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QUALITY INDICES OF WATER SOURCES FROM AGBOR, DELTA STATE

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ABSTRACT
Borehole, well and river water quality were examined to ascertain their suitability for domestic, agricultural and industrial uses. The results of the determination revealed several loads of contaminants hence, most of the water samples are unsuitable for immediate consumption without treatment. In terms of BOD, the borehole samples are better than the well water samples. The BOD values range from 2.38 to 4.01mg/l for the borehole water; 2.20 to 4.01mg/l for the well water and 2.50 to 3.00mg/l for the river water samples. No E. Coli was detected in the river sample while 50% of borehole samples examined are contaminated with E. Coli. Almost all the borehole water samples are contaminated with chromium while about 58% of the well water samples have chromium levels above the desirable limits of chromium in drinking water. The results revealed that the water sources examined are suitable for agricultural productions (irrigation and aquaculture) but relatively potable for drinking and other domestic and industrial activities. To further enhance the water quality, filtration system should be integrated into the water supply line to reduce and eliminate dissolved organic and inorganic matter levels in the water.It is also recommended that measures to minimize discharge of microbial and chemical contaminants into water sources be adopted by the local council authority.

Keywords: water sources, Agbor, Quality indices, source protection

INTRODUCTION

There are enormous ranges of problems facing the world today and these problems may persist if appropriate measures are not urgently canvassed to forestall them. Some of the problems include but not limited to food insecurity, lack of adequate safe drinking water, climate change, global warming, desertification and antimicrobial resistance.

The availability and sustainability of potable drinking water rank as one of the more important and urgent of those problems. About 1.1 billion People do not have access to potable water and 2.4 billion lacks access to improved sanitation [1]. Lack of access to potable water is a leading cause of death worldwide. Globally, 80 percent of all sickness and disease results directly or indirectly from poor water supply and 19 percent of all deaths are due to waterborne infections [2].

In addition, 1.8 million people die from diarrheal diseases (including cholera) while 3,900 children die from water-related diseases or poor hygiene on daily basis globally [1]. In developing countries, 30,000 people die per day from poor water supply and sanitation[3]. This corresponds to 10.9 million people per year. Although the incident rates are more prominent in developing countries, health-related problems,particularly from microbiological contamination of water supplies occur periodically in the developed countries. In the United States, an estimated 19.5 million illnesses per year occur from waterborne infections [4]. So, as water sources become more stressed due to population growth and climate change, the casualty numbers could increase substantially.

Therefore, water of good quality is essential for achieving sustainable health and environmental developments. Water is crucial in maintaining good health and hygiene and by large, for sustainable socio-economic development [5,6 and 7]. There is barely any activity of man that excludes water utilization. Thus, the place of good water quality for sustainable health development cannot be undermined.

Water quality is the degree to which water is clean and free from contaminants and/or pollutants [8]. Safe (quality) drinking water is water that does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages [9]. Agood (safe) drinking water is that which is aesthetically acceptable and does not contain pathogenic agents and dangerous chemical substances [10].

Water quality indices on the other hand, are parameters essential for the ascertainment of water suitability for human use. Acceptable water quality indices show the safety of drinking water in terms of its physical, chemical and bacteriological parameters [11].

Hence, assessing the fate of available water sources is essential for sustainable water resources management. Water quality indices are many in number however, the point of use of water usually guide the choice of parameters to analysed for. The point(s) of use of water determine whether the water is polluted or not. Water is said to be polluted when some substances affect the water to such a degree that it cannot be used for specific purposes. So, pollution depends not only on the nature of the pollutants but also on the intended use (s) of the water. Water that is too polluted for drinking may be satisfactory for industrial use, as for cooling. Water too polluted for swimming may not be too polluted for fishing. Water too polluted for fishing may still be suitable for sailing or for electrical power generation [8].

Agbor being a food hub of Delta state, is also characterized with surface water and deep groundwater resources. These water sources are abstracted for use without any form of treatment. Worst still, the fate of most of these water sources are unknown, hence the present study. The present study is set to evaluate the quality parameters of river, borehole and well water sources in Agbor to ascertain their desirability for domestic uses.

MATERIALS AND METHODS

The study area

Agbor town is the headquarters of Ika south local government area of Delta state and it spread out on hills and a deep valley (the Orogodo valley). The town is geographically located at latitude $6^0 16^1$ North and longitude $6^0 9^1$ East. The area is laterite-rich with good loamy soil for agricultural productions. The town is characterized with low water table and a surface water course along the valley at Orogodo area of the town. Majority of persons in this area are farmers with some civil servants and traders. There are many vegetables farms around the lone river. The study area is also a beehive of commercial as well as academic activities. It houses a college of education, school of nursing and other numerous institutions.

Study population

The population consists of all boreholes, well and Orogodo river water sources in Agbor.

Sample collection

The water samples were collected during the day between 7.00hrs and 15hrs in the months of October, November, December, 2018 and January, 2019 for analyses. Plastic containers of 2-litre capacity were used for the collection of samples. The containers were pre-washed with detergent, rinsed with distilled water and then with 5% nitric acid and finally with distilled water.

LABORATORY ANALYSIS

The parameters investigated in this research were pH, Dissolved oxygen (DO), Electrical conductivity (EC), Temperature, Biological Oxygen Demand (BOD), Copper, Manganese, Chromium, Nikel, Sulphate nitrate and Total Coliform Count. The pH, Dissolved oxygen (DO), Electrical conductivity (EC), and Temperature were measured in-situ with a potable multi-meter. Sulphate and nitrate were measured by colorimetric method at 425nm and 470nm respectively while Biological Oxygen Demand (BOD), Copper, Manganese, Chromium, Nikel, and Total Coliform Count determined by [12].

RESULT AND DISCUSSION

The results of the analyses are summarized in tables 1-4 below. The temperature values range from 24.9 - 29.3; 24.8 - 27.8; and 25.6 - 25.8 for borehole water samples, well water samples and river water samples respectively. The temperature values varied with prevailing atmospheric temperatures.

The electrical conductivity (E.C.), sulphate (SO_4^{2-}), and nitrate (NO_3^-) for the water samples are within the desirable limits for drinking water [1]. The electrical conductivity values range from 10.26 - 180.50uScm^{-1} for the borehole water samples; 3.68 - 58.60 uScm^{-1}for thewell water samples;and 20.99-21.00 uScm^{-1}for the river water.These results show that water sources in Agbor town are fresh.The E.C, BOD, NO_3^- values for the downstream water samples is greater than the \ values reported for the upstream water samples. This may be due to extensive washing activities at the downstream of the river (R_2) (table 4).

Most of the borehole water samples are moderately acidic. The pH values range from 3.50- 8.46(table 2). Borehole water sample (AAB_2) has the highest pH value (8.46). This sample was collected about 1-kilometer from Orogodo river and less than 0.5Km from Agbor main market. This pH value (8.46) is above the pH value for the river water samples (4.57-4.60). Most of the borehole water samples are moderately acidic. The pH values range from 3.50- 8.46 (table 2).

TABLE 1: COMPARISON OF RESULTS OF THE STUDY WITH WHO STANDARDS

Parameters	← Range		→	WHO standards	
	BW	**WW**	**RW**	**Desirable level**	**Max. Allowed level**
Temperature (°C)	24.9 -29.3	24.6 -27.8	25.6-35.8		
E.C(μScm^{-1})	10.26 -180.50	3.68 -58.60	20.99-21.00	900	1200
NO_3^- (mg/l)	-	-	2.33-2.35	10.00	50.00
SO_4^{2-} (mg/l)	-	-	17.21-25.82	200	400
DO	3.55-7.86	3.00-7.78	3.80-5.20	3.0 -8.0	4.0 -8.0
BOD	2.38-4.01	2.20-4.01	2.50-3.00	< 3	< 3
pH	3.50 -8.46	4.00-9.27	4.57-4.60	6.0-8.5	6.5-8.5
Cr (mg/l)	0.02- 0.20	0.00 – 0.23	0.04 - 0.09	0.05	0.05
Ni (mg/l)	0.00-0.04	0.01-0.03	-	-	0.02
Cu (mg/l)	0.02-0.35	0.01-0.03	0.00-0.10	0.50	2.00
Mn(mg/l)	0.02-0.06	0.01-0.58	0.00-0.01	0.01	0.40

WW = Well water, BW = Borehole water RW = River water

Adopted from [11]

Borehole water sample (AAB_2) has the highest pH value (8.46).This sample was collected about 1-kilometer from Orogodo river and less than 0.5Km from Agbor main market. This pH value (8.46) is above the pH value for the river water samples (4.57-4.60). The pH values for the well water samples range from 4.00- 9.30. Most of the well water samples are alkaline and this may result from water contacts with the concrete wall separating the wells from natural geological material.

Also, the water samples are saturated with oxygen hence, suitable for irrigation purpose and livestock productions. The DO values range from 3.00 to 7.86mg/l; 3.00 to 7.78mg/l, and 3.80 to 5.20mg/l for the borehole, well and river water samples respectively (table2).

TABLE 2: PHYSIO-CHEMICAL AND HEAVY METAL LEVELS IN BOREHOLE WATER SOURCES FROM AGBOR

	Parameter				mg/l					
SAMPLE CODE	P^H value	E.C. ($uScm^{-1}$)	Tempt (^oC)	Depth (Ft)	DO	BOD	Cu	Mn	Cr	Ni
AAB_1	4.78	14.54	24.9	360	3.55	3.06	0.15	0.05	0.14	NDL
AAB_2	8.46	33.30	25.5	200	5.20	2.38	0.02	0.03	0.06	0.03
AOB_1	3.50	180.50	28.6	340	3.78	4.01	0.12	0.03	0.16	NDL
AOB_2	5.38	28.40	29.3	335	5.03	3.05	0.02	0.02	0.02	NDL
AOB_3	5.40	20.85	26.5	330	7.86	3.02	0.03	0.02	0.14	NDL
NRB_1	5.08	18.10	27.6	330	3.00	2.88	0.02	0.02	0.15	0.01
NRB_2	4.74	16.60	26.8	150	3.80	3.82	0.12	0.03	0.04	0.02
NRB_3	4.64	115.40	26.8	130	4.10	3.52	0.02	0.04	0.10	0.01
OB_1	3.86	95.50	27.2	120	5.80	3.03	0.12	0.03	0.22	0.05
OB_2	4.53	13.83	28.4	360	4.00	3.83	0.14	0.05	0.15	0.02
OB_3	4.73	44.50	27.9	380	3.80	3.20	0.35	0.03	0.03	0.28
ALB_1	5.60	10.26	26.7	320	6.00	3.28	0.15	0.06	0.16	0.03
ALB_2	5.48	25.64	26.4	330	4.60	2.88	0.14	0.05	0.07	0.04
ALB_3	5.86	24.43	27.0	328	5.60	3.08	0.13	0.04	0.20	0.03

E.C. = Electrical Conductivity, Tempt = Temperature; DO = Dissolved Oxygen; BOD = Biological Oxygen Demand; Cu = Copper; Mn=Manganase; Cr = Chromium; Ni = Nickel; AA= D.D.P.A; AO = Agbor-Obi; NR = Near River (Orogodo river); AL = Alihame areas; O =Owanta areas, NDL= Not within Detection limit

The BOD measures the levels of organic matter in water for over 5days period. The BOD values range from 2.38 to 4.01mg/l for the borehole water; 2.20 to 4.01mg/l for the wellwaterand 2.50 to 3.00mg/l for the river water samples.Hence, in terms of BOD, the borehole water is safer than the well water. About 86%of the well water samples and 79% of the borehole water samples have BOD values (tables 2 and 3) above the maximum permissible limits of 3mg/l recommended by [11] and [13] for drinking water. Hence, long term storage of these water samples maycause them to be unsuitable for drinking as it may encourage rapid microbial growth and ultimately, water borne outbreak.

TABLE 3: PHYSIO-CHEMICAL AND HEAVY METAL LEVELS IN WELL WATER SOURCES FROM AGBOR

	Parameters				mg/l					
SAMPLE CODE	**P^H value**	**E.C. ($uScm^{-1}$)**	**Tempt (^oC)**	**Depth (Ft)**	**DO**	**BOD**	**Cu**	**Mn**	**Cr**	**Ni**
AAW_1	9.01	40.48	24.8	40	3.52	2.20	0.01	0.58	0.02	NDL
AAW_2	4.00	58.60	24.6	30	5.24	3.17	0.13	0.01	0.01	0.02
AOW_1	6.38	24.38	27.0	38	3.90	3.38	0.03	0.02	NDL	NDL
AOW_2	6.38	15.47	27.8	35	4.86	3.32	0.02	NDL	0.05	NDL
AOW_3	6.52	3.68	27.0	30	7.78	3.42	0.01	0.05	0.04	0.01
NRW_1	6.74	24.61	26.6	35	3.00	3.72	0.03	0.03	0.09	NDL
NRW_2	8.84	41.27	27.2	40	3.84	4.01	0.02	0.05	0.23	NDL
NRW_3	7.78	46.88	27.0	36	4.18	3.70	0.12	0.04	0.05	NDL
OW_1	8.34	34.82	26.5	35	5.66	3.32	0.02	0.06	0.01	NDL
OW_2	8.90	26.48	26.8	38	4.02	2.96	0.01	0.04	0.08	NDL
OW_3	8.45	36.71	27.1	35	3.52	3.28	0.02	0.02	0.02	NDL
ALW_1	8.53	34.35	25.5	40	5.55	3.75	0.13	0.05	0.13	0.02
ALW_2	9.27	46.47	25.8	42	4.10	3.72	0.12	0.06	0.10	0.03
ALW_3	8.93	37.61	25.2	38	4.80	3.50	0.08	0.22	0.05	0.02

E.C. = Electrical Conductivity, Tempt = Temperature; DO = Dissolved Oxygen;
BOD = Biological Oxygen Demand; Cu = Copper; Mn=Manganase; Cr= Chromium; Ni = Nickel;
AA= D.D.P.A; AO = Agbor-Obi; NR = Near River (Orogodo river); AL = Alihame areas;
O =Owantaareas, NDL= Not within Detection limit

TABLE 4:PHYSIOCHEMICAL, HEAVY METAL AND BACTERIAL LEVELS IN THE RIVER WATER SAMPLES

	Parameters				mg/l							
SAMPLE CODE	**P^H**	**E.C. ($uScm^{-1}$)**	**Tempt (^oC)**	**SO_4^{2-}**	**DO**	**BOD**	**NO_3^-**	**Cr**	**Ni**	**Cu**	**Mn**	**Bacterial count (ppm)**
R_1	**4.60**	**20.99**	**25.8**	**25.82**	**3.80**	**2.50**	**2.33**	**0.09**	**NDL**	**0.10**	**0.01**	**03**
R_2	**4.57**	**21.00**	**25.6**	**17.21**	**5.20**	**3.00**	**2.35**	**0.04**	**NDL**	**NDL**	**NDL**	**07**

R_1= Uptream water sample, R_2 = Downstream water sample, E.C. = Electrical Conductivity, Tempt = Temperature; DO = Dissolved Oxygen;BOD = Biological Oxygen Demand; Cu = Copper; Mn=Manganase; Cr= Chromium; Ni = Nickel; NDL= Not within Detection limit

Relative contaminations of water samples with heavy metals are reported in tables 1, 2, and 3. Of the four (4) heavy metals determined in the whole water samples, copper (Cu) loads is below the WHO desirable limits for drinking water. The upstream water sample is contaminated with Mn while the downstream sample has undetectable level of Mn (table 4).

So, higher heterotrophic bacterial counts in upstream water sample (R_1) were anticipated but the actual bacterial count is a bit much in the downstream water sample (R_2) than in the upstream (R_1). This is due to greater anthropogenic activities at the downstream of the Orogodo river. No E. Coli was detected in the river water samples which makes it safe for bathing, drinking and for other domestic chores.

The concentrations of chromium (Cr) range from 0.04-0.09mg/l in river water samples. The concentration of Cr is higher in the upstream water samples than the downstream water samples. Discharge of animal wastes (tanning activities) from abattoir, which is less than 500m tothe bank of upstream section, accounts for the undesirable levels of Cr in this sample (R_1).

Almost all the borehole water samples are contaminated with chromium while about 58% of the well water samples have chromium levels above the desirable limits of chromium in drinking water [11]. Indiscriminate discharge of garbage and rubbish couple with storm water runoffs may account for the greater chromium concentrations reported at the Alihame areas: (0.07-0.20mg/l for boreholes and 0.05-0.13mg/l for the well waters).

The borehole water samples are contaminated with manganese (Mn) (table 2). Mn contaminations are known to encourage growth of microbes and induce bitter taste into water [14]. The levels of Mn range from 0.02 to 0.06mg/l in borehole water and 0.01 to 0.58mg/l in the well water samples. About 86% of well water samples are contaminated with Mn. The implication is that thesewater samples may have high heterotrophic bacterial counts due to high values of Mn concentrations reported in borehole and well water samples.

The heterotrophic bacterial count is a measure of the number of live bacteria present in water and does not directly indicate health threats. Ideally, water suitable for drinking must be free of pathogenic bacteria. The borehole water samples as well as about 86% of the well water samples are contaminated with bacteria species though the numbers of colonies obtained are below the WHO desirable limits of 10cfc/100ml of water. E. Coli is present in 50% of the borehole samples (table 5). The microbial loads in the entire borehole and the well water samples from Alihame area (ALB_1, ALB_2, ALB_3, ALW_1, ALW_2 and ALW_3) exceed the ones from other studied areas (table 5 and 6). The level of microbial loads is significantly higher than the amount reported for borehole waters from Obiaruku town, Delta state [15]. Poor wastes management practices and indiscriminate sitting of soak-away pits may account for these contaminations. The well water samples have lesser heterotrophilic count than the borehole water samples. Infiltrations of microbes into the well water samples from potential contaminant sources may have been hampered due to the concrete walls around the wells.

TABLE 5: BACTERIAL LOADS IN BOREHOLE WATER SAMPLES FROM AGBOR

	SAMPLE LOCATION/CODE													
Bacterial count (ppm)	**AA B_1**	**AA B_2**	**AO B_1**	**AO B_2**	**AO B_3**	**NR B_1**	**NR B_2**	**NR B_3**	**O B_1**	**O B_2**	**O B_3**	**AL B_1**	**AL B_2**	**AL B_3**
***Escherichia* Coli (E. Coli)**	0	0	01	01	0	0	0	0	0	01	02	02	03	01
Total Heterotrophilic count	05	03	07	05	02	04	02	01	05	06	08	06	09	06

AA= D.D.P.A; AO = Agbor-Obi; NR = Near River (Orogodo river); AL = Alihame areas; cfc = colony forming unit

TABLE 6: BACTERIAL LOADS IN WELL WATER SAMPLES FROM AGBOR

	SAMPLE LOCATION/CODE													
Bacterial count (ppm)	**AA W_1**	**AA W_2**	**AO W_1**	**AO W_2**	**AO W_3**	**NR W_1**	**NR W_2**	**NR W_3**	**OW_1**	**OW_2**	**OW_3**	**AL W_1**	**AL W_2**	**AL W_3**
***Escherichia* Coli (E. Coli)**	0	0	00	00	01	00	00	00	00	00	00	01	01	01
Total Heterotrophilic count	04	03	06	02	08	01	00	00	04	01	06	05	07	03

AA=D.D.P.A; AO = Agbor-Obi; NR = Near River (Orogodo river); O= Owantaareas ;AL = Alihame areas; cfc = colony forming unit

CONCLUSION

On the bases of the results, the water sources are suitable for agricultural productions (irrigation and aquaculture) but relatively potable for drinking and other domestic and industrial activities. It is therefore recommended that measures to minimize discharge of microbial and chemical contaminants into water sources be adopted by the local council authority since it is the constitutional responsibility of the government to provide adequate potable water for the citizenry. To further enhance water quality, filtration system should be integrated into the water supply line to reduce/ and eliminate dissolved organic and inorganic matter levels in the water.

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