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PHYSICO-CHEMICAL PROPERTIES OF WELL WATER SAMPLES FROM SOME VILLAGES IN NIGERIA WITH CASES OF STAINED AND MOTTLE TEETH

*EZERIBE, A. I.[1], OSHIEKE, K. C.[2] & JAURO, A.[3],

[1]Department of Science Laboratory Technology, Federal Polytechnic, Bauchi, Nigeria
[2]Department of Chemistry, Government Day Secondary School, Bauchi, Nigeria
[3]Department of Chemistry, ATBU, Bauchi, Nigeria
*ezeaugustine208@yahoo.com

INTRODUCTION

An adequate supply of safe and portable water assist in preventing the spread of gastrointestinal diseases, supports domestic and personal hygiene, and improves the standard of living (Ike & Ugodulunwa, 1999). Today human activities are constantly adding industrial, domestic and agricultural wastes to ground water reservoirs at alarming rate (Aremu *et al.*, 2011). In the same vein, both the quantity and quality of water are affected by an increase in anthropogenic activities and any pollution either physical or chemical causes changes to the quality of the receiving water body (Aremu *et al*., 2011). Chemical contaminants occur in drinking water throughout the world which could possibly threaten human health. Determining the health effects of these contaminants is difficult, especially researching and learning how different chemicals react in the body to damage cells and cause illness (Hornsby, 2009).

Toxic doses of chemicals cause either acute or chronic health effect. An acute effect usually follows a large dose of chemicals, almost immediately. Example of acute health effects are nausea, lungs irritation, skin rash, vomiting, dizziness and even death (Hornsby, 2009). The levels of chemicals in drinking water, however, are seldom high enough to cause acute health effects. There are more chronic health effects that occur long after exposure to small amount of chemicals, for examples chronic disorders of the nervous system, mottled teeth in children and damage to the immune system (John *et al.,* 1979). Delivery of safe

and portable water to communities in Bauchi, Gombe and plateau states is the responsibility of the government which in most cases has been inefficient and inadequate. Dass Local Government, Kaltungo Local Government and Langtang North local Government in Bauchi, Gombe and Plateau States respectively are some of the areas that do not enjoy portable water supply. Most dwellers there depend on well water as an available water source. The qualities of this well water generally are not guaranteed and at times pose health problems to consumers who rely on them as a drinking source. This study aims at assessing the physico-chemical quality of well water from Dass Local Government Area of Bauchi State, Kaltungo Local Government Area of Gombe and Langtang North Local Government Area of Plateau State, all in Nigeria. This is imperative as there are cases of stained and mottle teeth in people living in these areas.

Sample collection, treatment and preservation: Water samples were collected from different locations, labeled A, B, C, D, E, in Bauchi state (Bungdot, Sabon Gari and Dot), Kaltungo Local Government Area of Gombe State (Kasar Wuje and Sabon Layi) and Langtang North Local Government area of Plateau state (Palam and Shishiri). Each point of collection was about 50 meters away from each other. Sampling and preservation of samples were carried out as prescribed by APHA method (APHA, 1992). The samples were kept in pre-cleaned 1 liter polythene plastic bottle and acidified with Analar grade concentrated nitric acid to pH 1.5. The water samples were kept in ice chests and transported to the laboratory where they were stored in a freezer and analysed within 3 days.

Physico-Chemical Analysis: Water samples collected were analyzed by both classical and automated instrumental methods prescribed by standard methods for the analysis of water and wastewater and United State Environmental protection Agency (Standard Method, 1999). The concentrations of major ions; such as Sulphates (SO_4^{2-}), nitrates (NO_3^-), chlorides (Cl^-) and phosphate (PO_4^-) were determined spectroscopic ally using (HACH DR/2010). A digital Jenway 3505 pH meter was calibrated with standard solutions (pH 4 and 10.0). The water surface temperature was determined by lowering the probe to about 1cm below the water surface for about five (5) minutes until it stabilized and the temperature was recorded immediately. Conductivity, Total Dissolved Solids, and Turbidity were measured by a HACH Conductivity meter. Alkalinity and Total Hardness were determined by titrimetric methods.

The results obtained for various tests carried out on the physico-chemical properties of the well water samples and their comparison with the World Health Organization (WHO) standard specified for drinking water (Table 1). The table shows the mean and standard deviation values of the parameters determined in the research along with the recommended standards.

Temperature: The mean values and standard deviations for well water temperatures for Dass, Kaltungo and Langtang are 27.8ºC ± 0.45 ˚C, 29.0ºC ± 0.00 ºC and 28.8 ˚C ± 0.48˚C respectively. The values reported in this work are within the range recommended by WHO (30ºC) and National Guideline and standards for water quality (20 ºC-33 ºC) in Nigeria for aquatic life, industrial and agricultural uses (FME, 1992). Ehimeh *et al*., (2011) reported similar result (21.0 ± 0.1ºC) for rivers Inachalo and Niger in Idah, Kogi State, while Manilla & Frank (2009) and Clarke *et al.,* (2004) reported 25.3 ± 0.03 ˚C. Although, there is seasonal fluctuation in well water temperature values, this may be due to function of the climatic conditions at a particular geographical location and period.

pH: The test for pH of water was carried out to determine whether it is acidic or alkaline in nature. The mean values obtained for the three wells are within the range of 6.5-8.9, recommended by WHO (1996) for drinking water. Although the values indicate that the well water samples are slightly basic, it is in agreement with what was reported by other researchers in similar study (Edimeh *et al.*, 2011; Aremu *et al.*, 2011).

Conductivity: The conductivity mean and standard deviation values for Dass (38.7 ± 0.30 µs/cm), Kaltungo (30.20 ± 0.56 µs/cm) and Langtang (38.8 ± 0.40 µs/cm) are within the WHO maximum permissible limits (8-10,000 µs/cm) for drinking water. However the values obtained were higher than values reported in the streams, wells and bore-hole water in Nasarawa Eggon local government area of Nasarawa State, Nigeria by Aremu *et al.,*

TABLE 1. MEAN AND STANDARD DEVIATION VALUES OF PHYSICO-CHEMICAL PARAMETERS OF THE WELL WATER SAMPLES COMPARED WITH WHO STANDARD FOR DRINKING WATER.

PARAMETER	WHO	DASS	KALTUNGO	LANGTANG
Temperature ºC	30	27.80 ± 0.45	29.00 ± 0.00	28.80 ± 0.48
pH	6.5-8.9	7.74 ± 0.13	7.8 ± 0.00	7.76 ± 0.89
Conductivity(µs/cm)	8-10,000	38.70 ± 0.30	30.20 ± 0.56	38.80 ± 0.40
Turbidity(NTU)	5	6.30 ± 1.00	3.60 ± 3.50	13.50 ± 1.09
Total dissolved solid (mg/L)	1000	183.20 ± 1.30	166.40 ± 5.50	184.08 ±1.47
Alkalinity (mg/L)	150	139.20 ± 12.20	78.40 ± 1.10	150.40± 2.30
Total hardness(mg/L)	500	329.80 ± 18.90	137.80 ± 11.20	336.80± 15.20
Sulphate (mg/L)	400	10.20 ± 0.45	8.04 ± 0.09	24.00 ± 0.84
Phosphate(mg/L)	6.5	0.86 ± 0.55	0.29 ± 0.09	0.14 ± 0.02
Nitrate(mg/L)	5.0	9.78 ± 0.84	24.2 ± 0.15	10.15 ± 0.15
Fluoride(mg/L)	1.5	1.72 ± 0.11	2.08 ± 0.11	1.96 ± 0.90
Chloride(mg/L)	250	64.90 ± 32.60	18.40 ± 3.21	82.10 ± 6.52

(2011). This may be due to differences in geochemical conditions and soluble ions in the locations analysed.

Turbidity: The turbidity of water depends on the quantity of solid matter present in the suspended state. It is a measure of light-emitting properties of water and the test is used to indicate the quality of waste discharge with respect to colloidal matter. The mean turbidity value obtained for Kaltungo (3.60 ± 3.50 NTU) is lower than the WHO recommended value of 5.00 NTU, while that of Dass (6.30 ± 1.0) and Langtang (13.5 ± 1.09 NTU) are higher than WHO maximum permissible level. This may be due to the presence of clay, silt, finely divided organic matter, plankton and other microscopic organisms (Durance, 1986). The greater the turbidity, the higher the risk of gastro-intestinal diseases (Eri & Catherine, 1997).

Total Dissolved Solid: The mean and standard deviations of total dissolved solids for Dass (183.20 ± 1.30 mg/L), Kaltungo (166.40 ± 5.50 mg/L) and Langtang (184.08 ± 1.47 mg/L) (Table 1) are lower than the recommended value of 500 mg/L by the National guideline and standards for water quality in Nigeria and the WHO specification limits (1000 mg/L) for drinking water (Edimeh *et al.*, 2011). The value also differ from that reported by Aremu *et al.,* (2011). They reported a value of 1048.67 mg/L, which could be due to differences in organic matter that remains as residue in the well water.

Alkalinity: Mean and standard deviations of Alkalinity values of 139.80 ± 12.20mg/L for Dass, 78.40 ±1.10 mg/L for Kaltungo and 150.40 ± 2.30 mg/L for Langtang north were close to the maximum permissible level of WHO (150 mg/L). This may be due to the presence of carbonates and bicarbonates in the well water because they contribute to the hardness of the water (Magit, 2002).

Total Hardness: The mean and standard deviation values of total hardness for the three locations are within the WHO specification limits for drinking water, but they are high enough to cause hardness of water. Therefore, this explains further the presence of carbonates/bicarbonates which may cause poor lather formation and scales on boilers (Durrance, 1986).

Sulphates: Sulphates are formed due to the decomposition of various sulphur containing substances present in water bodies. The sulphate ions (SO_4^{-2}) occur naturally in most water supplies and hence are also present in well waters. The values obtained for each of the three locations in this study are low compared with the WHO permissible limits and therefore are incapable of causing bad smells.

Phosphate: The standard deviations and mean phosphate concentrations of each of the three locations are within the limits set by WHO. The observation is also in agreement with the findings of other workers in similar studies (Aremu *et al.*, 2008 & Emeshili, 2007).

Chlorides: Chlorides in natural waters such as well water result from the leaching of chloride-containing rocks and soils with which the water comes in contact. The standard deviations and mean values obtained in the samples analyzed are within the limits set by WHO (Table 1). Chlorides are the most stable components in water and its concentration is largely unaffected by most natural physio-chemical and biochemical processes. Hence the value of its concentration in water is a useful measure in water sample. Chloride concentration can range from <10 ppm to >2500 ppm in sea water (Aremu *et al.*, 2011).

Nitrates: Nitrates indicates the presence of fully oxidized organic matter. The mean values obtained for the three Local Government Areas were higher than that of WHO limits for drinking water (Table 1). The implication of this is that the well water analysed contain high level of oxidized organic matter which appears in the form of soluble anions such as nitrates. Excess levels of nitrates can cause Methemoglobinemia as blue baby disease. Although nitrates levels that affect infants do not pose a direct threat to older children and adults, they do indicate the possible presences of other more serious residential or agricultural contaminants such as bacteria or pesticides (Robert, 2006).

Fluoride: The standard deviations and mean fluoride concentrations for each of the three sampled locations, (Table 1) were all higher than WHO maximum acceptable concentration (1.5 mg/L) for drinking water (WHO, 2006). The high concentration of fluoride as recorded may be attributed to the presence of both organic and inorganic compounds containing fluoride in water such as hydrofluoric acid (HF), sodium fluoride (NaF) and uranium haxafluoric (UF_6) (Mcdongh *et al.*, 2004). Fluoride, although known to prevent early stage tooth decay, high level of its concentration in drinking water and food have been found to have serious health effects in humans and animals, like mottled teeth that occur in children (Mcdongh *et al.*, 2004). This and some other factors may be responsible for the mottled teeth seen in children in the three locations studied.

In conclusion, this work has presented the levels of physico-chemical parameters such as temperature, pH, conductivity, turbidity, total dissolved solids, alkanity, total hardness, sulphates, phosphates, nitrates, fluoride and chloride contents in the well water samples collected from Dass, Kaltungo and Langtang North.

The results showed that most of the parameters determined did not exceed the permissible limit of the world Health Organization (WHO, 2006). Turbidity levels, nitrates and fluoride concentrations in Dass, and Langtang North exceeded the WHO (1984) standard specified for drinking water. The water samples analyzed in the three locations were also considered hard although the fall within the WHO specification limit. The water may cause the formation of scale on boilers, poor lather formation and minerals build up on fixtures (David & Brao, 2006).

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