QUALITY ASSESSMENT OF TWO SURFACE DAMS IN TWO COMMUNITIES OF PLATEAU STATE, CENTRAL NIGERIA

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Abstract
Water samples of two surface dams in parts of Plateau State, Central Nigeria, were subjected to physico-chemical and microbiological analyses to assess their suitability for domestic uses. The results of the study showed that the physical parameters like temperature, colour, odour, taste and total dissolved solids (TDS) for both dams are within the WHO standards for drinking water. However, the turbidity was found to be high with values of 35±2.13 and 16±0.92 for the respective dams as compared to the WHO value of 5.00NTU. Similarly, chemical parameters of pH, conductivity, biochemical oxygen demand (BOD), dissolved oxygen (DO), oil and grease, ammonia, Mg Ca-hardness, chloride, phosphate and alkalinity for both dams were found to be above the WHO recommended values for drinking water. Elemental analysis using ICP-OES also indicated that Zn, Pb, Ni, Mo, Mn and Ba were above the tolerable limits recommended by WHO for drinking water. The total viable counts for all the samples exceed the limit of 1.0 x 10^2 cfu/ml for water. Identified isolates included staphylococcus aureus, salmonella spp, pseudomonas spp, Escherchia coli and proteus spp. Based on the outcome of this study the two dams are considered not potable and have serious health risks to the communities using them for drinking purposes.

Key words: Quality assessment, dam water, health risks.

Introduction

Life on earth would be non-existence without water, as the human physiology depends very much on its availability (1). With 70% of the earth's surface being covered with water in the oceans, lakes, rivers and glaciers (2), life ought to have been thriving without water related problems. However, it is sad to note that today's water crisis is not an issue of scarcity but that of access.

Unsafe water is not just a third world problem as it is even harder to find safe drinking water especially in industrially developed countries such as the United States of America (3). Every day, lack of access to clean water and sanitation kills thousands, leaving others with reduced quality of life. According to the WHO and UNICEF, dirty drinking water kills 2.2million people per year, over 1.5 million of whom are children under the age of five (4). Every 20 seconds, a child dies from a water related disease, with diarrhea accounting to 43% of these deaths mostly in the developing world as a result of lack of safe drinking water, sanitation and hygiene, as well as poorer overall health and nutritional status (5). This means that contaminated drinking water is in a tight competition with diseases like AIDS and cancer to be the biggest killer of human beings on earth (3).

The availability and access to safe drinking water has become a critical and urgent problem, and it is a matter of great concern to families and communities depending on non-public water supply system especially in Africa and some parts of Asia. Increased human activities (urbanization, industrialization, agriculture and domestic activities) have not only rendered most water bodies (streams, lakes, rivers, ponds, dams, wells and canals) unfit for domestic purposes, but breeding ground for most deadly pathogens. Cases of water borne bacterial and viral infections (polio, hepatitis, cholera, typhoid, diarrhea and stomach cramps) have all been reported in different parts of Nigeria and sub-Saharan Africa (6, 7).

Ori and Kwaikong dams are two surface water sources used for different purposes by the two communities in Plateau State, Central Nigeria. While Ori dam is being used to generate

electricity by the National Electricity Supply Company (NESCO), Kwaikong dam on the other hand, is mostly used for washing cars and household purposes, where domestic animals also have free access to the water. It is survival of the fittest between human and animals during the dry season in Kwaikong village. Therefore there have been reported cases of water borne diseases like diarrhea, typhoid and hepatitis, in these communities (8 – 10).

In this work, the physico-chemical and microbiological characteristics of the two dams were investigated and the results compared with standards set for drinking water by the Standard Organization of Nigeria (SON) (11) and the World Health organization (WHO) (4).

Materials and Methods

Three samples each of Ori and Kwaikong dams water were collected at three different spots (point of usage by human (A), 15 - 20meters into the center of the dams (B) and at the opposite side (C)) of the dams using sterile plastic containers and analyzed within one week of collection.

The temperature of the samples was measured at the point of collection using the method described by FAO (12). Winkler Azide Modification Titrimetric and Bottle Incubation (3 days at 27 °C) methods described by Standard Analytical Procedures, SAP (13), were used for dissolved oxygen (DO) and biochemical oxygen demand (BOD) respectively. Other physico-chemical parameters followed the modified 19th edition of the APHA, AWWA (1995) of SAP (14) by the government of India and the Netherlands. The procedures described by Mishra and Bhatt (15) and Norrakiah et. al. (16) were found satisfactory for the bacteriological study of the water samples. Elemental analysis was carried out using Inductively Coupled Plasma Optical Emission Spectrometry, ICP-OES after elemental separation and precipitation with sodium dibenzylidithiocarbonate(NaDBDTC).

Results and Discussion

The physicochemical and bacteriological results of the two dams are shown in Tables 1 to 5. The measured physical parameters are all within recommended standards except for the turbidity, 352.13 (Ori) and 16 ± 0.92 (kwaikong), which are all above the WHO standard of 5.00NTU.

The mean value for chemical parameters is shown in Table 2. Ori dam generally has low chemical values than kwaikong water. This may be attributed to the fact that the water is majorly used for hydro electric power generation and it flows through a channel where the communities use for domestic purposes. All kind of human activities is carried out in kwaikong dam, coupled with its non-flowing nature, a possibility of harboring all kinds of deposited and generated chemical substances. Both samples showed high alkalinity values of 152 ± 0.00 (Ori) and 250 ± 2.3 (Kwaikong). High value in Kwaikong could be from fertilizers through runoff from farm lands around the dam. High values were obtained for nitrate (16.30±1.000) mg/l and phosphate (230±3.42) mg/l in Kwaikong. Source of these could be from agricultural runoff, sewage and animal wastes which can lead to increased photosynthetic activity and blue green algae, as this organism thrive in the presence of the added nutrients. The dead of these algae increase the BOD as oxygen demanding bacteria take over the ecosystem, decomposing the algae and using up the DO in the process (17). This is clearly seen in the BOD and DO values for the two dams, with Kwaikong recording a BOD value of 25.1 ± 1.33 mg/l and DO of 13.20 ± 0.38mg/l as against Ori, 16.30 ± 0.07mg/l (BOD) and 25.41 ± 0.11mg/l (DO). Chloride was high in Kwaikong (125 ± 6.21)mg/l and low in Ori (16.10 ± 0.08)mg/l, indicating that agricultural runoff, road salting, geology of the area and possible combination of chlorine with the metals present in the sample may be key to this.

TABLE 1: MEAN OF PHYSICAL PARAMETERS OF ORI AND KWAIKONG DAMS WATER

Parameters	Ori dam	Kwaikong dam	SON Value	WHO value
Temparature(°C)	28±1.0	27±1.0	NS	NS
Colour(TCU)	brownish	brownish	clear	clear
Odour	UO	UO	UO	UO

Taste	UO	UO	500	500
TDS (mg/l)	369±3.44	220±5.32	500	500
Tubidity (NTU)	35±2.13	16±0.92	5.0	5.0

KEY: UO = Unobjectionable; NS = Not stated

TABLE 2: MEAN OF CHEMICAL PARAMETERS OF ORI AND KWAIKONG DAMS WATER

Parameters	Ori dam	Kwaikong dam	SON Value	WHO value
pH	6.75±0.01	7.90±0.01	6.50-8.50	6.50-9.50
Conductivity (µs/cm)	0.2±0.00	0.05±0.00	1000	1200
Alkalinity(mg/l)	152±0.00	250±2.13	NS	NS
Chloride(mg/l)	16.1±0.08	125±.21	100	250
Ca-Hardness(mg/l)	250.±2.19	1500±7.36	750	NS
Mg-Hardness(mg/l)	17.5±0.91	82.0±1.30	0.20	20
Sulphate(mg/l)	31.0±0.63	65.8±1.29	100	500
Nitrate(mg/l)	1.52±0.04	16.30±1.08	10	50
Phosphate(mg/l)	1.0±0.00	230±3.42	NS	NS
Ammonia(mg/l)	2.00±0.02	6.92±0.13	0.2	0.2
Oil & grease (mg/l)	0.38±0.00	12.35±2.11	NS	NS
BOD (mg/l)	16.30±0.07	25.1±1.33	NS	NS
DO (mg/l)	25.41±0.11	13.20±0.38	5.0	5.0

KEY: NS = Not stated

The high value of oil and grease in Kwaikong (12.35 ± 2.11)mg/l must have resulted from the washing of gasoline vehicles and motorcycles which is a common practice in the area. Ammonia is also on the high side for Kwaikong (6.92 ± 0.13) mg/l and Ori (2.00 ± 0.00) mg/l. One surprising value is Ca-hardness which kwaikong recorded 1500 ± 7.36 mg/l as against Ori (250 ± 2.19) mg/l. Maybe the rock formation / mineral composition in the area have some contribution to its high value in kwaikong. The mean value of the chemical parameters determined is shown in Table 2.

The mean value for the metallic analysis is shown in Table 3. Most of the values are within the Maximum Allowable Limit (MAL) for drinking water by WHO except for manganese (0.81 ± 0.00; 0.57 ± 0.00) mg/l, molybdenum (3.27 ± 0.03; 0.04 ± 0.00) mg/l, lead (0.12 ± 0.00; 0.18 ± 0.00) mg/l, nickel (0.03 ± 0.00; 0.41 ± 0.00) mg/l, zinc (5.14 ± 0.32; 3.75 ± 0.00)mg/l and uranium (ND; 4.44 ± 0.08) mg/l respectively for Ori and Kwaikong. Uranium is a serious concern to kwaikong, and the source is still not certain for now apart from possibility of dissolution in phosphate fertilizers which can get into the water through runoff (18).

TABLE 3: MEAN METALLIC CONTENTS (mg/l) OF ORI AND KWAIKONG DAMS WATER

Element	Ori dam	Kwaikong dam	SON Value	WHO value
Al	2.11±0.03	0.003±0.000	0.2	0.2
Ba	0.17±0.00	0.072±0.000	0.05	0.07
Co	0.02±0.00	0.001±0.000	0.50	0.50
Cr	0.01±0.00	0.008±0.001	0.05	0.05
Cu	0.02±0.00	0.07±0.000	1.00	2.00
Mn	0.81±0.00	0.57±0.000	0.02	0.50
Mo	3.27±0.03	1.31±0.000	0.07	1.00
Ni	0.02±0.00	0.41±0.000	0.02	0.02
Pb	0.12±0.00	0.18±.001	0.01	0.01
U	ND	4.44±0.080	0.1	1.4

Zn	5.14±0.32	3.75±0.000	3.00	3.00
Ar	ND	0.12±0.000	0.01	0.01

KEY: ND = Not detected

TABLE 4 BIOCHEMICAL CHARACTERISTICS OF ISOLATES

	ORI			KWAIKONG		
Test	A	B	C	A	B	C
Catalase	+	+	+	+	+	+
Coagulase	+	+	-	+	+	+
Citrate utilization	+	+	+	+	+	+
Oxidase	+	+	+	+	+	+
Indole	+	-	-	+	+	-
Motility	+	+	+	+	+	+
Urease	+	+	-	+	+	+
Sucrose	+	-	-	-	+	-
Lactose	+	-	-	-	+	-
Glucose	+	+	+	+	+	+

TABLE 5 IMPLICATION OF THE BIOCHEMICAL TEST

	ORI			KWAIKONG		
Organism	A	B	C	A	B	C
Staphylococcus aureus	+	+	+	+	+	+
Pseudomonas spp	+	+	+	+	+	+
Escherchia coli	+	-	-	+	+	-
Salmonella spp	+	+	+	+	+	+

TABLE 6. AVERAGE TOTAL VIABLE COUNTS (ATVC) AND AVERAGE MOST PROBABLE NUMBER (MPN)/100ml OF ORI AND KWAIKONG DAMS WATER

SAMPLE	24HR (CFU/100ml)	INCUBATION	MEDIA	MPN/100ml
Ori	3.5×10^5		PCA	28
Kwaikong		4.4×10^5	PCA	110

The Average Total Viable Counts, ATVC of 3.5×10^5 and 4.4×10^5 on PCA for Ori and kwaikong indicate that both samples have high microbial load after 24hrs of incubation. This is evident by the Average Most Probable Number, AMPN/ml of between 28 to 110. This is significant enough to raise an alarm on the polluted nature of the water. The biochemical characteristics of the isolates revealed the presence of *staphylococcus aureus, pseudomonas spp salmonella spp* and *Escherchia coli* in both samples (Table 5). A general comparison of the two dams showed that Ori dam is less polluted than Kwaikong. However, this is not a guarantee for potability of Ori dam.

Conclusion

The study showed that the two dams are polluted. Both were found to contain manganese, molybdenum, lead, nickel and zinc with concentrations above the maximum allowable limits for drinking water set by the SON (11) and WHO (4). These metals are mostly carcinogenic and can also have the potential to cause high blood pressure (4). High turbidity can be a problem during disinfection of the water because it shields bacteria from disinfection agents (2). The presence of ammonia, oil and grease coupled with the microbial load are potential health risks. The two dam water are not potable and should be treated before domestic applications.

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References

1 A. Lamikanra (1999). Essential microbiology for students and practitioner ofpharmacy, medicine and microbiology. 2nd edition. Amka books. Lagos. 406.

2 WATER FACT (2010). Water Health Topics. http://www.who.int/topics/water/en/. Retrieved 19 November, 2010.

3 APEC (2010). Advanced Purification Engineering Corporation. www.free drinking water.org. Retrieved 09 December, 2010.

4 WHO/UNICEF (2000). Global water supply and sanitation assessment report 2000. WHO and UNICEF joint monitoring programme for water supply and sanitation http://www.who.int/water_sanitation_health/monitoring/globalassess/en/. Retrieved 10 November, 2010

5 UNICEF/WHO (2009).Diarrhea. why children are still dying and what can be done. http://whqlibdoc.who.int/publications/2009/9789241598415_eng.pdf. Retrieved 06 December, 2010.

6 M. O. Edema, A. M. Omemu, and O.M Fapetu (*2001*). Microbiology and physicochemical analysis of different sources of drinking water in Abeokuta, Nigeria. *Nigerian Journal of Microbiology. 15. 1. 57-61.*

7 O. I. Omezuruike, O. D. Adejoye, T. A. Ogunnusi, E. A Fajobi and O. B. Shittu (2008). Microbiological and physicochemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota, Lagos State, Nigeria. *African Journal of Biotechnology. 7(5) 617-621.*

8 J. J. Gongden and Y.N. Lohdip (2009). Climate change and dams drying. A case study of three communities in Langtang South Local Government of Plateau State, Nigeria. *African Journal of Natural Sciences. 12. 37- 43.*

9 Y. N. Lohdip (2011). The Insolvency of the Universal Solvent: That All May Have Enough to Drink'. *52nd Inaugural Lecture of the University of Jos,* delivered on Friday 29th July, 2011

10 Y. N.Lohdip & J. J. Gongden (2012) "Sustainable Low Cost Water Treatment for Some Nigerian Rural Communities". Paper presented at the *Network of African Science Academies (NASAC) - Royal Netherlands Academy of Arts and Sciences (KNAW)* Conference on "Water Management Issues in Africa" Reduit, Mauritius, 28 - 31 March 2012.

11 Standard Organization of Nigeria, SON (2007). Nigerian standard for drinking water. NIS 554 ICS 13.060.20.

12 FAO - Food and Agricultural Organization (1997a). Chemical analysis manual for food and water. 5th Edition. FAO ROME 1.

13 SAP (1999A) - Standard methods for the examination of water and waste water. Published by APHA, AWWA, WEF. 19th Edition.

14 SAP (1999B) Standard Analytical Procedures for Water Analysis May 1999 Government of India & Government of The Netherlands http://www.cwc.gov.in/main/HP/download/Standard%20Analytical%20Procedures.pdf Retrieved 16 October 2012.

15 A.Mishra and V.Bhatt (2008). Physicochemical and microbiological analysis of underground water in V.V Nagar and nearby places of Anand District Gujarat, India. *E-journal of Chemistry.* 3. 5 487- 492

16 A.S, Norrakiah, C.L Chan, and M.K. Zalifah, (2001). Microbiological and physicochemical quality of drinking water. The *Malaysian Journal of Analytical Sciences. 11. 2 414-420.*

17 Thinkquest (2010). Eutrophication. Human water use. Project by students for students www.library.thinkquest.org. Retrieved 12 December, 2010.

18 US EPA (2009). "Radiation Protection:Fertilizer and Fertilizer Production Wastes". March 11, 2009. http://www.epa.gov/rpdweb00/glossary/termuvwxyz.html#uranium. Retrieved 12 December, 2010.