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Original article

MICROBIAL ANALYSIS OF SOME SELECTED BOREHOLES WATER AT IBRAHIM BADAMASI BABANGIDA UNIVERSITY, LAPAI MAIN CAMPUS, NIGER STATE, NIGERIA

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ABSTRACT

The microbial status of seven boreholes water at Ibrahim Badamsi Babangida University main campus in Lapai, Niger State, Nigeria, was assessed between May 2019 and August 2019. The aim of the study was to determine the water quality status of the bore holes, situated within the main campus of the University. Total coliform was determined using the Most Probable Number (MPN) technique as described by UNEP/WHO. Isolation and bacterial characterization was done using standard procedures. Highest value (12.50) of total coliform counts was recorded from borehole D (twin lecture theater) and lowest in borehole G (student hostel), which differ significantly ($P < 0.05$). The highest total faecal() counts at borehole F (central mosque) and lowest at borehole G (student hostel), which also differ significantly ($P < 0.05$). Monthly variations in coliform counts also differ significantly ($P < 0.05$) with highest in boreholes D (twin lecture theatre) and B (staff quarters) in May and June respectively, Borehole F in both July and August. Highest faecal count was recorded at borehole D in May, Borehole B (staff quarters) in June, boreholes C (administrative building) and F in July and also borehole F in August. Total coliform counts of water from boreholes D and F were above the set limits for drinking water. Boreholes water with the exception of E (biological garden) were above the set limit of faecal streptococcus counts. Boreholes E, G and A are safe for drinking. Water from these boreholes except borehole E need to be treated before consumption, continuous monitoring of the water need to be done, indiscriminate visit by animals and extent of usage by people need to be stopped and controlled respectively, the tap nozzle of these boreholes need to be covered to prevent further contamination.

Keywords:- Microbial analysis, Boreholes, Total coliform counts, faecal streptococcus counts, Lapai

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INTRODUCTION

Water is well - known natural resource and source of life on earth because it is needed every day for various purposes. It covers 71% of the earth's surface, portable water being an important requirement for good health. The provision of portable and clean water is an important constituents for good health, social as well as economic growth of the human population. The safety of drinking water is therefore important to human well - being and for development [1]. The existence of man on earth continue to depend on the supply of good and quality drinking water. Man with an average body weight of between 53 - 63kg require about 3 liters of daily for drinking as well as in food to remain in a healthy state [2] .

In order for water to be portable, it must conform to specified standards in relation to their physical, chemical and microbial characteristics. However, these characteristics of water whether from streams, lakes, rivers, ground water (bore - hole and well) and reservoirs are influenced by the climatic condition, geochemical, types of rocks and pollution levels and the catchment areas. Changes in the concentrations of water components, which flows into another water body cause variations in the quality of water [3].

Borehole water is a common available natural water, which serve the purpose as source of water for domestic activities in rural and semi - urban areas of the country. In addition, it is important in the maintenance of lives for both animals and plants [4]. However, the quality of this water is influenced by both chemical and microbial contaminants that originated from different sources such as seepage, feaces, catchment water, inadequate collection and disposal of wastes generated from households or domestic activities. Once these microbial contaminants get into drinking water, it results to acute as well as chronic health concerns. Therefore, the inability to provide portable water is of great concern because it exposes the public to health risk [5].

Contaminated water carries pathogenic microbes and also serve as vehicle for the transmission of several water - borne disease, which cause health issues. The commonest and widespread source of drinking water contamination include human and animal excrement and sewage amongst others. Drinking of unsafe drinking water has contributed to 88% of diarrhea infection globally [6]. Other ailments include vomiting, nausea, abdominal pain and even typhoid fever. Faecal contamination of drinking water introduce varieties of intestinal pathogens that are related to microbial diseases ranging from mild to severe conditions. Examples of such bacteria causing disease in drinking water include *Pseudomonas* spp., *Streptococcus faecalis*, *Escherichia* species, and *Staphylococcus* species.

Poor microbial water quality can lead to outbreak of water related diseases, which are quite infectious resulting to serious epidemic leading to several infection and subsequently death. Borehole has been identified and used over the years as source of water supply. Their usage has increased over the years in both rural and urban communities and are being sunk indiscriminately. It is the major source of water supply on main campus of Ibrahim Badamasi University in Lapai, Niger State. Studies have been carried out on the microbial profile of boreholes water. This include the works of [7] in boreholes water samples in Ilorin metropolis and [8] in some selected boreholes water in Kano metropolis amongst others. However, there is dearth of information on the quality of water from these boreholes. Apart from humans utilizing the water, animals also come around some of these boreholes to drink and on the process urinate and pass out feaces. This could also portray a serious health risk if the water is consumed and when its safety is not known. Out of the 71% of water that covers the surface of the earth, only 1% is accessible for consumption to man. The inability to supply quality drinking water has caused serious health implications especially in developing countries where 80% of all the diseases and 30% deaths were related to drinking water [9]. Since borehole is a major source of water provision to students, staff of the university and the surrounding community, it is of immense importance to have knowledge of the microbial profile of this water. Human life depended on water, their utilization and proper management [2]. The aim of this study is to ascertain the quality of boreholes water available at main campus of Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.

MATERIALS AND METHODS

Description of study area

The study was conducted at Ibrahim Badamasi Babangida University main campus, Lapai, Niger State, Nigeria. Lapai is a Local Government headquarters and is located on Latitude 8^{o}49'N and Longitude and 6^{o}41'E. It is about 50 km from Minna, the state capital with a population of 110,127 according to 2006 census with a total area of 3,051 km^2.

Water sample collection

Water samples were collected from seven (7) boreholes at different locations within the study area as shown on Table 1.

Table 1: Sampling Area description within Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.

Borehole / Sampling sites	Sampling location/description
A	School Farm
B	Staff Quarters
C	Administrative Building
D	Twin Lecture Theatre
E	Biological Garden
F	Central Mosque
G	Student Hostel

Water samples from these locations were collected in well-labeled sterile plastic containers. Cotton wool was soaked in 70% acetone - alcohol and used to sterilize the nozzle of the boreholes and water was allowed to flow for two (2) minutes afterward. The plastic containers were then carefully uncapped and filled with water before recapped. This was then taken to Biology Department of Ibrahim Badamasi Babangida University, Lapai, Niger State in insulated containers for analysis. This was done for four (4) months between May 2019 and August 2019. Water samples were collected from these boreholes twice every month.

Microbial Analysis of Water Samples

Water collected from the seven (7) boreholes were transported to regional water quality laboratory at Minna, Niger State under Federal Ministry of Water Resources, were analyses for total coliform (cfu/100ml), feacal streptococcus (cfu/100ml) and *E - coli* was done within twenty four (24) hours.

Total *coliform*: This was determined using the Most Probable Number (MPN) technique as described by [10]. A combination of positive and negative tubes and MPN index of each water sample was determined with the aid of Most Probable Number (MPN) standard table.

Isolation and bacterial characterization

This was done using standard procedures according to [11] as follows: Bacteria sample was inoculated into primary isolation media, such as nutrient agar, Mac Conkey agar, Eosin methylene blue agar, Manito salt agar in a culture plate (petri dishes). This was then incubated at 37°C for 24 hours. Colonies from the plate was sub - culture into another fresh medium to obtain pure colony. The colonies was subjected to biochemical tests, which include gram reaction, indole, methyl red, voges proskauer, oxidase and catalase.

Data Analysis

Percentages, mean, standard deviation, range, minimum and maximum values were computed using descriptive statistics. Analysis of variance (ANOVA) was used to test for any significant difference at 95% confidence level. Post - hoc using new Duncan Multiple Regression Test (NDMRT) was used to rank for differences in means. Special Package for Social Sciences (SPSS) Version 21.0 was used. The results of water samples for both colony forming unit was compared with that of World Health Organization.

RESULTS

The coliform counts (cfu/100) mean values of boreholes water at Ibrahim Badamasi Babangida University, Lapai main campus, Niger State is shown in Table 2. There were variations in these values during the period of study. Borehole D (Twin lecture theatre) had the highest mean (12.50) followed by borehole F (Central mosque) of mean 11.50 while the lowest was borehole G (Student hostel) of mean 3.63.

There was significant difference ($P<0.05$) in the total coliform counts across the boreholes during the period of study.

Table 2: Mean coliform counts (cfu/100) of boreholes water at Ibrahim Badamasi Babangida University, Lapai main campus, Niger State, Nigeria

	Total Coliform Count	
Sampling sites	**Minimum - Maximum**	**Mean ± SD**
A (School farm)	2.00 - 8.00	5.00 ± 1.93^{cd}
B (Staff quarters)	5.00 - 14.00	9.75 ± 2.82^{ab}
C (Administrative building)	0.00 - 12.00	7.63 ± 4.31^{bc}
D (Twin lecture theatre)	7.00 - 16.00	12.50 ± 2.83^{a}
E (Biological garden)	0.00 - 8.00	3.75 ± 3.20^{d}
F (Central mosque)	4.00 - 17.00	11.50 ± 4.41^{a}
G (Student hostel)	2.00 - 5.00	3.63 ± 1.19^{d}

Values on the same column with different superscript is significantly different ($P<0.05$)

The mean monthly coliform counts (cfu/100) of boreholes water at Ibrahim Badamasi Babangida University, Lapai main campus, Niger State is shown in Table 3. There were variations in these values across.

Borehole D (Twin lecture theatre) had the highest mean (10.5) in May and lowest was borehole E (Biological garden) with mean 0.50. Borehole B (Staff quarters) recorded the highest mean (4.50) in June while boreholes E (Biological garden) and G (Student hostel) did not record any coliform.

Borehole F (Central mosque) recorded the highest mean coliform count (14.00) in July while borehole G (Student hostel) was the lowest (4.00). In August, borehole F (Central mosque) also had the highest mean coliform count (16.00) while boreholes E (Biological garden) and G (Student hostel) each with 4.50 were the lowest.

There was significant difference ($P<0.05$) in the total coliform counts across months during the period of study.

Table 3: Mean monthly coliform counts of boreholes water at Ibrahim Badamasi Babangida University, Lapai main campus, Niger State, Nigeria

	May		June		July		August	
Sampling sites	**Min-Max**	**Mean ± SD**	**Min - Max.**	**Mean ± SD**	**Min - Max**	**Mean ± SD**	**Min - Max**	**Mean ± SD**
A	2.00-4.00	3.00 ± 1.41^{b}	1.00-2.00	1.50 ± 0.71^{b}	4.00-5.00	4.50 ± 0.71^{de}	4.00-6.00	5.00 ± 1.41^{c}
B	5.00-9.00	7.00 ± 2.83^{ab}	4.00-5.00	4.50 ± 0.71^{a}	9.00-10.00	9.5 ± 0.71^{bc}	8.00-10.00	9.00 ± 1.41^{b}
C	0.00-3.00	1.50 ± 2.12^{b}	0.00-1.00	0.50 ± 0.71^{b}	11.00-12.00	11.50 ± 0.71^{ab}	10.00-11.00	10.50 ± 0.71^{b}
D	7.00-14.00	10.5 ± 4.95^{a}	1.00-1.00	1.00 ± 0.00^{a}	10.00-14.00	12.00 ± 2.83^{ab}	14.00-16.00	15.00 ± 1.41^{a}
E	0.00-1.00	0.50 ± 0.71^{b}	0.00-0.00	0.00 ± 0.00^{c}	7.00-8.00	7.50 ± 0.71^{cd}	3.00-6.00	4.50 ± 2.12^{c}
F	4.0-7.00	5.50 ± 2.12^{ab}	0.00-1.00	0.50 ± 0.71^{ab}	13.00-15.00	14.00 ± 1.41^{a}	15.00-17.00	16.00 ± 1.41^{a}
G	2.00-4.00	3.00 ± 1.41^{b}	0.00-0.00	0.00 ± 0.00^{c}	3.00-5.00	4.00 ± 1.42^{e}	4.00-5.00	4.50 ± 0.71^{c}

Values on the same column with different superscript is significantly different ($P>0.05$)

A: School Farm **B:** Staff Quarters **C:** Administration Building **D:** Twin Lecture Theatre
E: Biological Garden **F:** Central Mosque **G:** Student Hostel

The faecal counts (cfu/100) mean values of boreholes water at Ibrahim Badamasi Babangida University, Lapai main campus, Niger State is shown in Table 4. There were variations in these values during the period of study.

Borehole F (Central mosque) had the highest mean (2.13) with range of 0.00-5.00, followed by Borehole D (Twin lecture theatre) with mean (1.88) with range of 0.00-4.00 then borehole B (Staff quarters) of mean 1.75 with range of 0.00-5.00 values while the lowest was borehole G (Student hostel) of mean 0.13 with 0.00-1.00 as range value.

There was significant difference (P>0.05) in the faecal strep counts across the boreholes during the period of study.

Table 4: Mean Faecal Strep counts (cfu/100) of boreholes water at Ibrahim Badamasi Babangida University, Lapai main campus, Niger State, Nigeria.

Sampling sites	Total Faecal Count Minimum - Maximum	Mean ± SD
A (School farm)	0.00 - 2.00	0.38 ± 0.74^{bcd}
B (Staff quarters)	0.00 - 5.00	1.75 ± 1.91^{ab}
C (Administrative building)	0.00 - 4.00	1.50 ± 1.51^{abc}
D (Twin lecture theatre)	0.00 - 4.00	1.88 ± 1.46^{a}
E (Biological garden)	0.00 - 0.00	0.00 ± 0.00^{d}
F (Central mosque)	0.00 - 5.00	2.13 ± 2.10^{a}
G (Student hostel)	0.00 - 1.00	0.13 ± 0.35^{cd}

Values on the same column with different superscript is significantly different (P<0.05)

Table 5 shows the mean monthly faecal counts (cfu/100) of boreholes water at Ibrahim Badamasi Babangida University, Lapai main campus, Niger State. There were variations in these values across months during the period of study.

Borehole D (Twin lecture theatre) had the highest mean (1.00) in May, while boreholes B (Staff quarters), E (Biological garden), A (School farm), C (Administration building), F (Central mosque) and G (Student hostel) did not record any faecal count. Borehole B (Staff quarters) recorded the highest mean (4.50) in June with no such counts in boreholes E (Biological garden) and G (Student hostel). Boreholes C (Administrative building) and F (Central mosque) recorded the highest mean faecal count (3.50) in July while boreholes A (School farm), E (Biological garden) and G (Student hostel) did not record any faecal count. In August, borehole F (Central mosque) also had the highest mean faecal count (4.50) while boreholes A (School farm) and E (Biological garden) did not record any of such count.

There was significant difference (p>0.05) in the faecal counts across months with the exception of May during the period of study.

Table 5: Mean monthly faecal counts (cfu/100) of boreholes water at Ibrahim Badamasi Babangida University, Lapai main campus, Niger State, Nigeria.

Sampling sites	May		June		July		August	
	Min-Max	Mean ± SD	Min - Max.	Mean ± SD	Min - Max	Mean ± SD	Min-Max	Mean ± SD
A	0.00-0.00	0.00 ± 0.00^{a}	1.00-2.00	1.50 ± 0.71^{b}	0.00-0.00	0.00 ± 0.00^{c}	0.00-0.00	0.00 ± 0.00^{c}
B	0.00-0.00	0.00 ± 0.00^{a}	4.00-5.00	4.50 ± 0.71a	0.00-1.00	0.50 ± 0.71^{bc}	2.00-2.00	2.00 ± 0.00^{b}
C	0.00-0.00	0.00 ± 0.00^{a}	0.00-1.00	0.50 ± 0.71^{bc}	3.00-4.00	3.50 ± 0.71^{a}	2.00-2.00	2.00 ± 0.00^{b}
D	0.00-2.00	1.00 ± 1.41^{a}	1.00-1.00	1.00 ± 0.00^{bc}	1.00-2.00	1.50 ± 0.71^{b}	4.00-4.00	4.00 ± 0.00^{a}
E	0.00-0.00	0.00 ± 0.00^{a}	0.00-0.00	0.00 ± 0.00^{c}	0.00-0.00	0.00 ± 0.00^{c}	0.00-0.00	0.00 ± 0.00^{c}
F	0.00-0.00	0.00 ± 0.00^{a}	0.00-1.00	0.50 ± 0.71^{bc}	3.00-4.00	3.50 ± 0.71^{a}	4.00-5.00	4.50 ± 0.71^{a}
G	0.00-0.00	0.00 ± 0.00^{a}	0.00-0.00	0.00 ± 0.00^{c}	0.00-0.00	0.00 ± 0.00^{c}	0.00-1.00	0.50 ± 0.71^{c}

Values on the same column with different superscript is significantly different ($P>0.05$)
A: School Farm **B:** Staff Quarters **C:** Administration Building **D:** Twin Lecture Theatre
E: Biological Garden **F:** Central Mosque G: Student Hostel

DISCUSSION

Coliforms density has been used over the years to establish the microbiological quality of water. The highest total coliform count from borehole D (Twin lecture theatre) and lowest borehole G (Student hostel), which differ significantly ($P<0.05$) was lower than coliform counts of 16 cfu/100ml reported by [7]. The overall range of total coliform of boreholes in this study range from 0.00-16.00 cfu/100ml. This implies that the count in these boreholes water with the exception of D (Twin lecture theatre) and F (Central mosque) were low. [8] reported range of 0.00 -11.00, which is lower than the findings of this study. On the other hand, [12] reported mean total coliform counts of boreholes as 7.0 ± 2.4 and 6.0 ± 1.6 in Benin City, which are greater than that of boreholes A (School farm), E (Biological garden) and G (Student hostel). This could be due to differences of the level of contamination.

The presence of these bacteria in water is indicative of contamination by faecal materials, which is considered indicative of a health risk. The highest faecal count in borehole F (Central mosque), which was significantly different ($P<0.05$) from other boreholes was lower than 74 cfu/100ml reported by [13]. This could be due to poor methods of faecal waste management, shallow depth of the borehole and refuse disposal. No faecal contamination was recorded in borehole E (Biological garden), which could be due to less activities or accessibility, which could contaminate the water.

Fluctuation in the level of contamination in water is a common observation. The highest total coliform count recorded in borehole D (Twin lecture theatre) in May differs significantly ($P>0.05$) from the rest and also highest in borehole B (Staff quarters) in June could be due to high human activities, which increases the level of contamination. Similarly, the highest coliform counts in July and August in borehole F (Central mosque) could be due to the extent of water usage, which give rise to increase of contamination.

Borehole D (Twin lecture theatre) like in the case of total coliform counts was highest in faecal counts in May and B (Staff quarters) in June, which is only significantly different ($P<0.05$) in total coliform count. This could be due to faecal deposits, waste dumps, rearing of livestock around such premises amongst others. Similar trend was also observed in July and August at boreholes F (Central mosque), although borehole C (Administrative building) also recorded highest count in July, which was also significantly different ($P<0.05$). This could be due to the presence of faecal deposits resulting from toilet soak away at these premises. There was no feacal contamination at borehole E (Biological garden) throughout the months. This could be due to non-contact or deposit of faecal materials either from human or livestock.

Water is very important in day to day sustenance of humans. Therefore, it must meet the set standards especially when the purpose is for drinking and other domestic activities. The total coliform count acceptable for drinking water according to WHO and NSDWQ are ≤ 10 and up to 10cfu/100ml. The findings of this study revealed that boreholes D (Twin lecture theatre) and F (Central mosque) where greater than these set limits. This implies that these boreholes did not comply with the set standards for drinking water. [8] also reported borehole water to have exceeded the coliform limit set by WHO.

Faecal count of water suitable for drinking according to WHO should be 0.0MPN/100ml. This implies that water need not to contain faecal coliform in 100ml of sample. The boreholes in this study with the exception of borehole E (Biological garden) were above the set standard and therefore, contaminated with faecal materials. This could be due to the presence of toilet facilities, faecal deposits from livestock and other indiscriminate activities around these boreholes. Microbiological evaluation of water quality checklist stipulated by [14], categorized water as follows; zero = safe, 1-10 = reasonable quality, 11-100 = polluted water, 101-1000 = dangerous and >1000 = very dangerous. This implies that water of boreholes E (Biological garden), G (Student hostel) and A (School farm) are safe, while the remaining boreholes are of reasonable quality.

CONCLUSION

There were significant differences (P<0.05) in coliform counts and faecal counts of the boreholes water. Boreholes D (twin lecture theatre) and F (central mosque) recorded the highest coliform count and faecal count respectively.

There were significant differences (P<0.05) in monthly coliform counts of the boreholes water and also in monthly faecal counts with the exception of May. Borehole E (biological garden) did not record any faecal contamination. Borehole E (Biological garden) water is the safest and have the best quality for drinking while the remaining boreholes are of reasonable quality.

Therefore, (i) **w**ater from these boreholes with the exception of borehole E (biological garden) need to be treated before usage especially for drinking purposes.(ii) Continuous monitoring of water from these boreholes should be done. (iii) Indiscriminate visit of these boreholes by animals should be stopped and the extent of usage by people need to be controlled.

(iv) The tap nozzles of these boreholes should be covered when not in use to prevent further contamination.

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