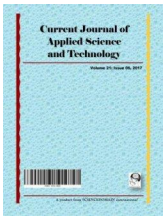

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Microbiological and Physicochemical Comparative Analysis of Portability of Owo Main Water Corporation and Some Selected Borehole Water Sample within Owo Metropolis

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Authors' contributions

This work was carried out in collaboration between two authors. Author BEO designed the study, performed the laboratory test, produced the manuscript and carried out the statistical analysis. Author OOF collected the samples and searched the literature. Both authors read and approved the final manuscript.

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ABSTRACT

A comparative study of the portability of sample from Owo main water corporation and some selected borehole water sample within Owo metropolis. The water sources were assessed for microbiological quality and physico-chemical properties (temperature, odour, colour and pH). The samples were investigated for microbial load using Eosine Methylene Blue agar (EMB) Nutrient agar (NA) and Mannitol Salt agar (MSA). The physicochemical analysis of the water was also determined. *Bacillus subtilis*, *Escherichia coli*, *Proteus* species, *Enterobacter* species and

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Staphylococcus aureus were isolated and identified from the samples. The total viable count ranges from 10 x 10^1 – 5.7 x 10^2 cfu on Mannitol salt agar for sample from water Corporation and Folahanmi borehole sample respectively. The investigation revealed that samples from Folahanmi and Rugipo contain all the isolated microorganisms while sample from Iselu contain *Escherichia coli*, *Proteus* species and *Enterobacter* species only. The pH of the water sample ranged from 4.80 to 7.37 Rugipo borehole sample and sample from water corporation respectively. All the samples appear colourless and odourless. Of the water samples examined it was observed that only the sample collected from water corporation conform with the specification of Environmental Protection Agency.

Keywords: Water safety; microbiological quality; physicochemical parameters; portability.

1. INTRODUCTION

Water plays a significant role in the proper functioning of the earth's ecosystem and man uses water for various purposes which include drinking, transportation, industrial and domestic use, irrigation, recreation, fisheries and waste disposal among others [1]. Water that is of a good drinking quality is important to human physiology and man's continued existence depends so much on its availability [2,3]. The activities of man among which are feacal contamination or nature makes water unsafe for consumption [4]. Water borne disease causes acute diarrhea, the most common water born disease by bacteria includes typhoid, fever, cholera and dysentery [5].

Borehole is an hydraulic structure which were properly designed and constructed that permits the economic withdrawal of water from an aquifer [6]. In developing countries, borehole serves as the main sources of water for drinking and domestic use. The underground water supplies are usually considered safe provided they are properly located, constructed and operated according to the World Health Organization Guidelines for Drinking Water [7]. Main origin of pollution of boreholes and other ground water are industrial, domestic and agricultural sources which can be continuous or accidental. The Industrial pollution may involve seepage of used water containing chemicals such as metals and radioactive compounds, contaminated water from damage pipelines infiltrating into the borehole, Domestic pollution may involve seepage from broken septic tanks, pit latrines, cesspolls while the agricultural pollution is from irrigation water and runoff water after rains, carrying fertilizers, pesticides, herbicides and faecal matter [8].

In the developing world, there are always reported cases of diseases associated with the consumption of water which ranges from mild to severe. It is however important to look into the menace and identify the microorganisms associated with the bore hole water samples which serves as the main source of water to the inhabitant of Owo metropolis and also analyse the physicochemical parameters of the sample which may give a clue to the safety of such sample.

2. METHODOLOGY

2.1 Sample Collection

Borehole water samples were collected from five different sources, Oke Ogun, Iselu, Rufus Giwa Polytechnic, Folahanmi quaters, and Water Corporation, all in Owo, Ondo State Nigeria. The water samples were allowed to rush for two minutes before collection and they were labeled and transported to the laboratory.

2.2 Media Preparation

Nutrient agar (NA), Eosin Methylene Blue (EMB) and Mannitol Salt agar (MSA) all made by Titan media and were used for the bacterial investigation and was prepared according to standard procedures with reference to a manual of clinical microbiology.

2.3 Microbiological Analysis

Serial dilution of the collected samples was carried and 1 ml of the dilutes samples 10^{-2} replicate was carefully transferred into a different sterile petri plates and pour plated with different agar medium for microbial investigation. The plates were incubated invertedly upon solidification at 37^0C for 86400 seconds to 172800 seconds [9]. The number of the colonies formed after the incubation were counted using an illuminated colony counter (Gallen Kamp,

England) and the count for each plate was expressed as colony forming unit of the suspension (cfu/ml) [10]. The colonies were also sub-cultured in order to obtain pure culture [11].

2.4 Identification of Isolates

The identification of the colonies was based on morphological and biochemical test: Gram staining catalase Test [12], motility test [13], and sugar fermentation [14].

2.5 The Physicochemical Analysis

2.5.1 Potential hygrogen

This was determined using Jenway 3505 pH meter model which had been standardized with buffer solution of 7. This was done by dipping the sensitive end of the meter into the sample.

2.5.2 Colour

This was determined using the Hunter Lab system and a Minolta colorimeter model CR200. The sample was examined in a cuvette.

2.5.3 Temperature

Was determined using 10430 digital thermometer model.

2.5.4 Odour

Was organoleptically determined.

2.6 Statistical Analysis

Data obtained were analyzed by one way analysis of variance and means were compared by Duncan's multiple range test (SPSS 16.0 version). Differences were considered with significance at $p<0.05$.

3. RESULTS

Table 2 represents the morphological characteristics of the isolated microorganisms some of which were raised and some flattened in their elevation. They also varied in size from small to large and also ranging from whitish to creamy in colour. This showed that there are different microorganisms associated with the water samples.

Table 3 shows the biochemical characteristics of the probable microorganisms two of which are gram positive and three gram negative.

Table 1. Randomly selected sample location

Sample location	Sample identification code
Oke Ogun	A
Iselu	B
Folahanmi	C
RUGIPO	D
Ministry of Water Corporation	E

Table 5 depicts that all the implicated microorganisms are present in the samples from Folahanmi and RUGIPO bore hole. It is also revealed that only the sample treated by the water corporation was free from *E. coli.*

The Fig. 1 revealed that the water corporation sample had the least bacterial count while the highest was observed for sample from Folahanmi borehole. Investigation into the microbial load also revealed that Iselu, Oke Ogun and Water corporation sample are free from *S. aureus.* The total microbial load also ranges from $4.5x10^1$ to 1.61x103 in water corporation sample and Folahanmi water sample respectively.

4. DISCUSSION

The bacterial count of the samples collected from different locations (Table 1) were carried out by using Eosin methylene blue for the coliform counts, Mannitol salt agar for the *Staphyloccocal* count and Nutrient agar for the total bacterial count. The coliform counts ranged from 2.1×10^2 to 4.0×10^2 Cfu/ml with sample from Folahanmi quarters having the highest count and sample from water corporation having the lowest count. The same trend was also observed for microbial count on Mannitol salt. The organisms isolated are *Bacillus subtilis, Escherichia coli, Staphylococcus aureus, Enterobacter* spp*, Proteus* spp (Table 4). The high number of colonies counted on the samples suggested that the water sources may have been contaminated by different sources. According to EPA [15] it was reported that the standard limit of bacteria count for drinking water is 1.0×10^2Cfu/ml. this shows that only the sample collected from ministry of water corporation (sample E) is fit for consumption.

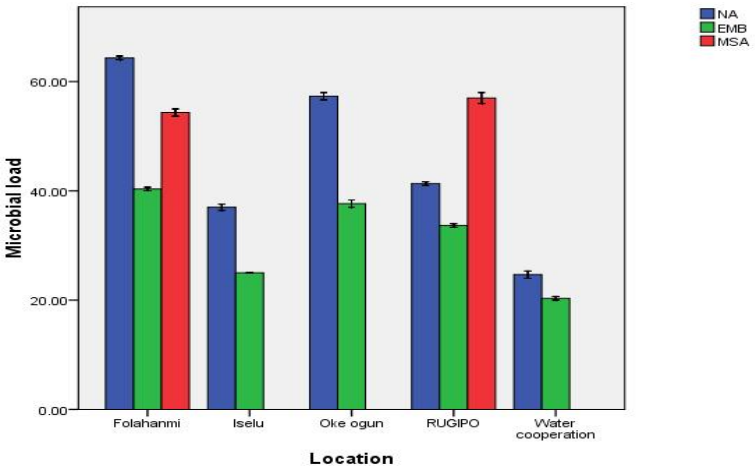

Fig. 1. Bacterial count from the water samples (x 10^1 Cfu/ml)

Table 2. Morphological characteristics of bacterial isolates

Isolates	Size	Edge	Elevation	Surface	Colour	Transparency	Tag
A	Small	Entire	Flat	Smooth	Whitish	Opaque	X_1
B	Small	Entire	Raised	Rough	Creamy	Opaque	X_2
C	Large	Rhizoid	Raised	Smooth	Whitish	Transparency	X_3
D	Small	Entire	Raised	Smooth	Whitish	Opaque	X_4
E	Large	Rhizoid	Flat	Rough	Creamy	Opaque	X_5

Table 3. Biochemical characterization of the bacterial isolates

Shape	Gram reaction	Motility	Catalase	Sucrose	Fructose	Gluctose	Galactose	Lactose	Mannitol	Tag
Rod	+	+	+	+	+	+	+	-	+	X_1
Rod	-	+	+	+	+	+	+	+	+	X_2
Cocci	+	-	+	+	+	+	-	+	+	X_3
Rod	-	+	-	+	-	+	+	+	+	X_4
Rod	-	+	+	-	-	+	+	-	+	X_5

+ = Positive - = Negative

Table 4. Probable organisms isolated

Tags	Probable organisms
X_1	*Bacillus subtilis*
X_2	*Escherichia coli*
X_3	*Staphylococcus aureus*
X_4	*Enterobacter* spp
X_5	*Proteus* spp

The isolated microorganisms were confirmed to be B. subtilis. E. coli, S. aureus, Enterococcus spp and Proteus spp

Table 5. Occurrence of isolates in the sample

Samples	*Bacillus subtilis*	*E. coli*	*Proteus* spp.	*Enterobacter* spp.	*Staphylococcus aureus*
A	-	+	+	-	-
B	-	+	+	+	-
C	+	+	+	+	+
D	+	+	+	+	+
E	-	-	+	+	-

+ = Present;- = Absent

Table 6. Potential hydrogenale and temperature parameters of water samples

Sample	pH	Temperature (^{0}C)
A	6.47 ± 0.57^d	26.83 ± 0.57^d
B	5.83 ± 0.11^c	26.7 ± 0.0^c
C	5.27 ± 0.58^b	26.37 ± 0.58^a
D	4.80 ± 0.36^a	26.40 ± 0.0^b
E	7.37 ± 0.12^c	26.87 ± 0.57^d

Each value significantly differs from each other.
The pH ranges from 4.80 to 7.37 in RUGIPO and water corporation

Table 7. Parameters of the samples

Samples	Odour	Colour
A	Odourless	Colourless
B	Odourless	Colourless
C	Odourless	Colourless
D	Odourless	Colourless
E	Odourless	Colourless

The physicochemical properties revealed that all the samples were colourless and Odourless

The high coliform count encountered in sample C shows that the water may have been contaminated with feacal materials due to the sanitation of the community and also the lowest coliform bacteria encountered in sample E may be due to the regular treatment of the water by Ministry of Water Corporation. The occurrence of *Bacillus subtilis* in the water sample may be connected to the contamination from soil. The presence of this organism in drinking water has been reported as a source of disease in severely immune compromised patients [16]. *Staphylococcus aureus* is pathogenic in nature and ubiquitous in the environment. This organism may be introduced into the water through the environment and its presence in the water may give rise to illness [17]. The presence of *Escherichia coli.* a coliform which is usually used as indicator of fecal contamination in water may be attributed to seepages from septic tanks into household drinking water supply, unhealthy latrine systems which have exceeded their expected life span or post treatment contamination along the distribution line. The presence of this indicator organism in drinking water sources provides an indication of water borne problems which may pose serious health risk to consumers. This result is in line with [18] who affirm that the presence of *E.* coli in water samples is an indication of fecal contamination. The presence of *Proteus* spp in water may also be due to the contamination of the water through feaces, sewage or decomposing animal matter. They are opportunistic pathogens, commonly responsible for urinary and septic infections [19]. *Enterobacter* spp may be introduced into the water through fecal contamination of the water and this organism can cause numerous infections including cerebral abscess, pneumonia, meningitis, septicemia and urinary tract [20].

The physico-chemical analysis conducted (Table 6), showed that the borehole water samples from B and D sources were acidic (4.80 and 5.83) when compared with World Health Organization standard, ranges between 6.5 to 7.5 [21]. High acidic content of the water may be due to the location of the water and the secretion of acidic substances by the organisms or by the metals pumping the water. Sample E compared well with the World health Organization standard and this might be due to the treatment given to sample E by the ministry of water corporation. The temperature of the water samples were in line with the WHO standard [22]. The colour of the samples (Table 7) also compares well with the World Health Organization Guidelines for Drinking Water Quality.

5. CONCLUSION

It can be concluded from the study that the various diseases reported by the dwellers or inhabitants within the metropolis could have been as a result of the consumption of the water sample. However, it can therefore be concluded that the treatment adopted by the water corporation unit to ensure the safety of the sample which was discovered to keep the microbial load relative to the standard prescribed by Environmental Protection Agency, 2006 should also be adopted in treating other samples to ensure their safety before consumption.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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