EVALUATION OF DRINKING WATER SOURCES ON THE HEALTH SAFETY OF PEOPLE OF ILORIN, KWARA STATE

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ABSTRACT

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Quality status of drinking water sources from some selected points in Kwara State was analysed. Some physical and chemical parameters such as pH, turbidity, dissolved oxygen; electrical conductivity, suspended solids, nitrogen, nitrate, nitrite, phosphate, chloride, sulphate, potassium, sodium, magnesium and calcium were evaluated using standard methods.Laboratory analyses of the water samples conducted revealed variation in their physical and chemical parameters for both the western and eastern parts of the river basin dam within Ilorin metropolis. The following amongst others were observed; pH ranging from (5.82$\pm$ 0.29– 7.13$\pm$0.36); Suspended solids (0.11$\pm$0.01 –0.26$\pm$0.03%); Dissolved oxygen (0.01$\pm$0.00–0.48$\pm$0.05ml /O_2/L); Chloride (0.43$\pm$0.04–3.12$\pm$0.22mg/L); Sulphate (2.38$\pm$0.17–4.40$\pm$0.22ppm) and Phosphate (5.65$\pm$0.28 – 9.09$\pm$0.45ppm) etc. The results obtained showed some variations in quality of water samples from both the west and eastern part of Ilorin when compared with the World Health Organization's standard for drinking water. However, the physicochemical indicators as well as Cations analysed show that the water sourced from these areas may not really pose risk to human health, since they could be supplemented for in human diets or the values had not gone beyond specifications

Keywords: *Water, Physico-chemical properties, World Health Standard, Safety, Human Health.*

INTRODUCTION

Water is a ubiquitous chemical substance that is essential for the survivor of all known forms of life. Typically, water refers to only its liquid form or state, but the substance also has a solid state, ice, a gaseous state, water vapour or steam. Water covers about 71% of the earth's surface (CIA, 2008; Ball, 2007). It is found mostly in oceans and other large water bodies, with 1.6% of water below ground and 0.001% in air as vapour, clouds (form of solid and liquid water particles suspended in air), and precipitated (Smith, 2005). The chemical formula H_2O: one molecule of water has two hydrogen atoms covalently bonded to a single oxygen atom (Campbell *et al*, 2006). The colour of water and ice is, intrinsically, a very light blue hue, although water appears colourless in small quantities (Brawn and Sergei, 1993).

Water is valuable for drinking, recreation, domestic cooking and washing, aquaculture, aquatic life support, livestock production, irrigation and industrial production. Each of the uses of water requires that the water possess certain specific quality chacteristics, but sometimes do not, either due to non or improper treatment, pollutions, contaminations or the source(s) of the water (Deberedetti and Stanley, 2003; Shiklomanov and Deberedetti and Stanley, 2003; Rodda, 2003; Pimentel *et al*., 2004). Clean, fresh water is necessary for human and other life on earth (Bjorn, 2001). Human can survive without food for several weeks, but for only a few days without water (Deberedetti and Stanley, 2003). A constant supply is needed to replenish the fluid lost through normal physiological activities, such as respiration, perspiration and urination, with about 70% of water used in agriculture (Banori *et al.*, 2007). Unfortunately, much of the available fresh water is not fit for drinking due to pollution related to discharge of sewage, agricultural wastes, indusrial effluent, municipal runoffs and wastes, domestic/kitchen wastes, and oil spills (UN, 2005). In terms of mineral nutrients intake, the contribution of water is unclear. However, inorganic minerals generally enter surface water and ground water via storm water runoff or through the earth's crust. Treatment processes also lead to the presence of some mineral nutrients such as fluoride, calcium, zinc, manganese, phosphates and sodium compounds (Azoulay *et al*., 2001; Hallberg, 2004).

Drinkable water should be high in quality to ward off risk of immediate or long term harm. Drinkable water should be accessed under two categories; chemical/physical and microbiological. Chemical/physical parameters include heavy metals, trace organic compounds, total suspended solids (TSS), and turbidity. Most thriving chemical material producing industries in Nigeria discharge their liquid effluent untreated or inadequately treated into some land or water course. The impact on some small water courses is sometimes devastating as this often makes such waters no longer suitable for use. Some of such water bodies become coloured, smelly and sterile (that is lost its life, as most animals within such water may be dead and the usual fishing activities, swimming etc, no longer take place) with regards to aquatic life (Onianwa, 2015). Most of the water sources in Kwara state are tributaries to River Niger, major rivers that traverse the state capital and hence, best suited to access the quality of water consumed in Kwara State. Preserving the quality of fresh water is important as it can be compromised by the presence of infectious agents, toxic chemicals, and radiological hazards (WHO, 2009).

In 2006, water borne diseases were estimated to cause 1.8million deaths, with about 1.1billion people lacking proper drinking water (US Centre for Disease Control, 2006), while about 2.2million died per annum from unsanitary water in 2007 (Clasen *et al.*, 2007). As a result of these and more, there is a need to take appropriate steps to resolve the problems associated with poor water quality. The aim of this study was to determine quantitatively the concentration of the different chemical/ physical pollutants present in the water samples from the west and eastern ends of the dam; and to compare the results obtained to the standard recommended by World Health Organization (WHO).

MATERIAL AND METHODS

Water samples were collected from the western and eastern end of Asa River Basin, Ilorin, Kwara State, streams flowing out of the dam, wells dug close to the streams and boreholes within the Oyun community in Ilorin, Kwara State. The samples were collected in the morning in sterile transparent white glass bottles after the water had been allowed to run for several minutes, labeled properly and immediately taken to the laboratory for analysis. Turbidiy, electrical conductivity ($R_{(KCl)}$), suspended solids (Mg/l), Chlorides (MI/l), Phosphate, Sulphate, Dissolved oxygen, pH, Calcium, Magnesium, Nitrogen, Nitrate and Nitrite in the collected samples were determined using standard methods of (AOAC, 2000).Digital pH meter used for the pH measurement was calibrated with buffers at pH 4.0 and 7.0. After each reading, electrode was washed with distilled water and dried up with tissue paper before other readings. The electrical conductivity was measured with mettle multi-parameter meter. Alkalinity of the water samples were done by titrating 100ml of water sample with 0.02M HCl solution using methyl orange as indicator. Chlorine was determined by titrating 100ml of the samples with 0.025M $AgNO_3$ solution using 5% $K_2Cr_2O_7$ as indicator. Phosphate, Nitrate, Nitrite and sulphate were equally done by titration. Total suspended solids were determined by gravimetic method. Calcium, magnesium was done using EDTA. All reagent used were of analytical grade.

RESULT AND DISCUSSIONS

Table 1 shows the result of the physical parameters of water samples from both the western and eastern ends of the dam. The pH is a measure of the strength of an acid or a base and WHO's recommendation for drinking water is between *6.5 and 8.5*. The pH values are all within the specification, that is fell within the recommendation except for water sample of the stream (pH of 5.8) on the western end. The stream water was not fit for drinking due to its acidity level. It was reported by Onuh and Isaac (2009) that pH lower than 6.5 can lead to corrosion of pipes causing release of metals like Zn, Pb and Cu in the water sample, while pH far above 6.5 increases scale formation vessels used for heating and equally reduces bactericidal effect of chlorine.

According to (WHO, 2005), electrical conductivity and turbidity are non-specific measure of natural dissolved inorganic substances in water and a measure of the cloudiness of water respectively. Electrical conductivity ranged from 1.28± 0.9mV (stream on the western end) to 0.39±0.04mV of the stream also at the eastern end of the dam. From the western end, it was noticed that the electrical conductivity decreases in concentration as the sampling move farther from the stream centre. The eastern portion displayed a slight increase as the sampling move farther away from the stream centre. It could be deduced from this that due to lateral flow of the water table, there was seepage from the stream to the various sources of water. The pH values are all within specification. The electrical conductivity from the water sources was insignificant with the stream having the lowest concentration (0.39±0.04 mV) and borehole, the highest (0.65±0.07mV). The borehole could have obtained its concentration from the treatment process and/or its environment. Other samples could have also obtained their higher concentrations from their environment.

The standard for Turbidity is *4NTU, which was equally supported by SON (2003), that state 5NTU*. From our result, it could be seen that the turbidity levels were significantly low. They ranged from 2.85±0.20 NTU in sample A_3 at the western end to zero in some of the other samples. The contamination noticed in sample A_3 could be traced to its environment likely due to muddy soil. Turbidity indicates water quality level and filtration effectiveness. Higher turbidity level is often associated with higher level of disease causing microorganism such as viruses, parasites and some bacteria. These lead to short term symptoms such as nausea, cramp, diarrhea and associated headache. The amounts of solids in water affect both removal and disinfection process. It varies with season and equally provides information on the pollution level of the water (Kulshireshitha, 1998) and by WHO, 1993 standard; it should be about 500mg/L. It was reported by Daniel *et al*. (2007), Nwosu and Ogueke (2004) and Goel (2006) that poor odour and taste may result from contamination with dirt and dissolved solids and could result in poor filtration on the long run. The result of the analysis showed that the borehole at the eastern end had the lowest concentration of 0.11±0.01%, while sample sourced at 10 meters away from the stream also at the eastern end had the highest value (0.26±0.03%). The result of suspended solids was insignificant when compared to the standard set by (WHO, 1993) (500 mg L^{-1}).

Dissolved oxygen is the amount of oxygen in water. It indicates the water body's ability to support aquatic life (Shiklomanov, 2000). Dissolve oxygen in water has no specific standard (WHO, 1993). The result, as seen in Table 2, showed that stream (western end) had the highest concentration of dissolved oxygen (0.48± 0.05ml/O_2/L), while sample B_1 and A_2 had the least.

Table 1: Physical parameters of water samples

Samples	pH	Electrical conductivity (MV)	Turbidity (NTU)	Suspended solids (%)	Dissolved oxygen ($ml/O_2/L$)
Stream (W)	5.82±0.29c	1.28±0.09	2.48±0.17b	0.12±0.01b	0.48±0.05a
Stream (E)	6.72±0.35b	0.39±0.04c	1.03±0.07d	0.22±0.02a	0.09±0.01c
Borehole (W)	7.13±0.36a	0.43±0.04b	ND	0.21±0.02a	0.05±0.01c
Borehole (E)	7.13±0.36a	0.65±0.07a	ND	0.11±0.01	0.08±0.01
A_1(W)	6.93±0.35a	0.55±0.06b	ND	0.18±0.02a	0.22±0.02b
B_1(E)	7.11±0.35a	0.40±0.04c	0.13±0.01e	0.13±0.01b	0.01±0.00c
A_2 (W)	6.96±0.35a	0.52±0.05b	ND	0.17±0.02b	0.01±0.00c
B_2 (E)	7.00±0.35a	0.48±0.05b	0.03±0.00e	0.18±0.02a	0.03±0.00c
A_3 (W)	7.05±0.35a	0.46±0.05b	2.85±0.20a	0.17±0.02b	0.12±0.01b
B_3 (E)	7.13±0.36a	0.41±0.04c	1.42±0.01c	0.26±0.03a	0.05±0.01c

Values are means of 3 determinations ± S.D.
ND: Not Detected
W and E represent the western and eastern ends of the dam respectively; A and B are water samples from wells at different distances from the stream source; A_1: Well water, 3metres from the stream; A_2 Well water, 5 metres from the stream; A_3: Well water, 10 metres from the stream

Table 2: Concentration of dissolved anions in the water samples

Samples	Chloride	Sulphate	Phosphate	Nitrogen	Nitrate	Nitrites
	------------------------mg L^{-1}------------------------			-----------------------%------------------------------		
Stream (W)	0.43±0.04b	2.66±0.19c	7.70±0.39c	0.14±0.01a	0.62±0.06a	0.40±0.04a
Stream (E)	2.12±0.15e	2.52±0.18c	7.31±0.37cd	0.02±0.00b	0.12±0.01c	0.09±0.01c
Borehole (W)	2.13±0.15e	4.40±0.22a	8.73±0.44b	0.06±0.01b	0.25±0.03b	0.19±0.02b
Borehole (E)	3.12±0.22a	2.86±0.20b	9.09±0.45a	ND	ND	ND
A_1(W)	2.55±0.18b	2.60±0.18c	6.33±0.32e	0.06±0.01b	0.25±0.03b	0.19±0.02b
B_1(E)	1.98±0.14cd	2.71±0.18b	5.65±0.28f	0.02±0.00b	0.12±0.01c	0.09±0.01c
A_2 (W)	2.27±0.16c	2.50±0.18c	9.30±0.47a	0.11±0.01a	0.50±0.05a	0.38±0.04a
B_2 (E)	1.70±0.12d	2.71±0.18b	6.39±0.32e	0.05±0.01b	0.24±0.02b	0.19±0.02b
A_3 (W)	1.70±0.12d	2.38±0.17d	7.12±0.36d	0.11±0.01a	0.50±0.05a	0.38±0.04a
B_3 (E)	2.97±0.21a	2.74±0.19b	8.78±0.44b	0.05±0.01b	0.22±0.02b	0.17±0.02b

A_1: Well water, 3metres from stream; A_2 Well water, 5 metres from stream; A_3: Well water, 10 metres from the stream
Values are means of 3 determinations ± S.D.
ND: Not Detected, W and E represent the western and eastern ends of the dam respectively; A and B are water samples from wells at different distances from the stream source; $A_{1,}$ A_2 and A_3 are water samples from wells

Table 2 gave the concentrations of Dissolved Anions in the water samples. According to (WHO, 2005), chloride is a component of common salt and has a recommended standard value requirement of 250 mg L^{-1}. The concentration of the water samples were insignificant with the sample having the highest concentration recorded 3.12±0.22 mg L^{-1} (borehole at the eastern end), while the stream (at the western end) had the lowest concentration (0.43±0.04 mg L^{-1}). It could however be deduced that the various water samples were not contaminated by the stream based on the results obtained. Chloride helps in maintaining fluid balance in the body. It is an essential component of the hydrochloric acid in the gastric required for digestion. Lack of it could result in repeated vomiting, diuretic therapy, or kidney disease. The results obtained for all the samples were highly insignificant, as the values were lower than the recommended standard. Likewise, Sulphate has a standard value of 250 mg L^{-1} (WHO, 2005). Its concentrations in the water samples were insignificant. High concentration of sulphate present problem, as it gives unpalatable taste, while low to moderate concentration of sulphate ions add palatability to water taste (Goel, 2006). Borehole from the western end had the highest concentration, 4.40± 0.22 mg L^{-1}, and sample A_3 (well water sampled at about 10 meters from the stream) had the lowest concentration of sulphate (2.38± 0.17 mg L^{-1}).

Although the amount of phosphate in water is not regulated, World Health Organisation (WHO) provided a maximum safe level of around 5.0 mg L^{-1}. Judging by this, the concentrations of phosphate in the samples were significantly high. It ranged from 5.65±0.28 mg L^{-1} to 9.30±0.47 mg L^{-1} in all the samples. It could be deduced that none of the water samples was save for drinking with respect to the phosphate concentration. Phosphate safe level is believed to be around 5mg/L though not regulated. It could be concluded that the samples got their concentration from the environment, while samples sourced from well close to the stream could have gotten seepages from the stream or even the environment. The standard for Nitrate is 50 mg L^{-1} (WHO, 2005). The results in table II shows that nitrate levels in all the water samples were insignificant judging by the standard value. Nitrates which occur naturally in all sources of water could be removed by ion exchange, water treatment or through blending with other low nitrate sources. Nitrite on its own is sometimes produced as a by-product when chloramine (more soluble and long lasting disinfectant) is used as the essential residual disinfectant in a public water supply. The nitrite level in the stream was the highest (0.41±0.04%), while the lowest was 0.19±0.02%.

Nitrate naturally occurs in water sources although higher concentration tends to occur where fertilizers are used on the land (WHO, 2005). Recommended standard value of Nitrate in drinking water is 50 mg L^{-1}. It could then be deduced that the quantity/concentration of nitrate noticed in the samples could be due to fertilizer pollutant in their environment, while the zero value recorded for the borehole could be that the treatment processes removed the nitrate content. The recommended level of nitrites in drinking water is 0.5 mg L^{-1}. The study result showed nitrite levels to be insignificant for the samples. Environmental influence might have affected the content of nitrites in the samples. Table 3 shows the cation concentrations (potassium, sodium, magnesium and calcium) in the water samples from both ends of the dam. From the report by (WHO, 2009), it was not considered necessary to establish a health-based guideline value for potassium in drinking water. This is an essential element in humans, and is seldom, if ever, found in drinking water at levels that could be a concern for healthy humans. Currently, there is no evidence that potassium levels in municipally–treated drinking water, even water treated with potassium permanganate, are likely to pose any risk to the health of consumers. The highest concentration of potassium was found in sample B_1 (42.50±0.43 mg L^{-1}), while the lowest concentration was found in the borehole (western end) sample (2.50± 0.18 mg L^{-1}).

Table 3: Cation concentrations in the water samples

Samples	Potassium (K^+)	Sodium (Na^+)	Magnesium (Mg^{2+})	Calcium (Ca^{2+})
	--mg L^{-1}--			
Stream (W)	6.25±0.31cd	300.00±3.00bc	1.97±0.14d	0.56±0.06e
Stream (E)	6.50±0.33cd	260.00±1.60c	3.15±0.22b	1.66±0.12d
Borehole (W)	2.50±0.18e	49.00±0.49d	4.52±0.23a	0.21±0.02e
Borehole (E)	7.01±0.35c	120.00±0.20cd	0.09±0.01e	0.99±0.01e
A_1(W)	10.00±0.50c	230.00±2.30c	1.88±0.13d	5.08±0.25c
B_1(E)	42.50±0.43a	750.00±7.50a	4.01±0.28a	115.62±1.16a
A_2 (W)	4.50±0.23d	300.00±3.00bc	2.53±0.18c	2.04±0.14d
B_2 (E)	13.50±0.14b	510.00±3.10b	4.32±0.30a	117.97±0.18a
A_3 (W)	5.25±0.26d	290.00±2.90bc	3.50±0.25b	5.46±0.27c
B_3 (E)	6.50±0.33cd	180.00±1.80c	3.78±0.26b	13.16±0.13b

A_1: Well water, 3metres from stream; A_2 Well water, 5 metres from stream; A_3: Well water, 10 metres from the stream
Values are means of 3 determinations ± S.D. W and E represent the western and eastern ends of the dam respectively; A and B are water samples from wells at different distances from the stream source

The standard value of sodium in drinking water is 200 mg L^{-1} (WHO, 2005). The result of the analysis shows that sodium concentrations in the various water samples were significantly high except for some (borehole from both ends and well water sampled 10 meters from the stream at the eastern end) that had values less than the standard value. The importance of magnesium to human health cannot be over-emphasized. Magnesium is an essential cofactor for more than 350 enzymes systems and it is involved in energy metabolism, nucleic acid synthesis, cellular balance, cardiovascular health and hormonal function. Low intake of magnesium has been associated with osteoporosis, increased calcium inbalance, insulin resistance, metabolic syndrome, increased oxidant stress and increased risk of cardiovascular disease. It standard level in drinking water has been tentatively put at 10mg/L (WHO, 2006). The results showed that the concentration of magnesium cation in all the water samples were highly insignificant when compared with the standard value. The borehole (at the western end) had the highest concentration (4.52±0.23 mg L^{-1}), while sample the borehole (at the eastern end) had the lowest concentration (0.09± 0.01 mg L^{-1}). The result of the study showed that all the samples were highly insignificant as they were all below the set standard. Calcium plays a vital role in bone structure, muscle contraction, nerve impulse transmission, blood clothing and cell signaling. About 99% of calcium is in bone and teeth, while the remainder in soft tissue. According to (WHO, 2006), there seems to be no specific standard for calcium in drinking water, but low intake is associated with osteoporosis, rickets and hypertension. Adequate consumption in drinking water also reduces the risk of kidney stones, probably by complexing with oxalate in the diet that compose of some types of kidney stones. The highest concentration was found in sample B_2 (117.97±1.18 mg L^{-1}), while sample from the borehole had the lowest concentration (0.21±0.02 mg L^{-1}). It could be deduced that the water samples could have obtained their concentration from their environment or industrial activities around.

CONCLUSION

Wholesome drinking water should not present risk of infection, or contain unacceptable concentration of chemicals hazardous to health and should be aesthetically acceptable to the consumers. This study on water samples from both the western and eastern part of the state in comparison with World Health Organisation (WHO) standard shows that most of the results were insignificant, that is, would likely not cause any hazard for consumers. The pH of the samples fell within WHO's standard except sample from the stream on the western part of the state. Sodium concentrations of most of the samples were higher than the standard safe for borehole and B_3 (Eastern Part), while phosphates were above standard. It could however be concluded that though most of the results obtained were within WHO (1993) Guidelines for Drinking–Water Quality, and the few that were above the standard need further treatment before usage. With these results, the water might not pose health danger to the people in the area since the shortfall could be supplemented for in their diet or lost nutrient could be restored via proper treatment.

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