

# An Assessment of the Bacteriological Quality of Ground Water in Geidam Municipality, Jigawa State Nigeria

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## Paper History

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## Abstract:

An investigation was conducted to determine the human impact and bacterial contamination of untreated groundwater. Geidam is a region with numerous sources of contamination, including a large animal market, municipal landfills, and pit latrines. From the boreholes (BH1–BH15), groundwater samples were obtained and analysed according to prescribed standards. Thirteen of the boreholes revealed coliform organisms. Four boreholes [BH11, BH12, BH13, and BH15] featured threshold *E. coli* levels that exceeded the Nigeria Standard for Drinking Water Quality (NSDWQ) recommended limits. In order of prevalence, cholera, dysentery, and typhoid waterborne diseases affected a large number of people in the years 2017, 2018, and 2019, respectively. The diseases are attributed to leaching and infiltration, mainly from waste dump sites and contamination of groundwater. Without proper purification, the water from these sources was therefore unfit for human consumption. It was suggested that groundwater be monitored regularly and environmental sanitation be strictly emphasised. An alternative process of disinfection, such as boiling water for domestic use, should be encouraged for the local residents to prevent the proliferation of waterborne diseases.

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## 1. Introduction (11 Bold)

Water is one of the best natural resources in the world's ecosystem. It is the most essential element, connecting everything. It can be made to serve various functions, such as domestic, industrial, agricultural, transportation and other uses. Additionally, it is a universal solvent that cannot be created nor destroyed on the surface of the earth. Neither man, plants, nor other animals can survive for long without water. Water that is meant for drinking should be of high quality [1, 2]. Most people in developing economies get most of their water from groundwater, which is found below the earth's surface in soil pores and cracks in rock formations [4-6]. Unfortunately, human activities contribute to polluting groundwater in both urban and rural areas. In Nigeria, where the population is estimated to be around 200 million, with 52.0 percent of the population living in cities, approximately 40% of the population lacks access to improved drinking water, and more than 62.5 percent lack access to improved sanitation [7 - 9]. Conditions 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 microscopic, unicellular organisms that thrive in large numbers in all environments, both within and outside of other living things, and are responsible for fermentation or nitrogen fixation and for many plant and animal diseases [8, 9].

In Nigeria, the rate of urbanization, which is characterized by high population concentration, increasing industrial and agricultural activities, combined with environmental pollution and degradation, and indiscriminate disposal of all types of waste, is perceived to pose serious pollution threats, with all of the associated health hazards to groundwater quality, particularly in urban areas [2]. This concern has attracted scholars in the field of

environmental pollution to embark on surface and groundwater pollution studies. Ezezie, *et al.* [4] revealed in his study 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. So, a lot of people depend on hand-dug wells and borehole systems to get groundwater devoid of treatment [1]. The determination of groundwater quality for human consumption is important for the well-being of the ever-increasing population [5]. The supply of good quality water is one of the important components of groundwater protection and conservation strategies and is therefore useful in the planning and management of groundwater. Inland surface water quality depends on the quality of recharged water, atmospheric precipitation, inland surface water and subsurface geochemical processes [6].

Water pollution affects not only the quality of the water, but also human health, economic growth, and social well-being. Water quality includes all physical, chemical, and biological factors of water that influence its beneficial use. The provision of safe drinking water and water of acceptable quality remains a prime target for both advanced and developing countries. By far, the greatest water quality problem in developing countries is the occurrence of water-borne diseases [7]. The bacteriological quality of most drinking water in many rural areas of sub-Saharan Africa is worrisome. Interestingly, water-borne illnesses like typhoid fever, amoebic and bacillary dysentery, cholera, meningitis, and diarrhoea, as well as food and equipment damages, are caused by bacteria [8]. Studies of Aminu and Amadi [9] have shown that the act of disposing of faecal waste and untreated effluents into rivers and streams is still common in rural areas of the country. Water is an important resource that

needs to be protected from pollution and biological contamination. Unfortunately, in many countries around the world, clean water has become a scarce commodity as only a small proportion of the population has access to treated water. Water related diseases are the single largest cause of human sickness and death, thus, improvement of access to clean water is a crucial element in the reduction of underage mortality in rural areas [9]. In Nigeria, groundwater is the most common source of water in rural communities [3]; it has proved to be the most reliable resource for meeting water demand in rural areas. There is a need for consistent monitoring of the rate and impact of microbial contamination of water bodies, especially in rural and semi-urban areas where high dependence on groundwater is rife. The purpose of this study is to examine the levels of water quality parameters related to microorganisms. In order to correlate the potential human health risk, an assessment of the potential increase of waterborne diseases in the study region was also conducted. The purpose of this study is to examine the levels of water quality parameters related to microorganisms. In order to correlate the potential human health risk, an assessment of the

potential increase of waterborne diseases in the study region was also conducted.

## 2. Materials and methods

### 2.1 Study area

Geidam is one of the seventeen local governments in Yobe State, Nigeria. It is located at latitude 12° 54' 33" N and longitude 11° 55' 21" E. Geidam Town is its capital, with a population of about 89,595 [10]. The climate of the area, like other parts of northern Nigeria, is characterized by dry and rainy seasons. These seasons are usually punctured by the harmattan wind from the Sahara Desert, which brings about cold, usually in the months of December to February. The area consists of scattered trees, sparse shrubs, and grass. The trees here grow long tap roots and thick bark that make it possible for them to withstand the long dry season. The grass too has long, durable roots that remain underground after the stalks are burned away or wilted in the dry season, only to germinate with the first rain. Farming is the main occupation of the people, and groundwater is the main source of water for both irrigation and domestic use for most of the seasons.

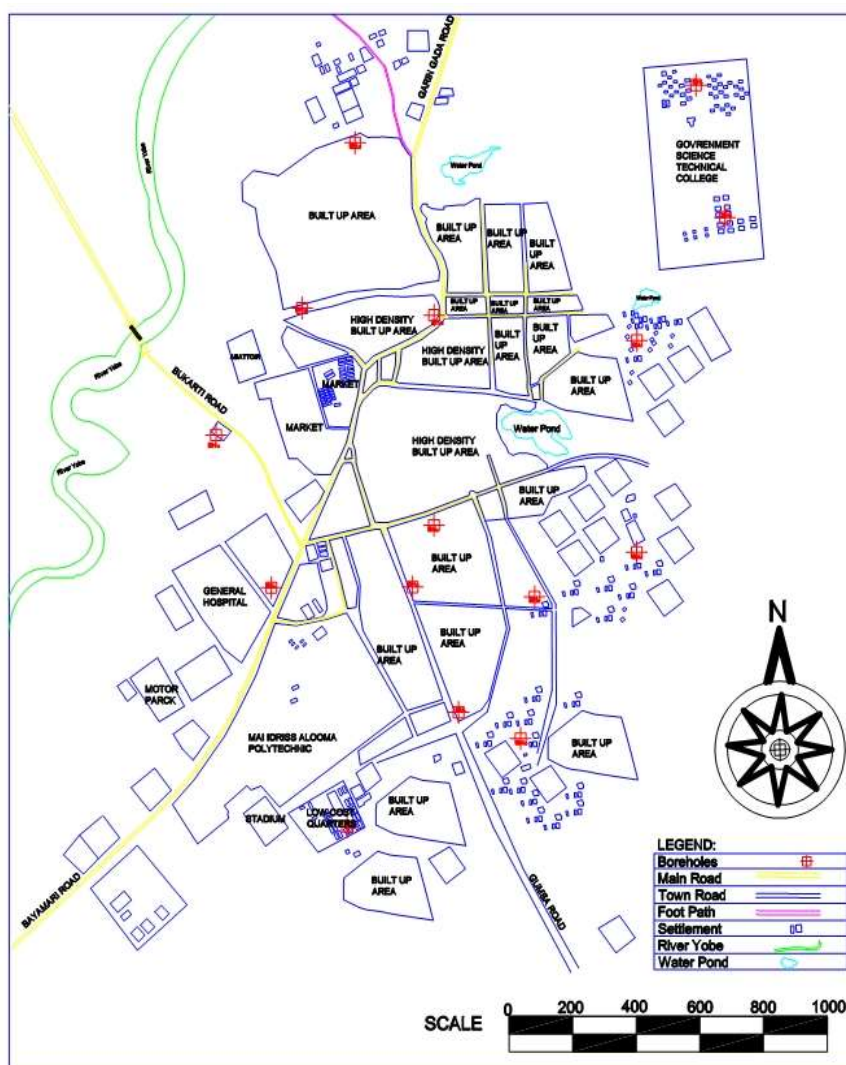


Fig.1.0 Sketch Map of Geidam Town showing the location of boreholes

### 2.2 Sample collection

Samples were procured from fifteen boreholes. Sampling bottles were sterilized by autoclaving at a temperature of 121°C for 15

minutes. These were used for collecting samples for microbial analyses. Each bottle was labeled according to the sampling location and transported to the laboratory.

Table 1: GPS readings of the selected fifteen sites in the study area

Location Name	Code	N	E	Elevation (m)
Filin Idi*	BH <sub>1</sub>	12°53.853'	11°56.225'	334.3
Fulatari M. D. Mosque*	BH <sub>2</sub>	12°53.337'	11°56.218'	325.8
G.T.C. Admin*	BH <sub>3</sub>	12°54.387'	11°56.354'	324.0
G.T.C. Quarters*	BH <sub>4</sub>	12°53.058'	11°56.465'	326.7
General Hospital Main*	BH <sub>5</sub>	12°53.266'	11°55.260'	301.8
Hausari Kankare*	BH <sub>6</sub>	12°53.408'	11°55.690'	327.0
Kusurmai Main*	BH <sub>7</sub>	12°52.933'	11°55.753'	324.4
Low-course Main*	BH <sub>8</sub>	12°52.682'	11°55.450'	331.1
Maikeli Fulatari	BH <sub>9</sub>	12°53.231'	11°55.950'	326.3
Alhaji Sani	BH <sub>10</sub>	12°52.888'	11°55.911'	327.1
Mohammed Babin	BH <sub>11</sub>	12°53.259'	11°55.635'	315.8
Filin Ajari*	BH <sub>12</sub>	12°53.919'	11°55.727'	327.0
Musa Tashan Maini	BH <sub>13</sub>	12°53.939'	11°55.354'	322.5
Ngadala Primary School*	BH <sub>14</sub>	12°54.340'	11°5.496'	334.4
Nuri 1	BH <sub>15</sub>	12°53.633'	11°55.125'	331.4

\* = Public boreholes. BH= Borehole

Water quality parameter analyses carried out in accordance with standard methods [11] were total coliforms and faecal coliforms (*E. coli*). A medical report of diseases related to drinking water was simultaneously collected from the survey data of the primary health care department in the local government.

### 2.3 Bacteriological analysis of the water samples

The presumptive test was performed using 10 mL of lactose broth diluted with 10 mL of distilled water in a McCartney bottle. The McCartney bottle was fitted with a Durham tube. The bottle holding the water sample and lactose broth was kept in an incubator at 36 °C for 24 hours. After 24 hours, the McCartney bottle was removed from the incubator and examined for the presence of air bubbles, which indicates the presence of coliforms. The Eosin methylene blue (EMB) was poured into the petri dish and allowed to coagulate for the full test. Using a sterile wire, the water sample from the confirmation test was streaked. It was observed for a change in pigment after 24 hours of storage. A change in the EMB's color reveals the type of bacteria present.

### 3. Results and discussions

The data presented in fig. 2 shows that the total coliform for BH<sub>1</sub>, BH<sub>10</sub>, and BH<sub>14</sub> did not exceed the allowable limits according to the Nigerian standards for drinking water quality [11]. But for BH<sub>11</sub>, BH<sub>12</sub>, BH<sub>13</sub>, and BH<sub>15</sub>, the values exceeded the limit of 10 cfu/100 ml (see table 2 and 3) of the Nigeria standard of drinking water quality. The presence of coliform bacteria may indicate the presence of pathogens that cause dysentery, hepatitis, typhoid fever, or cholera. Even though not all coliform bacteria can cause illness in humans, the presence of any coliform poses a health risk. The presence of coliforms in water sources is predominantly caused by inadequate well casing, the feces of warm-blooded animals or humans, septic systems, economic activities (agricultural, industrial, and commercial), residential waste, and flooding all contribute to water pollution.

*Escherichia coli* (*E. coli*) an internationally recognized biomarker of fecal contamination is used for routine testing and surveillance [12]. *E. coli* is present in feces because it is a commensal of the gastrointestinal tract of animals. Therefore, the presence of *E. coli* in water indicates recent fecal contamination as well as the possible existence of enteric pathogens that can

cause water-borne gastrointestinal infection [13]. The analysis on the coliforms exceeded samples recorded values above the recommended limit. This may mainly be the result of contamination from waste that came into contact with the groundwater. In the study area, BH<sub>11</sub>, BH<sub>12</sub>, BH<sub>13</sub>, and BH<sub>14</sub> were in close proximity (less than 100 meters) to a popular cattle market site. Animal dung, or litter, is common in the area. And the pit latrines were unlined and not located at conveniently safe distances. All these could have generated a high concentration of microbial organisms. Other researchers have shown that high coliform counts are a common characteristic of rural ground water in Nigeria [7, 14, 15].

In addition, it is worth noting that while the presence (or concentration) of *E. coli* in water supplies at any given time indicates some level of contamination susceptibility, the apparent lack of indicators only suggests an absence in the sample taken but not essentially an absence from the water supply over time (i.e., an absence of susceptibility), unless corrective action is taken. Consequently, routine monitoring of fecal indicator bacteria (FIB) as well as their occurrence in groundwater is required to develop sampling variability indicators and potential risk assessments for well water consumers and health officials.

Table 2: Report of Microbiological Parameters

Location	Total Coli form [CFU/100ml]	E. Coli [CFU/100ml]
BH <sub>1</sub>	5	0
BH <sub>2</sub>	3	0
BH <sub>3</sub>	2	0
BH <sub>4</sub>	3	0
BH <sub>5</sub>	3	0
BH <sub>6</sub>	5	0
BH <sub>7</sub>	2	0
BH <sub>8</sub>	1	0
BH <sub>9</sub>	1	0
BH <sub>10</sub>	0	0
BH <sub>11</sub>	12	2
BH <sub>12</sub>	15	1
BH <sub>13</sub>	26	5
BH <sub>14</sub>	0	0
BH <sub>15</sub>	25	5

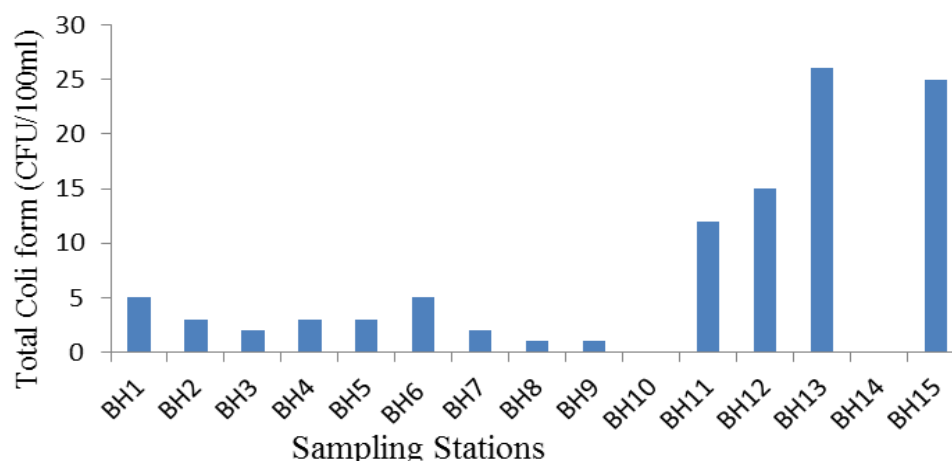


Fig. 2. Total coliform at the sampling locations

Table 3.0 Microbiological limits from the Nigerian Standard for Drinking Water Quality NSDWQ, [2015]

Parameters	Unit	Maximum permitted level	Health impact
Total coliform count	CFU/100ml	10	Indication of fecal contamination Urinary tract infections, bacteraemia, meningitis, diarrhea (one of main cause of morbidity and mortality among children), acute renal failure and hemolytic anemia.
Thermo tolerant coliform or E. coli	CFU/100ml	0	
Fecal streptococcus	CFU/100ml	0	Indication of recent fecal contamination
Clostridium perfringens spore	CFU/100ml	0	Index of intermittent fecal contamination.

### 3.1 Community health indicators.

The data on Table 4 shows medical reports of diseases related to drinking water for the years 2017, 2018, and 2019 in the study area as reported by the surveillance office, primary health care department, Geidam local government. The Table depicts the evolution of hospital treatments for waterborne diseases in Geidam from 2017 to 2019. There is a discernible trend of fluctuation in the number of cases during the period under consideration. Cholera is the most prevalent disease, which affected 1567, 1565, and 1688 people in the years 2017, 2018, and 2019, respectively, followed by dysentery (807, 1062, and 144) and typhoid (246, 246, and 153). This number of potentially

affected individuals places a tremendous strain on the public health system. The origins of the diseases are identical: inadequate water quality and sanitation conditions contribute to the spread of these infections. Several waterborne diseases, such as cholera, dysentery, and typhoid fever, are prevalent in many developing nations. These diseases are closely linked to poverty and low socioeconomic conditions, such as poor sanitation and a lack of access to safe drinking water. Waterborne diseases continue to be a significant cause of morbidity among vulnerable and disadvantaged populations worldwide, particularly in economies with low incomes.

Table 4: Medical records containing cases of drinking water-associated disorders

Month	YEAR								
	2017			2018			2019		
	Cholera	Dysentery	Typhoid Fever	Cholera	Dysentery	Typhoid Fever	Cholera	Dysentery	Typhoid Fever
January	134	137	18	124	118	32	115	2	0
February	76	35	2	133	123	04	204	9	9
March	167	5	16	145	26	28	205	9	0
April	157	12	12	132	76	09	79	15	18
May	112	34	22	87	123	14	120	0	0
June	157	109	32	167	139	12	74	10	0
July	137	127	30	127	117	18	228	18	23
August	122	147	33	132	127	23	118	0	24
September	138	31	25	128	41	29	89	34	23
October	98	1	27	91	15	37	65	8	12
November	112	94	8	122	71	12	204	7	18
December	157	75	21	177	86	28	187	32	26
<b>Total</b>	<b>1567</b>	<b>807</b>	<b>246</b>	<b>1565</b>	<b>1062</b>	<b>246</b>	<b>1688</b>	<b>144</b>	<b>153</b>



#### 4. Conclusion

This investigation evaluated the level of microbial contamination in Geidam's boreholes using samples collected at 15 study sites. There was coliform contamination in 86.7% of the sources. In addition, 26.7% of the sources had *E. coli* concentrations above the recommended limit and were classified as having a very high risk of fecal contamination. This result demonstrates that the water from some boreholes is not suitable for consumption and requires additional treatment prior to consumption. High *E. coli* concentrations were primarily found sources in close proximity to areas with inadequate sanitation, such as the animal market, indicating that sanitation conditions may influence the level of *E. coli* contamination. Therefore, it is recommended that the water supply be adequately protected from contamination and that water sources be routinely monitored to reduce water-related diseases. Continuous analysis of water quality based on the detection of indicator organisms is one method for determining the hygienic state of water. Encouragement of improved community participation in sanitation for sustainability through public health education and sensitization campaigns by the government.

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