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Microbial and Physico-Chemical Analysis of Water from Boreholes in Mosimi and Environs, Ogun State, Nigeria

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Authors' contributions

This work was carried out in collaboration with all the three authors. Author AAA designed the work and managed the literature searches, author AU Carried out the research work and author JAA did the statistical analysis and wrote the first manuscript. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

This study was carried out to determine the microbiological quality of borehole water in Mosimi area in Ogun state. Microbiological and physic-chemical analyses of eleven boreholes in the area were determined and mean standard error was used to compare the results obtained. The study was carried out within a period of 3 months. Microbiological and physico-chemical analyses were carried out on water samples from eleven boreholes in Mosimi and environs in Ogun State, Nigeria. Membrane Filtration Method was used for the determination of Total Plate Count, Total Coliform Count and *E. coli* Count. Microbes identified include *Escherichia coli, Enterobacter aerogenes, Citrobacter* sp, *Pseudomonas* sp, *Micrococcus* sp, *Bacillus* sp, *Staphylococcus aureus and Klebsiella* sp. The Total Plate Count ranged from 0 cfu/ml to 102 x 10^2 cfu/ml. The Total Coliform Count ranged from 0 cfu/ml – 15 x 10^2 cfu/ml, while the *E. coli* count ranged from 0 cfu/ml – 5 x 10^2 cfu/ml, some of which are above the WHO and the Nigerian Standard for Drinking Water Quality;

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analysis of variance was carried out for the microbial analysis using SPSS 16.0. The physico-chemical analysis showed that all the parameters were within the WHO limits except for pH which ranged from 5.7 – 8.0. Water samples from four of the boreholes were faecally contaminated but there was no chemical contamination of the ground water. There is the need for treatment of the boreholes water samples especially the contaminated samples to make the water potable.

Keywords: Physico-chemical; contamination; boreholes; groundwater; coliform count.

1. INTRODUCTION

Groundwater occurs in the interstices (pores and crevices) of rock below the earth's surface. In many places it is the vital source of water that sustains life and agriculture [1,2]. It is generally accepted that ground water contains less pathogenic organisms compared to other sources of water. Improving access to safe drinking-water can result in tangible health benefits as every effort should be made to achieve a drinking-water quality as safe as practicable [3]. Provision of potable water to the rural and urban population is important in preventing health hazards [4].

Borehole is a water source in which at least a depth of 150 feet (45.72 m) is drilled to reach ground water and source for drinking-water [5,6]. The quality of ground water is a function of natural processes as well as anthropogenic activities; ground water (e.g. borehole) is not completely protected from contamination, which could be either microbial or inorganic agent or even due to human activities and environmental conditions [2]. The chemical composition of ground water is a measure of its suitability as a source of water for human consumption or for agricultural and industrial purposes. Ground water can be rich in dissolved solids, especially carbonates and sulfates of calcium and magnesium as well as chloride and bicarbonates, depending on the strata through which ground water flow, thus, additional treatment may be required in order to provide pleasant water for drinking and household use [7].

During passage through the ground, water dissolves minerals in rocks, collects suspended particulate matter, particularly those of organic sources as well as pathogenic microorganisms from faecal matters [8]. In some cases natural water may contain elevated concentrations of several potentially toxic elements or microbiological contaminants that may lead to diverse effects on human health [9]. Changes in borehole water quality may be due to ground water pollution [10,11]. According to [11], water pollution is the modification of the physical, chemical and biological properties of water. [12] reported that because aquifers (where ground water occurs) are not directly exposed to man, animals, and the atmosphere, they are somewhat protected from contamination.

Certain requirements must be met for water to be fit for human consumption. These requirements are freedom from organisms and chemical substances which might be injurious to health. Drinking water should be of such composition that consumers do not question the safety of the water. This implies that turbidity, color and taste should be unobjectionable, and macro organisms (e.g. worms, aquatic and fly nymphs) should be absent [13].

Water quality assessment has become a big issue today because of the realization of the potential health hazards that may result from contaminated drinking-water, contamination of drinking-water from any source is therefore of primary importance because of the danger and risk of water-borne diseases [14].

Increase in human population has exerted enormous pressure on the provision of safe drinking-water especially in developing countries [15]. In Nigeria, majority of the rural people do not have access to potable water and therefore, depend on well, stream and river water for domestic use [16,8].

The siting of boreholes also predisposes them to the contamination or pollution of water from the environment. [15] in their study on borehole water quality in Ilorin metropolis discovered that some of the borehole sites revealed proximity to solid waste dumps and animals' droppings being littered around them.

This study seeks to determine the portability of some ground waters in Mosimi area, Ogun State, Nigeria, considering their microbiology and physic-chemical properties.

2. MATERIALS AND METHODS

2.1 Water Samples

Samples of borehole water were collected from 11 boreholes in the study area; collected samples were packed in ice and transported to the laboratory for analysis.

2.2 Microbial Quality Assessment

The media used in the microbiological assay included Eosin Methylene Blue agar (EMB) for *E. coli*, MacConkey Agar (for total coliforms isolation) and Nutrient Agar (for heterotrophs isolation) [17]. For total coliforms and *E. coli,* the plates were incubated at 37ºC for 24 hrs; for heterotrophs the plates were incubated at 37ºC for 48 hrs, using membrane filtration method. Analysis of variance carried out for the microbial analysis and means were separated according to Duncan's multiple range test. The Statistical analysis was carried out using SPSS version 16.0

2.3 Pysico-chemical Analysis

The pH, electrical conductivity, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) was determined using Model Combo manufactured by Hanna Instruments (P) Ltd. For determination of trace minerals, Lead (Pb), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Copper (Cu) and Zinc (Zn), the Atomic Absorption Spectrophotometer (AAS) was used. Ammonium ($NH4^+$) was determined by the Berthalot (Indophenol reaction) method described by {18} using Technicon AA11 Autoanalyzer. Phosphates and nitrate were determined using the UV spectrophotometer screening method.

3. RESULTS AND DISCUSSION

Table 1 shows the total plate count, total coliform count and *E. coli* count of the borehole water samples from Mosimi area of Ogun State. All of the samples have their total plate count fall below the 100 cfu/100 ml of the [19] standard except sample K (102 cfu/100 ml); sample A has 2 cfu/100 ml total coliform count while sample D had 10 cfu/100 ml, H had 4 cfu/100 ml and K had 15 cfu/100 ml as against the 0 cfu/100 ml tolerant level of the [19] standard. Sample D had 5 cfu/100 ml of *E. coli* and sample H had 2 cfu/100 ml which is against the 0 cfu/100 ml level tolerance of the WHO standard.

Temperature of sample B was 25ºC, E had 26ºC, F had 25.3ºC, H had 27ºC and J had 27.3ºC, all of which are above the 25ºC of the [20,21] standard. All of the borehole water samples except J and K (with pH 7.9 and 8 respectively) had their pH below the WHO standard range of 6.5-8.5. None of the samples analyzed had up to the [20] standard level of electric conductivity of 1000 µs/cm, all the tested borehole water samples had lower total dissolved solids compared with the 500 mg/L of the [19] standard.

The total plate count ranged from 0– 102 x 10^2 cfu/ml. Only 1 sample (Sample K) had a total plate count of 102 x 10^2 cfu/ml which is slightly above the WHO standard of 100 x 10^2 cfu/ml and the Nigerian Standard for Drinking Water Quality of 10 cfu/ml. The total coliform count ranged from 2 x 10^2 cfu/ml - 15 x 10^2 cfu/ml, the total coliform count of 4 samples (Samples A=2; D=10; H=4 and K=15) out of 11 samples was above the 0 x 10^2 cfu/m WHO standard and the Nigerian Standard for Drinking Water Quality. The *E. coli* count ranged from 2 x 10^2 cfu/ml – 5 x 10^2 cfu/ml and this was only observed from 2 samples (Samples D, 5 and H, 2) out of the 11 investigated. This result is also above the 0 x 10^2 cfu/ml WHO standard and the Nigerian Standard for Drinking Water Quality (Table 1). The presence of coliforms and *E. coli* in some of the boreholes water studied indicated that the water sources were faecally contaminated and that the water is not fit for human consumption; this finding agrees with the report of [8], and that of the work carried out by [21].

Table 2 shows the result of the physico-chemical parameters of the Borehole water samples from Mosimi area of Ogun State. The temperatures of the samples were in the range with the WHO standard of < 25ºC, except for that of Samples E (26), F (25.3), H (27) and J (27.3). This disparity in temperature may be due to variations in ambient temperature at the time of sampling and analysis. The pH though had a great variation from one sample to another as Sample A had a pH of 6, B, 5.9; C, 6.1; D, 6.2; E, 5.9; F, 6.1; G,6.0; H,5.8 and I, 5.7; as against the range 6.5-8.5 of the WHO standard.

There was no disparity between the mineral quantities observed in the water samples and the WHO standard as well as the Nigerian Standard for Drinking Water Quality as all fell below the

standard (Table 3). This shows that the borehole waters are free from chemical hazards; this agrees with the work of [22]. Generally the result of the present study agrees with the report of [2], that ground water is not completely protected from contamination.

Table 1. Microbial analysis results of the borehole water samples from Mosimi area of Ogun state

Samples	Total plate count heterotrophs (CFU/100 ml)	Total coliform count (CFU/100 ml)	*E. coli* (CFU/100 ml)
A	8±0.58	2±0.58	0±0.00
B	56±0.57	0±0.00	0±0.00
C	0±0.00	0±0.00	0±0.00
D	74±0.58	10±0.57	5±0.57
E	35±0.57	0±0.00	0±0.00
F	12±0.58	0±0.00	0±0.00
G	6±0.58	0±0.00	0±0.00
H	10±0.57	4±0.58	2±0.57
I	12±0.57	0±0.00	0±0.00
J	82±0.57	0±0.00	0±0.00
K	102±0.58	15±0.58	0±0.00
WHO standard	100	0	0
Nigerian standard for Drinking water Quality	100	0	0

Value = mean ± standard error. Mean value in red shows significant difference to the Standard

Table 2. Physico-chemical analysis results of borehole water samples from Mosimi area of Ogun State

Samples	Odour	Taste	Temp°C	pH	Elect. conductivity µs/cm	TDS mg/L	TSS mg/L	T solids mg/L
A	U	U	24	6.0	41	20	0.09	20.09
B	U	U	25	5.9	23	11	0.11	11.11
C	U	U	23	6.1	22	11	0.15	11.15
D	U	U	24.8	6.2	32	16	0.18	16.18
E	U	U	26	5.9	31	15	0.20	15.20
F	U	U	25.3	6.1	32	16	0.14	16.14
G	U	U	24.6	6.0	25	12	0.14	12.14
H	U	U	27	5.8	31	15	0.11	15.11
I	U	U	23.9	5.7	31	15	0.02	15.02
J	U	U	27.3	7.9	304	151	0.19	151.19
K	U	U	24.5	8.0	307	153	0.21	153.21
WHO standard	U	U	<25	6.5-8.5	1000	500	NA	N/A
Nigerian Standard for Drinking Water Quality	U	U	Ambient	6.5-8.5	1000	500	-	-

Samples designated A to J were collected from different areas in Mosimi U = Unobjectionable; NA = Not Available; Values in red d fall out of the Standards. Values in red are outside the range of the standard

Table 3. Mineral analysis results of borehole water samples from Mosimi area of Ogun state

Samples	Pb ppm	NO_3-N ppm	NH_4-N ppm	PO_4- ppm	Ca ppm	Mg ppm	Ca hardness mg/L	Mg-hardness	Total hardness mg/L	Mn-ppm	Fe ppm	Cu ppm	Zn ppm
A	0.00	0.87	0.02	0.00	0.46	0.4	1.15	1.63	2.78	0.00	0.00	0.00	0.27
B	0.00	0.38	0.02	0.00	0.43	0.24	1.08	1.00	2.08	0.00	0.00	0.00	0.05
C	0.00	0.4	0.00	0.00	0.43	0.22	1.08	0.92	2.00	0.00	0.00	0.00	0.05
D	0.00	0.33	0.01	0.00	0.64	0.33	1.61	1.37	2.98	0.00	0.00	0.00	0.05
E	0.00	0.39	0.02	0.00	0.61	0.4	1.53	1.66	3.19	0.00	0.00	0.00	0.05
F	0.00	0.48	0.02	0.00	1.25	0.27	3.11	1.10	4.22	0.00	0.00	0.00	0.05
G	0.00	0.55	0.02	0.00	0.43	0.2	1.08	0.83	1.91	0.00	0.00	0.00	0.05
H	0.00	0.36	0.02	0.00	0.74	0.35	1.84	1.43	3.26	0.00	0.00	0.00	0.05
I	0.00	0.99	0.01	0.00	0.71	0.45	1.76	1.86	3.63	0.00	0.00	0.00	0.05
J	0.00	1.82	0.02	0.00	20.74	2.6	51.8	10.72	62.51	0.00	0.00	0.00	0.27
K	0.00	1.52	0.02	0.00	19.22	2.67	48	11.01	59.01	0.00	0.00	0.00	0.25
WHO standard	0.05	10	0.02	0.54	-	30	75	30	100	0.05	0.03	1.0	5.0
Nigerian standard for drinking water quality	0.01	50	-	-	-	0.2	150			0.2	0.3	1	-

4. CONCLUSION

It could then be concluded that some of the ground water (borehole) in Mosimi area of Ogun State are not fit for human consumption, but needed to be treated before consumption, as the presence of coliforms and basically *E. coli* is seen in some of the samples.

COMPETING INTERESTS

Authors have declared that there are no competing interests.

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