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PHYSICOCHEMICAL AND MICROBIOLOGICAL ANALYSIS OF WATER BODIES IN UTURU, ABIA STATE-NIGERIA

Sunday O. Eze[1], Innocent C. Madumere[2]
Department of Chemistry, Abia State University, Uturu, Abia State,
NIGERIA.
[1] sundayoeeze@yahoo.com, [2] innocentchidkaobimadumere@yahoo.com

ABSTRACT

Sequel to the increasing importance of Uturu town because of population increase arising from the location of two universities and over ten secondary schools and the importance of water in such a place, the physiochemical and microbiological analysis of water samples taken from two streams, a spring and borehole from Uturu, Abia State Nigeria was undertaken. The physiochemical and chemical analysis includes the determination of pH, colour, total solid present (Ts), total dissolved solids (TDS), biological oxygen demand (BOD), chemical oxygen demand (COD), total hardness (TH), (Ca^{2+}, Mg^{2+}), phosphate, nitrate, heavy metals like lead, iron, zinc and copper using standard methods. Microbiological analysis was done by assessing the bacterial counts (MPN/100) coli forms. The physico-chemical qualities of these samples make them good and fit for drinking. The pH ranges from 5.7 (the Borehole) to 8.1 (Ihuku), shows slight difference from WHO, USEPA standard 6.5 – 8.2 and 6.5 – 8.5 respectively. The total viable counts of all the water samples were generally high exceeding WHO/FAO standard which is 1.0×10^2cfu/ml for potable water. The waters will therefore need to be treated, before it will be fit for drinking.

Keywords: Physicochemical, microbiological, analysis, water bodies, standards.

INTRODUCTION

The ensuring of good quality drinking water is a basic factor in guaranteeing public health, the protection of the environment and sustainable development (Ranjini et al., 2010). Water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability (Lemikanra, 1999; FAO, 1997). The provision of portable water to rural and urban population is necessary to prevent health hazards associated with poor drinking water (Nikoladze and Akastal 1989; Lemo, 2002). A significant proportion of the world's population use potable water for drinking, cooking, personal and home hygiene (WHO, 2004).

Before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is potable and safe for drinking (Tebutt, 1983). Potable water is defined as water that is free from disease producing microorganisms and chemical substances deleterious to health (Ihekoronye and Ngoddy, 1985). Water is the most common solvent for many substances and it rarely occurs in its pure nature (Caccio, 1973). Water can be obtained from a number of sources, among which are streams, lakes, rivers, ponds, rain, springs and wells (Okonko et al., 2008).

Unfortunately, clean, pure and safe water can exist only briefly in nature and immediately polluted by prevailing environmental factors aided by human activities. Water from most sources is therefore unfit for immediate consumption without some sort of treatment (Okonko et al., 2008).

The consequences of waterborne disease - diarrhoea,stomach cramps etc, have been well established but nitrate contamination just as deadly, consequent to the realization of potential health hazard that may result from contaminated drinking water from any source is therefore of primary importance because of the danger and risk of water borne diseases (Edema et al., 2001). The original sources of many drinking waters are often dirty and rich in aquatic microbes, some of which could be dangerous to man if they enter the human body.

In many developing countries, availability of 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.

Conformation with physiochemical and microbiological standards is of special interest because of the capacity of water to spread diseases within a large population. Although, the standards vary from place to place, the objective anywhere is to reduce the possibility of spreading water borne diseases to the barest minimum in addition to being pleasant to drink, which implies that it must be wholesome and palatable in all respects (Edema et al., 2000).

The principal objectives of municipal water are the production and distribution of safe water that is fit for human consumption (Lemikanra, 1999).

A good knowledge of the chemical qualities of raw water is necessary so as to guide its suitability for use. This work is therefore an attempt to examine the different sources of drinking water in Uturu and environs compared with standard table water in conformity to microbiological and physicochemical standard for potable water samples. This work is necessary because of the increasing population of the area due to the location of two universities within the area- the state owned Abia State University, Uturu and the private Gregory University, Amokwe Achara, Uturu. This is to safeguard the life of staff and students of the universities and over twelve secondary schools and many primary schools and the host communities.

MATERIALS AND METHODS

The samples for this analysis were collected with two-litre sterile polyvinyl chloride (PVC) plastic water bottles from four (4) designated sampling point in Uturu streams and borehole. These samples were collected from two streams- Ihuku and Aku, a spring– Nwaogba and the artificial water borehole in HopevilleUturu all in Isuikwuato Local Government area, Abia State, Nigeria on 9th of January, 2012.

The water samples were collected for both physiochemical and microbiological analysis. Samples were collected during the day at 9.00 am, 12.00 pm and 3.00 pm from each sampling point. The objective of the sampling was to collect a portion of material small enough in volume to be conveniently transported to and in lab, while still accurately representing the material being sampled. The preservation method for storage was refrigeration.

Water samples were analysed for physiochemical and microbiological quality and chemical characteristic were determined by the methods of FAO (1997), James (1995), ICMSF 1978 etc, the pH was determined using a Micro Computer pH meter

RESULTS AND DISCUSSION

The results of the physicochemical analysis, the metallic analysis and the microbial counts of the water samples are shown in tables 1, 2 and 3 respectively. Several physiochemical parameters of freshly collected water samples from Ihuku, Aku, Nwaogba and borehole comply with the WHO's standard for drinking water.

The colours of these water samples are unobjectionable. This falls within the standard that is acceptable to international bodies like W.H.O, EU, EPA.

The pH range of 65-8.1 (for Ihuku, Aku, Nwaogba) could be considered as being within the acceptable range for natural water, except a deviation recorded for the artificial underground water (borehole) with pH value of 5.7. According to Medera *et al* (1982) the pH of most natural water range from 6.5-8.5 which is a deviation from neutral 7.0 as a result of the CO_2/bicarbonate equilibrium.

The temperature range of 26.5-31.0 ^{O}C of the water samples is believed to have been influenced by the intensity of sunlight. The Ihuku and Aku stream have higher values (31^{o}C and 30^{o}C respectively) which may be due to exposure to sunlight. Nwaogba and the Borehole have lower ranges of temperature 26.5 and 29.0 respectively which may due to shades especially Nwaogba that is shaded by many trees (Mulusky, 1974).

Table 1. The Physicochemical Properties of the Uturu Water Bodies

Parameter	Ihuku	Aku	Nwaogba	Bore hole	WHO	USEPA
Colour	Unobjection-able	Unobjection-able	Unobjection-able	Unobjection-able	Unobjection-able	10mgpt/l
pH	8.1	7.8	6.5	5.7	6.5-8.2	6.5-8.5
Temp ^{o}C	31.0	30.5	26.5	29. 0	<25	<25
Total solids	733.33 4	540 10	25.5 5.0	45.0 7.6	500-1000	No limit
TDS	588.33	345.00	21.67	41.67	<600	No limit
Total solids	145.00	105.00	3.00	5.00	<500	No limit
BOD (mg/L)	3.70	2.73	1.69	1.99	<4	<4
COD(mg/L)	9.20	9.10	6.57	6.70	<10	<10
Nitrate	23	16.97	-	-	50	50
Phosphate	47.58 0.6	42.58 0.6	6.17 0.1	22.17 0.1	N0 limit	No limit
Sulphate	248.58	188.53	3.43	15.11	500	-
Total Hardness	30.07	29.70	15.42	38.46	100	

Table 3. Toxic/ Heavy Metallic Analysis

Parameter	Ihuku	Aku	Nwaogba	Bore hole	WHO	USEPA
Calcium (mg/L)	20.03	18.70	9.02	32.06	75	75-100
Magnesium(mg/L)	10.04	11.00	6.40	6.40	_	_
Lead (mg/L)	0.08	0.04	0.02	0.02	0.05	0.05
Iron(mg/L)	6.60	3.20	0.04	1.85	0.3	0.3
Zinc (mg/L)	2.45	1.3	-	0.15	0.5	0.51
Copper (mg/L)	0.18	0.08	-	0.02	0.05-1.5	No limit

Microbiological Properties

Total Viable Counts

Table 2. Bacterial load (TVC) cfu/ml

Samples	(Mean Total Viable Counts) cfu/mL
Ihuku stream	$6.83x10^4$
Aku stream	$5.83\ x10^4$
Nwaogba spring	$3.93\ x10^4$
Hopeville borehole	$4.00\ x10^4$
W H O Standards	$1.00\ x10^2$
USEPA Standards	$1.00\ x10^2$

Biological Oxygen Demand (BOD) measures the amount of oxygen used by microorganisms in this case bacterium, to oxidize organic matter present within the samples (Nielson, 2004). Water samples with the BOD less than 4.0mg/L are considered clean. From the table 4.2A the BOD ranges from 1.9-3.70mg/L. This means that these are clean water samples. (Rajini et al., 2010).

According to Rajini*et al* (2010), the WHO standard for COD of good quality water is < 10mg/L. If the COD is higher it will contain greater number of microorganisms.COD is a measure of the capacity of water to consume oxygen during the decomposition of inorganic chemicals such as nitrate and ammonia. The COD is related to the BOD. However, BOD only measures the amount of oxygen consumed by microbial oxidation and is most relevant to water rich in organic matter (Franson, 1975). The COD of these water samples are normal. This makes Ihuku and Aku streams as well as Nwaogba spring and the bore hole good potable and domestic water.

The level of nitrate in the water samples is low generally. The WHO standard for nitrate is 50mg/L and above this limit may cause cyanosis disease or blue baby syndrome in infants less than 3months (WHO, 2006).

No amount of phosphate in water is believed to have effects on human health (EPA, 1995). Phosphate has no significant adverse effect on man’s health. However, too much phosphate in water could lead to eutrophication. The level of phosphate in all the water samples is low. Therefore, they are good both for drinking and domestic uses.

The levels of sulphate in these water samples are low. The level of sulphate recommended by WHO is 500mg/L. Level of sulphate has no effect to adults but young children are very sensitive to sulphate. People that are not use to drinking water with high level of sulphate can experience diarrhoea. For a safety measure, water with sulphate level above 400mg/L should not be used in preparation of baby food. Reverse osmosis (RO) can be used in treating sulphate problems in water (WHO, 2006).

The total solid present in Ihuku stream and Nwaogba show higher values of TS, 733.33 and 540mg/L respectively. This shows that they fall within the range given by W.H.O. The Nwaogba spring and the Borehole have low values of total dissolved solids 25.5 and 40.0 mg/L respectively.

According to WHO (2006) the acceptable level of TS ranges from 500-2000mg/L with the range 500-1000mg/L being good for potable and domestic uses while above 1000 is acceptable for industrial water. This makes all these water good for drinking and other domestic uses. (WHO, 2006; USEPA, 1995 and UNEP,2002).

The level of total dissolve solids (TDS) Ihuku is slightly higher, then, all of them are within the recommended range 500 and above.TDS may affect the aesthetic Quality of water, interfered with washing clothes and corroding plumbing fixtures. The total hardness of these water samples shows that all the water one soft water. The standard in TH is 0.5 -50.0mg/L consider soft 100-150mg/L is moderately soft water. From the table the values attained were not up to 50mg/L that means they are soft water and good for both drinking and other domestics work. For aesthetic reasons, a limit of 500mg/L is typically recommended for potable water supplies (WHO, 2006). So are they all good for any use.

The level of calcium in the water sample is very low. This makes these waters soft water. Calcium has no effect on human health in water, but it can cause hardness problem risk.

The level of magnesium in all these water samples is very low. This makes them good for drinking. High level of magnesium in water can increase the water hardness and can also cause total dissolve solids problems (WHO, 2006).

The level of lead from the table data shows the Ihuku has higher content 0.08 which is moderately considerable; Aku has 0.04 mg/l. But Nwaogba and borehole have low lead contents. The higher values lead of in the streams samples may be caused by run-off water from residential area or waste from domestic work like paints etc. The higher level of lead may cause health problems like cancer, anaemia etc.

The level of deviation of Iron in all samples is very high compared with EPA standard 0.3mg/L. Ihuku stream is 6.60mg/L and Aku is 3.20mg/L and the borehole 1.85mg/L while Nwaogba is 0.4mg/L. This may be due to the nature of the metal, that it is strongly absorbed to soil and more easily dissolved in minutely-negligible amounts. Another contributory factor may be the presence of a metal waste deposit site near the streams with drawn "rust water" during erosion into these water bodies especially Ihuku and Aku streams (EPA, 1995).*Iron* when presence in high detectable amounts can affect the flavour of tea, coffee and alcoholic beverages. It can also promote the growth of iron bacteria in water and also makes the water distasteful (Yagoub and Ahmed, 2009).

The level of zinc in water is high Ihuku and Aku streams 2.45 and 1.3mg/L respectively. The spring water (Nwaogba) has no zinc detection and the borehole has 0.15mg/L. Zinc is needed in man's foods. In pregnancy zinc deficiency may cause growth retardation in the foetus. But high levels of zinc may cause adverse health effects like anaemia and injury to the pancreas and kidney, disturb protein metabolism and cause arteriosclerosis (Noakes et al., 2008). This level of zinc makes them fit for drinking.

Copper level of the water samples was good. The range of copper was b/w 0.02- 0.88 mg/L . the standard given by WHO (1995) on copper content range is 0.05- 1.5 mg/L. these water sample are almost free of copper contaminants, this also make them good for drinking and also domestic uses.

Microbiological analysis of the water bodies is shown in table 3. Total viable count (TVC) indicates that the microbial count were too high in these samples. Ihuku and Aku have higher counts i.e. 68.33×10^4 and 58.33×10^4 cfu/ml respectively, and Nwaogba and the Borehole show lower values of 3.93×10^4 and 4.0×10^4. The report of Edama (2006) which indicates that the presence of bushes and shrubs around water bodies makes it likely and possible that some individuals may have been coming around to drink water thereby passing out faeces into the stream water.

In general low pH values obtain in analysed sample might be due to level of CO_2 in water which may consequently affect the bacterial count. (Edama et al., 2001). Iron is known to promote the growth of "iron bacterial" in the water and also makes the water distasteful. WHO state that 0.3mg/l of iron does not affect the taste of water (Rajini et al., 2010).

CONCLUSION AND RECOMMENDATIONS

This study concluded that the drinking water quality in Uturu needs a serious effort in limiting the numbers of microbial organisms released into the system. The microbial level render them unfit for human consumption though they can be used for other purposes water should meet different quality specification depending on the particular uses. Portable and domestic water should be harmless for the health of man and other domestic uses (Rajini et al., 2010; Okonko et al., 2008).

According to WHO and USEPA recent news and reports, most tap, boreholes, streams and rivers water in use are not safe for drinking due to heavy industrial and environmental pollution. Toxic chemical, heavy metal and bacteria in water make people sick while exposing them to long term health condition. Water quality should be controlled in order to minimize acute problem of water related disease which are endemic to health of man. (Okonko et al., 2008).

Therefore, an effective and thorough sanitary condition should be given to these water bodies in order to maintain a good water quality.

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