PHYSICOCHEMICAL AND MICROBIOLOGICAL STATUS OF BOREHOLE WATER IN UTU EKPENYONG IN ESSIEN UDIM LGA IN AKWA IBOM STATE

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Abstract: Borehole is the commonest source of water in most cities in Nigeria, covering above 80% of the urban and rural dweller's water demand. The present study investigated the physicochemical quality of water from boreholes within four rural settlements covering Essien Udim local government, Nigeria. The investigated parameters showed average total coliform bacteria count to be between the ranges of 20% to 40% in the samples. The pH ranged from 6.00 – 6.08, The EC ranged from 19.99 – 28.10 Ns/cm while the ranges for the TDS and BOD. were 9.37 – 14.00 mg/l, and 5.55 to 11.73 mg/l respectively.

Key Word: Physico-chemical parameters, micro bacterial profile, water, borehole

Introduction

The provision of potable water supply is one of the major challenges that is been faced by the World Health Organization, water regulatory bodies and greater part of most nations of the world (Eddy and Ekop, 2007; Eddy and Udoh, 2006). Several literature agrees that there are more contaminated water than potable water in our current society. However, the distribution of contaminated water is widely connected with the level of urbanization, economic status, technological development and population and industrial activities (WHO, 2017). The rural areas are highly neglected concerning relevant environmental education, consequently, worse scenarios on water contamination shows significant impacts compared to expected impact in the urban areas. This is chiefly because of lack of adequate knowledge of the environmental consequences and remediation approaches against contaminated water (Kelly-Reif and Wing, 2016). In most rural settlements, water scarcity has compelled the residents to accept the only available choice, which may include stream water, rain water, shallow well water and water from boreholes (Aikowe and Mazancová, 2021; Shimamura *et al*., 2022). Several reported cases concerning the presence of various classes of contaminants in borehole water have been reported. For example, Aberikae *et al*. (2021) observed the presence of some radionuclides in borehole water from Asikam in the Fanteakwa South and concluded with an invitation for periodic observation.

Njar *et al*. (2012) observed the presence of heavy metals in some borehole water from Calabar South environment and remarked that the present concentration can constitutes significant environmental problem, if urgent actions are not taken. Imusa *et al*. (2023) reported that the adoption of physicochemical parameters in the assessment of water quality was capable of providing a significant information on the quality of borehole water within Maiduguri urban. It has been remarked that most contaminants in water have the tendency to become pollutants if the rate of inflow of such contaminants are not checked because processes such as bioaccumulation and biomagnification can increase their concentrations and circulate it within the ecosystem through the food chain. The first approach to the education of consumers in the rural areas is to established experimental documents on the quality of their various sources of water, including the major sources such as borehole. The existence of such database is not available in most region of Essien Udim Local Government area. Therefore, the present study is aimed at analyzing samples of borehole water from some selected locations within Essien Udim Local Government using the observed physicochemical parameters and comparing with the WHO standard.

Materials and Methods

The water samples were collected from four different sources in four villages within the community. The physico-chemical parameters were determined using standard methods: COD and NO_3^- by Odionenyi *et al*. (2015); SO_4^{2-} and NH_4^- by Ogoko (2017); pH was measured by using Jenway pH meter model 3305, (APHA, 1976). Conductivity was estimated by using HACH conductivity meter model 44600 after it had been calibrated. Turbidity by using turbidity meter, Jenway Model 6035. Total hardness of the water samples were determined by EDTA titrimtric method as described by Admoreti (1996) and Rahmanian et al (2015). Total alkalinity, suspended solid, BOD_5, methyl orange acidity were done as described by Ademoreti (1996)

Cultivation of the samples for the bacterial analyses was done as described by Cheedbrough (2005) after which the colony characterization, enumeration and purification of the isolates was subjected to several biochemical test in order to identify the the isolated microorganisms. The tests carried out were Gram reaction, spore standing, coagulase, citrate, mortality sugar fermentation and gas production.

Results and Discussion

Table 1 shows the total bacteria count observed in three water samples. The results show the total bacterial count to be above the WHO recommended limit, which suggest that the water is contaminated with respect to coliform count

Table 1: Total bacteria count in the samples

Sample	Total Count in the samples	WHO Standard for Water
B	22	0
C	18	0
D	28	0

Bacterial count, frequency occurrence and percentage frequency are presented in Table 2. The isolated bacteria detected were pseudomonas, mycobacterium spp, staphylococcus and bacillus.

Table 2: Bacterial count, frequency occurrence and percentage frequency.

Bacteria	Frequency Occurrence	Percentage Frequency (%)
Psudomonas sp	3	30
Bacillus sp	2	20
Mycobacterium sp	1	10
Staphylococuss sp	4	40
Total	**10**	**100**

Table 3: Fungi Isolate Morphology

Sample	Colony Pigmentation	Colour Texture	Colour Reverse Slide	Type of Hyphae	Vegetative and Reproductive Structure	Nature of Candida	Vesicle Head	Probable Fungi
1	Creamy	Raised muoid	milky	Non septate hypae	Candida appearing in pairs (budding in yeast cells)	Candida in pairs	No vesicle head	Sacchromyces sp
2	Orange like	Flat velvety	Light brown tan	Non septate	Presence of micro candida in slend and straight form	Presence of micro candida	No vesicle head	Fusarium sp

The physico-chemical analysis of the water samples are presented in Table 4.

Table 4. Physico-chemical Analysis of water Samples

Parameters	BWS 1	BWS 2	BWS 3	BWS 4	STANDARD
Temperature	28.10	28.10	28.00	28.30	23 - 40 ^{o}C
pH	6.08	6.00	6.00	6.03	6.50 - 8.50
TDS (mg/l)	14.02	10.00	10.90	9.37	1000mg/l
TSS (mg/l)	2.250	0.50	0.375	0.75	500mg/l
EC (Ns/cm)	28.10	20.01	23.30	19.99	1000 mg/l
T. Acidity (mg/l)	2.58	1.88	2.94	4.34	30 - 500 mg/l
T. Alkalinity (mg/l)	6.56	7.54	7.54	5.90	200 mg/l
Salinity (mg/l)	ND	ND	ND	ND	ND
BOD_2 (mg/l)	5.55	10.11	8.06	11.72	30 - 6.0 mg/l
DO (mg/l)	3.18	3.40	2.01	1.98	7.5 mg/l

The correlation matrix of the the physico–chemical parameters for the different samples were calculated and presented in Table 5 - 8. The results of the physico-chemical analysis of water Samples is presentd in Table 4. The pH range from 6.00 – 6.08 which lies in the range prescribed by WHO ((2008).

The Electrical Conductivity values range between 19.99 – 28.10 Ns/cm. The total dissolved solids (TDS) ranged from 9.37 – 14.02 mg/l. This is below the 1000mg/l of WHO and EPA. The total suspended solid (TSS) was between 0.375 – 2.250mg/l in the three samples which is lower than

2.42 – 4.3 mg/l as reported by Agbaire and Oyibo (2009). The total alkalinity was found to be between 5.9 – 7.54mg/l which is higher than the value 1.36mg/l recorded for private borehole water sample in Uruan by Ukpong and Okon (2013). BOD was found to be between 5.55 – 11.73mg/l. According to WHO Guideline (2017) unpolluted water should have a BOD of 5 mg/l or less. This is however within the range of WHO permissible standard. The DO was 1.98 – 3.40mg/l. The correlation matrix for samples 1 – 4 are shown in Tables 5 - 8. It is evident that distribution of pH, TDS, TSS, ECC, TAC, BOD is $r < 0.5$. The positive correlation in Table 5 is obtained between 32 unions (i.e. 91.4%) of the total number and less of 3 unions (8.57%) demonstrates negative correlation. Correlation value in Table 6 was obtained between 8 unions (22.85% of the total number) which demonstrated highly positive correlation. The water sample in Table 7 has six correlate values with an average of 17.14% of the total number. Each of these have a high positive correlated values. Table 8 had seven values with a total average of 20% with highly correlated positive value. Hence the correlation studies of the water quality parameters is of great significance in the study of the water reserves.

Microbial Analysis: The total *coliform* bacteria were more in the borehole water Sample D (40%) while Sample C had the lowest (10%). The values are higher than the WHO Guideline (2017). This contamination may be due to lack of sanitation and leakages on the pipe. Samples A and B had 30% and 20% colony convert respectively. A number of these microbacteria are known to cause some infections in human e.g in the blood, lung or other parts of the human system.

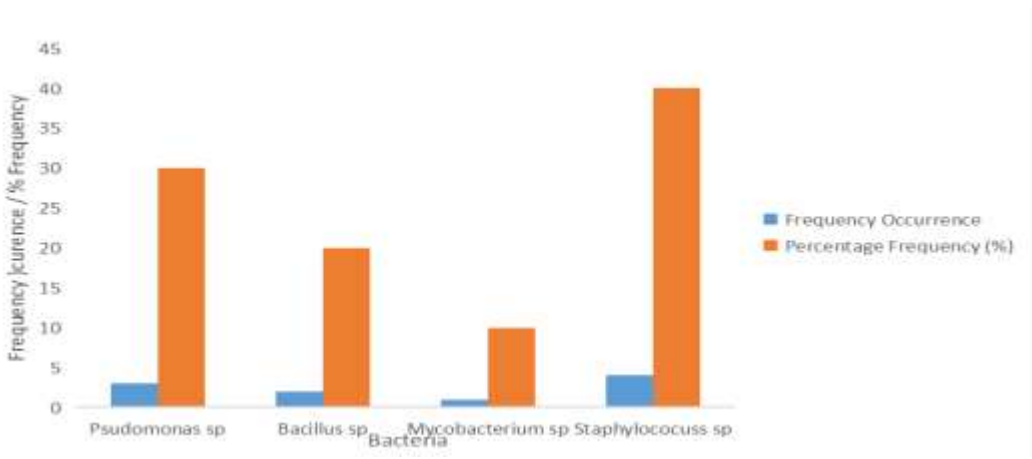

Figure 1: A plot of Bacterial Isolates Vs Percentage frequency Occurrence

Correlation Coefficient Matrix:

$$r = \frac{n\Sigma xy - (\Sigma x)^2(\Sigma y)}{\sqrt{n\Sigma x^2 - (\Sigma y^2)} \times n\Sigma x^2 - (\Sigma y)^2}$$

Table 5: Correlation Matrix for BWS 1 sample.

	Temp	pH	TDS	TSS	ECC	TAC	TAL	BOD	DO
Temp									
pH	0.9998**								
TDS	0.9532**	0.9666**							
TSS	0.7042	0.7374	0.8895*						
ECC	0.9998**	0.9994*	0.9592**	0.7137					
TAC	0.8707*	0.8933*	0.9786**	0.9623**	0.8772				
TAL	0.2424	0.2887**	0.5244	0.8595*	0.2554*	0.6882			
BOD_2	0.8787**	0.8969*	0.9803*	0.9601**	0.8811*	1.0000**	0.6823		
DO	0.5000	0.5409	0.7384	0.9670**	0.5116\	0.5116	0.9614**		

** Strongly positively correlated; * moderately positively correlated @ $P \leq 0.05$

Table 6: Correlation Matrix for BWS 2 Sample.
** Srongly positively correlated; * moderately positively correlated @ $P \leq 0.05$

	Temp	pH	TDS	TSS	ECC	TAC	TAL	S	BOD	D O
Temp										
pH	0.9997**									
TDS	0.7359	0.7517								
TSS	0.9696**	0.9752**	0.8791*							
ECC	-0.2678	-0.2449	0.4553	-0.0240						
TAC	0.2951	0.2723	-0.4298	0.0524	-0.9996					
TAL	0.6029	0'5838	-0.0966	0.3894	-0.9302	0.9402**				
S	0.5291	0.5491	0.9639	0.7206	0.6758	-0.6547	-0.3580			
BOD_2	0.8599**	0.8476*	0.2872	0.7090	-0.7221	0.7414	0.9256**	O.021 9		
DO	0.7299	0.7135	0.0743	0.5406	-0.8540	0.8685	0.9854	- 0.1938		

Table7: Correlation Matrix for BWS 3 Sample.

	Temp	pH	TDS	TSS	ECC	TAC	TAL	BOD	DO
Temp									
pH	0.4867								
TDS	-o.9975	-0.4234							
TSS	0.3449	0.9878**	-0.2774						
ECC	0.6331	0.9843**	-0.5766	0.9449**					
TAC	-0.1613	-o.9406	0.0908**	-0.9820	-0.8660				
TAL	0.6405	-0.3592	-0.6934	-0.5000	-0.1890	0.6547			
BOD_2	-0.8929	-o.0412	0.9226	0.1147	-0.2168	-0.3004	-0.9177		
DO	0.9071**	0.0738	-0.9347	-0.0822	0.2485	0.2691	0.9042**	-0.9995	

** Srongly positively correlated; * moderately positively correlated @ $P \leq 0.05$

Table 8: Correlation Matrix for BWS 4 Sample.

	Temp	pH	TDS	TSS	ECC	TAC	TAL	BOD	DO
Temp									
pH	-0.1429								
TDS	-0.3170	-0.8934							
TSS	-0.5636	-0.7370	0.9621**						
ECC	-0.6025	-0.7038	0.9479**	0.9989**					
TAC	0.1147	0.9668**	-0.9785	-o.8852	-0.8619				
TAL	0.1236	-0.9998	0.9020	0.7501	0.7175	-0.9716			
BOD_2	-0.7857	-0.5000	0.8358*	0.9538**	0.9671**	-0.7046	0.5168		
DO	-0.5766	0.8910*	-0.5921	-0.3500	-0.3047	0.7455	-0.8820	-0.0524	

** Strongly positively correlated; * moderately positively correlated @ $P \leq 0.05$

Conclusion

The study revealed that the physicochemical parameters of the water samples from the different location were not within the recommended level and hence not suitable for consumption. It should undergo pretreatment. The microbial parameters also were not in line with the acceptable limits.
In light of the above the supply system should undergo routine check, awareness should be created within the consumers, and also pretreatment should be done before usage.

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Conflict of Interest

The author has no relevant financial or non-financial interest to disclose

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