This is attributed to uncontrolled domestic sewage discharge and indiscriminate solid waste disposal which is so conspicuous in the area. The study recommends Public enlightenment campaigns against illegal and unplanned constructions of houses in the area. Public water supplies in form of standardized boreholes should be provided by the community with the intervention of the government to substitute the shallow wells.

Key Words: River Ginzo, Groundwater, Katsina, Water quality

INTRODUCTION

Water is indispensable for life and socio-economic development of any society. The use of water in general can never be over emphasized in domestic activities and in agricultural practices that involve irrigation and gardening. It is also used in generation of hydroelectric power, industrial operations and recreational activities. Water it is very essential for human existence and for sustenance of life. Water constitutes 60 - 70% of the total body weight. A human being can live for several days without food but will only survive for few days without water. Therefore, water is indispensable for normal physiological function of plants and animals. In spite of its importance in sustenance of life and livelihood, it is the major cause of morbidity and mortality because of limitation in access and quality (Andrew, 1998).

The basic physiological requirement for drinking water has been estimated at about 2 liters per capita per day which is just enough for survival (Gorchev and Ozolins, 1984). The World Health Organization (WHO) states that domestic water consumption of 30 -35 liters per capita per day is the minimum requirement for maintaining good health (Cleave, 1998). However, the amount of water required by individuals varies depending on climate, standard of living, habit of the people, and even age and gender.

The factor that impinges more on the accessibility to enough quality drinking water, that is the distance of the source from home, forces the individual more especially women and children to transverse many kilometers to get safe drinking water. In addition to this, in order to reduce the hardship in getting water, they may resort to reducing the quantity used in the house far below the recommended volume and also they may resort to be fetching water from unimproved sources, for example, unprotected wells and stream. (WHO & UNICEF JWP, 2006).

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Safe and quality drinking water is that which does not present any significant health risk over life time consumption, including any sensitivity that may occur in different stages of life (WHO, 2006). It is water which is free from pathogenic microbes, hazardous chemicals substance and aesthetically acceptable (pleasing to sight, Odorless, and good taste). It is important that this type of water should not only be available but also be available in enough quantity all the time (Park's, 2005).

Evaluation of ground water quality is to investigate or assess the quality of drinking water obtained from that source. In the course of doing that, physical, chemical and bacteriological parameters are expected to be considered. Although water from a source may not pose any health threat to consumers, they may abhor it due to its colour, odour or taste (WHO, 2006).

Physical parameters include colour, odour, temperature, pH, and turbidity. The chemicals parameters are mostly released due to anthropogenic activities. They include applications of fertilizer, pesticides, herbicides, industrial effluents and byproducts. The Bacteriological parameters are the pathogens associated with infectious risks on drinking water.

In Nigeria, 315,000 under 5 children die annually due to diarrhea which is 23 times more than under 14 years mortality in Europe caused by the same (Aliyu, 2000). This signifies the need for assessment of the ground water quality and to examine the quality of well water in some selected areas along the Ginzo river channel in Katsina state. This is an area with very poor environmental quality and high health risk. It represents an officially neglected area because of its rough terrain and as well located at the periphery of the city and close to the industrial area. Most of the waste generated close-by is dumped in this area and the area has no any provision of proper sewage drains.

The Study Area

The study area is the catchments of Ginzo River which drained parts of the urban and peri-urban Katsina, the capital city of Katsina state of Nigeria. The area lies between latitude 12°, 60' and 12°, 75' North of the equator; and between longitudes 07°, 35' and 08°, 10' east of the Greenwich (Maxlock Group, 1977). The area occupies part of the central plain of Hausa land, at the extreme part of Northern Nigeria on a height of about 500 meters above mean sea level. This is a part predominantly underlain by crystalline rocks of the basement complex. But at the Northern and eastern parts of the area, several feet weathered materials cover the solid rock, which has accumulated over drier climatic condition (Maxlock Group, 1977).

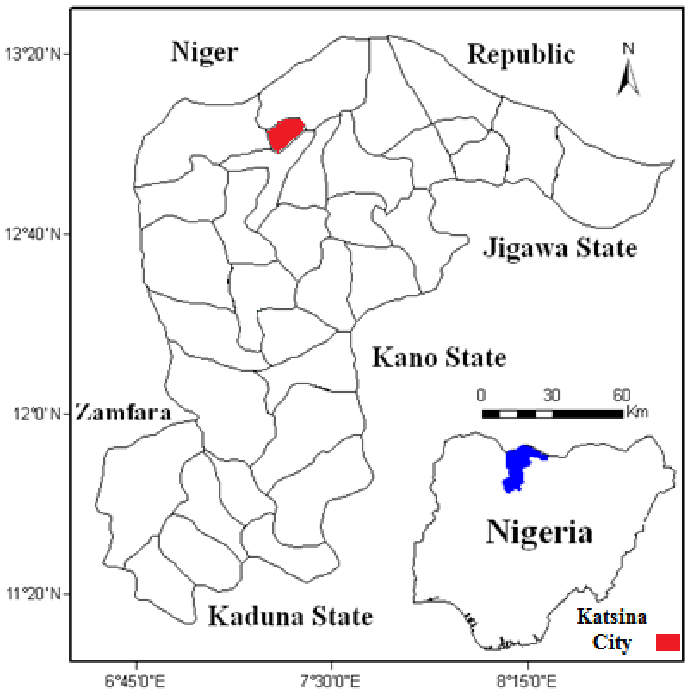

Figure 1: Map of the Study Area

The climate type of the study area is a hot one owing to its located in the dry tropics with mean annual temperature of about 27°C (NIMET, 2019). The temperature is uniformly high throughout the year, but open air condition can be very uncomfortable during the dry season. The mean monthly temperature vary from 24°C to 31°C and reaching about 36°C in March (NIMET, 2019). This shows a wide range of up to 12°C. The month of December and January are usually

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cold and dry with temperature of about 24ºC and 26ºC respectively. This condition is due to the influence of the Hamattan wind from the Sahara (NIMET, 2019). Katsina is within the tropical wet and dry climatic zone which is characterized by wet and dry seasons. The rainy season begins from May and end sometime in October with high variability in intensity and duration. The mean annual rainfall amount for the area is recorded as 879 mm (NIMET, 2019).

The soil type is the Ferruginous tropical Red and Brown soils of the Basement Complex Rocks in the area. The parent materials are composed of unconsolidated sand, the nature which renders the area very porous and susceptible to erosion on the interfluves and upper slopes of the underlying areas, while on the seasonally flooded valley floors a high clay content heavier grey soil occurs. The Lateritic drift soils of the area are coarse and tend to be shallow, less water retentive capacity and of low or medium fertility. This provides the medium for the growth of typical vegetation type of the area characterizes by sparse trees, grasses and shrubs of the Savannah (WAKUTI, 1978).

The Ginzo River is alongside Tille River and both are prominent tributaries of the Abdallawa River. The two rivers formed the main catchment, dividing the city of Katsina into two. Tille catchment occupying North-western part, while Ginzo catchment occupies the south-eastern part. The two rivers are seasonal in flow. They nearly dry up during the dry season if not because of the domestic sewages. Their flows varied significantly with time throughout the rainy season. The entire Ginzo Catchment covers an area of 48km^2 and has its length of streams totaling to 12.2 km, Ibrahim (2004).

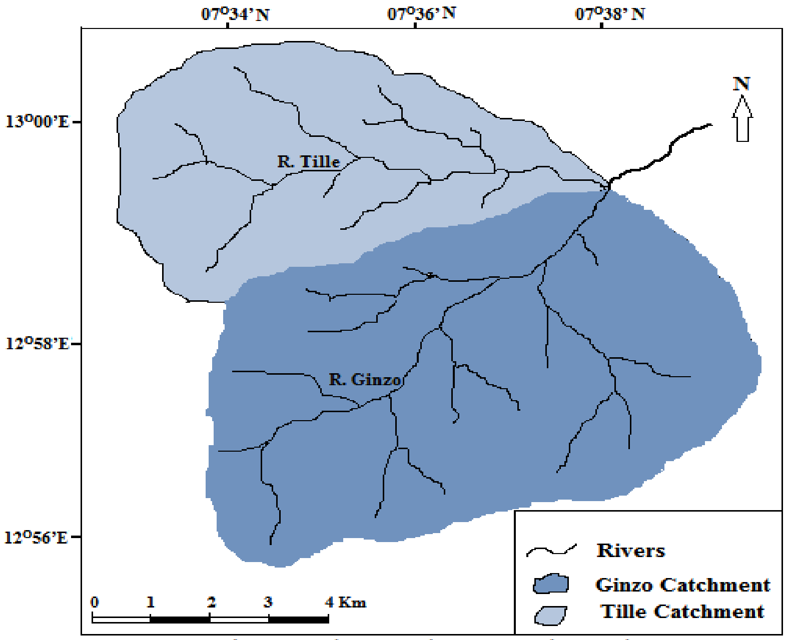

Figure 2: The Two River Catchments Under Study
Source: Sport 4 Imagery, 2008.

MATERIALS AND METHODS

Water Sampling

The stretch of the area identified suitable for sample collection extends for about three kilometers. The suitability of the area for sample collection is based on presence of risk factors which were marked by human activities with high potentiality of imposing contamination. These activities involve sewage and waste disposal as well as construction activities along the river banks.

Samples of water used in this study were collected from dug wells found at various locations along the river. The sampling technique was rather very simple because only wells within 300 metres away from both sides of the river were considered. This is to avoid encroaching into an area with a different land-use or human activity such as auto mechanic. For this reason, the sampling area was found small and number of wells were also not too many. However, a total number of seven wells were identified and considered for the study. The sampled wells were named well A, well B, well C, well D well E Well F Well G Well H Well I And Well J with respective depth of 7.3m, 4.89m, 6.44m, 5.43m, 7.03m, 6.25m, 7.00m, 4.50m, 5.02m and 7.45m. The samples were collected on 16-08-2019 which was taken to Ajiwa Water Treatment Laboratory for examination

Tests for Physical Parameters

- **Turbidity Test:** To obtain the turbidity of the water samples, the use of a Turbidometer was employed. Using other appropriate supporting tools, the turbidimeter was turned on and the LCD light was displayed which shows dash

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line, waited for 25 to 30 seconds for the result to be displayed for the readings of the first experiment. The water from the concave was discarded and repeated the same experiment with the same water sample three times and took their average. Then compared it with the standard range of WHO.

- **Determination of pH level**

To determine the pH value of water sample, the P^H meter which was already attached to the electrodes was turned on. The electrode was then immersed into the water gently and the reading was recorded. This was repeated three times using the same sample of water and at the end the average was obtained for comparison with the Standard of WHO as specified for drinking water.

- **Determination of Total Dissolved Solids (TDS)**

To determine the total Dissolved Solids in the water sample, the T.D.S meter was turned and then deepened the bottom sensor of the meter into the 150ml of water sample. After repeating the same test using the same water sample for three times then the average was taken and finally compared to the standard range of WHO T.D.S.

Test for Chemical Parameters

- **Total Hardness**

2ml of ammonia buffer solution was added to 100ml water sample in a conical flask on which 1 Tablet of Erichome Black T was added. The solution was then titrated till it turns colour blue.

- **Calcium Hardness Test**

1ml of 4N NaOH was added to 100ml of the water sample into a conical flask after which 1 tablet of Erichome Black T was dropped into the sample. The solution was then titrated with 0.2N EDTA until its colour changes to violate as illustrated below.

$$\text{Hardness (Mg/L) as } CaCo_3 = \frac{\mathbf{Volume(Mg)ofEDTAX1000}}{\mathbf{Volume(ml)ofwatersampleused}}$$

* Where, Volume (ml) of EDTA = TITER Value.

Bacteriological Test

- Diluted MacConkey broth was poured in the bottles at 10ml per bottle and were placed inside an autoclave for about 1 hour at 121^0C then was removed and allowed to cool.
- 75 numbers of bottles containing the MacConkey solution were divided into 5 parts resulting to 15 bottles for each part. Each part of the 15 bottles was further divided into 3 parts to have 5 bottles in each group. The 1st, 2nd, 3rd 4th and 5th were grouped for the number of samples of water from A to E respectively.
- Each water sample was poured into the MacConkey solution in 3 parts, the first 5 parts were 10ml, the second 5 parts were 1ml and the last 5 part was 0.01ml. These were all bonded together using masking tape and labeled accordingly.
- The 75 bottles were arranged on a flat tray and placed in an oven for 48 hours. The samples were removed from the oven and the observation was made on each 15 samples according to the specimen and recorded as the result of that respective sample.

RESULTS AND DISCUSSIONS

Result of Water Physical and Chemical Parameters Tested

The tables I and II represent the various results obtained from the experiments described so far on the physical and chemical parameters of water set for consideration in this study. The tables also compares the results obtained and that of the WHO standards in order to analyze the results obtained for further logical conclusions.

Table I: Results of Physical and Chemical Parameters Tested (Wells A – E)

S/N	PARAMETER	WELL A	WELL B	WELL C	WELL D	WELL E	W.H.O Standard
1.	Turbidity (FTU)	1.61	0.829	0.767	0.998	1.04	2.5
2.	pH (mg/l)	7.04	6.87	6.87	6.88	6.88	6.5 – 9.2
3.	T.D.S (mg/l)	338	359	521	437	355	1500
4.	Total Hardness (mg/l)	142	160	121	101	118	200
5.	Calcium Hardness (mg/L)	23.2	22	25.01	32	31.08	25 – 100

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Table II: Result of Physical and Chemical Parameters Tested (Wells F – J)

S/N	PARAMETER	WELL F	WELL G	WELL H	WELL I	WELL J	W.H.O Standard
1.	Turbidity (FTU)	0.410	0.729	7.79	1.31	0.747	2.5
2.	P^H (mg/l)	7.18	7.00	6.82	6.58	6.57	6.5 – 9.2
3.	T.D.S (mg/l)	905	1294	654	851	879	1500
4.	Total Hardness (mg/l)	150	131	140	102	150	200
5.	Calcium Hardness (mg/l)	30	25	15	35	25	25 – 100

Based on the analyses carried out on the water physical and chemical parameters under study ranging for all the sampled wells A to J, and the comparisons made so far with the standard and permissible ranges of the World Health Organization (WHO), the following were depicted as displayed in the above tables:

Turbidity: The turbidity which represents the solution of fine suspended particles of clay sand, silt or organisms contained in the water could be observed clearly in the tables. The tables reveal that the turbidity of the water in the study area ranges from a minimum of 0.410 in well F to a maximum of 7.79 in well H. With these therefore, almost all the results are ranging within the standard of the World Health Organization (WHO) with exception of well H. This implies that the Turbidity level can be safely consumed. Only well H is not permissible.

pH Levels: This stands for the Acidity/Alkalinity of the water or rather a measure of the relative amount of free hydrogen and hydroxyl ions in the water implying its Quality for specific use. The tables I and II shows a minimum of 6.57 in well J and a maximum of 7.18 in well F. This reveals that the pH parameter of the water samples from well A to well J are all within the range of the WHO standard of 6.5 to 9.2. It then implies that the waters in the respective wells are safe for consumption.

Total Dissolved Solid (TDS): The TDS level of water indicates the hardness of water. The TDS result obtained from Tables I and II above show that none of the wells have a total dissolved solids of up to 1500 which stand as the WHO standard. Having gotten results all below such standard, the water in the entire sampled wells can said to be safe for consumption.

Total Hardness: The rate of total hardness in the water sample having a maximum of only 1294 across the study area, is consumable regarding the standard of WHO (1500) which makes the water in the respective wells consumable with regard to their content of total hardness.

Calcium Hardness: This is expressed in terms of the amount of calcium carbonate (the principal of limestone) or equivalent materials in water. In comparing the Calcium hardness result from Tables I and II above, the values obtained from the samples collected shows that only well H falls below the WHO standard (25 – 100) with only 15, whereas all others stand to be safe for consumption going by their levels of calcium hardness.

RESULTS OF WATER BIOLOGICAL PARAMETERS TESTED

Faecal Coliform Test: This is a test for bacteria present in water that has been infected by surface water coming in contact with human or animal waste. The coliform bacteria (pathogens) are naturally found in both physical and non-physical environments.

Table III: Results of Biological Parameters Tested

PARAMETER	WELL A	WELL B	WELL C	WELL D	WELL E	W.H.O Standard
Faecal Coliform	3	1	2	1	3	5
Total Coliform	8	2	5	2	8	5

Table IV: Results of Biological Parameters Tested

PARAMETER	WELL F	WELL G	WELL H	WELL I	WELL J	W.H.O Standard
Faecal Coliform	0	1	4	2	1	5
Total Coliform	2	2	13	5	2	5

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The total coliform test is the primarily indicator of portability and suitability for consumption of water. Meaning the concentration of total coliform bacteria associated with possible presence of disease causing organism.

The results of total Coliform obtained from the laboratory which is presented in Table III and IV above shows that the water sample from wells B, D, F, G, and J fall below the WHO permissible limit of 5 with values of 2 for all of them. The results in the tables also shows other two sampled well (C and I) with values of 5 each, which is exactly the same with WHO permissible limit. For the remaining three wells, C, E and H have values of 5, 8 and 13 respectively. Their results are clearly above the WHO permissible limit of 5 which indicate presence of coliform at a rate which obviously render the well waters risky for consumption.

Many national and international studies have addressed so many impacts of solid waste and sewage on groundwater quality. Although, most of the related studies considered the variables, sewage and solid waste, separately. The outcome of this study coincides with some and has obviously stands on the contrary with some. For example, According to Anilkumar et al. (2015), the solubility of organic contaminants in waste can be slightly enhanced through the presence of high levels of organic carbon in the leachate. The results of tests confirmed that leachate from the municipal landfill site under review constituted a source of contamination of the water environment, which was also shown by Kanownik and Policht-Latawiec (2016). Other researchers also proved the impact of municipal solid waste landfills on the deterioration of groundwater quality with varying degrees of pollution (Han et al. 2016; Al-Hogaraty et al. 2008), (Mohammed, 2011).

CONCLUSION

In conclusion, the physiochemical parameters studied in this work are within the permissible limits set for safe drinking water. Except for few locations, there is no contaminations in this respect with regards sewage and solid waste disposals in the area. On the contrary, there is excess amount of total coliform presence in the water which makes the water from the respective wells in the study area not suitable for consumption due to the amount of coliform content in the water. The contamination is associated with the uncontrolled domestic sewage discharge and indiscriminate solid waste disposal which is so conspicuous in the area. The shallow nature of the wells also contributed to the bad condition of the ground water because the contaminants are not subjected to passing through thick earth material for adequate soil filtering. The ground water condition in the area is also found to be regular in its spatial distribution.

Recommendation

To curtail for the excess amount of total coliform identified in the water and concluded unsafe by this study, the following recommendations were made.

- Public water supplies in form of standardized boreholes should be provided by the community with the intervention of the government to substitute the shallow well susceptible to contaminations by sewage and waste dumps.
- The quality of the underground water from the boreholes should also undergo periodic test to ensure its safety for domestic use and to monitor any change in quality of the water for human consumption and other domestic activities.
- There is the need for Public enlightenment campaigns to avoid illegal and unplanned constructions of houses in the area which lead to uncontrollable and indiscriminate sewage waste disposal.
- Authorities should control population influx and illegal dwellings or alternatively ensure provision of safe piped born water supply for sustainable and safe livelihood in such low income earners lay-outs.
- More researches should be embarked upon on sources of drinking water and sanitization in urban slums in order to achieve long lasting solution to ground water contaminations for domestic use in such areas.

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