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An assessment of the physiochemical quality of drinking water from tube wells and its effects on human health in Sokoto metropolis

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Available, accessible and safe drinking water supply may enhance health and development. The availability of potable water supply plays a key role in the realization of health improvement measures in any community. Water supply reduces the incidence of water related diseases, infant mortality rates and increases the children's life expectancy. Safe and quality water is a basic need for every human being and catalyst for good health and development in any nation globally. Safe drinking water is the most important in the control of diseases such as dysentery, diarrhea, typhoid, etc. in fact its reported that 80% of all the diseases in the world especially in Africa are associated with unsafe water. This paper aimed at assessing whether if the tube wells ground water in Sokoto South Local Government are of good quality standard for human consumption as enshrine by WHO's (2017) guidelines and SON (2015) for the protection of human health. Meanwhile, primary data were generated by collecting samples of water from selected tube wells in different locations in the study area using purposive sampling techniques. Three most important physicochemical parameters were tested. The most important physic parameter tested and analyzed was pH, of the water while the most important chemical parameters tested and analyzed were chloride (Cl), and nitrate (NO_3) using descriptive statistics method. The results show that the water from the tube wells are physicochemically fit for human consumption. The paper recommended that such water should still be treated, boiled, frozen and thawed before consumption.

Keywords: Ground Water Quality, Physiochemical, Tube Wells, Drinking Water and Health effects.

1.　Introduction

Health and development can be enhanced with adequate, accessible and safe drinking water supply. The availability of potable water supply plays a key role in the realization of health improvement measures in any community. Water supply reduces the incidence of water related diseases, infant mortality rates and increases the children's life expectancy, improvement of water supply have potential benefits to mankind, which include time saving, improvement in health and agriculture and economic diversifications (Mustapha and Yusuf, 2012). Water is essential for human existence, and its importance for individual health and the well-being of a nation cannot be overstress.　The provision of an adequate supply of safe water was one of the eight components of primary health care identified by the International Conference on Primary Health Care in Alma-Ata in 1978 and six (6) components of sustainable development goals (UNDP, 2015).

Clean water and sanitation is also the 6th of the sustainable development goal. It is designed to ensure availability and sustainable water and sanitation for all people around the world by the year 2030. Safe and good quality water is a basic need for every human being and catalyst for good health and development in any nation globally. Clean water is the most important in the control of water-borne diseases such as dysentery, diarrhea and typhoid. Water is the most important solvent for maintaining the healthy life of individuals on earth. However, about 97% of water exists in ocean, that is not suitable for human consumption and only 3% is fresh water wherein only about 0.3 % is available as surface and ground water for human drinking (Muller, 2001 and Aryal, Sapkota & Gautam 2010). Ground water refers to water found below the surface of the earth, sometimes called subsurface water where it occupies all parts of void spaces (WHO, 1993 & 2004). Underground

water is recharged by precipitation (mostly rainfall), which percolates into the earth to form underground deposits or aquifers (Sani, Fada and Nura, 2019).

Water that is of good chemical, physical and biological quality is necessary for its acceptability to the people for drinking and protection of human health (WHO, 1993). According to Bashir (2005), 80% of all diseases in the world are associated with unsafe water. Groundwater is affected by pollution of soil and air, industrial and domestic waste disposal, organic components, pathogenic microorganism, application of fertilizer and pesticides among others, which directly or indirectly affect the human health. The provision of safe water is one of the components of primary healthcare in Alma-Ata declaration of 1978. However, in most countries of the world, the principal risk factors to human health are associated with the consumption of chemically or bacteriologically polluted water (WHO, 2010). Mohsin 1993), estimated that 80% of all diseases and over one third ($1/3$) of deaths in developing countries are caused by the consumption of contaminated water. Muller (2001), Fada (2015) and Sani (2021), has also asserted that the risk of acquiring water-borne infection increases with the level of contamination of water by pathogenic microorganism. It was further expressed that the relationship is not necessarily simple and it depends very much on other factors such as infectious dose and host susceptibility (WHO, 2010).

Water quality is usually affected directly or indirectly by human activities making it harmful for living plants and animals. One basic measure of water quality is the total dissolved solids (TDS), which is the total amount of solids in milligrams per liter that remains when a water sample is evaporated to dryness (Sorlini *et al* 2013). The WHO (1997) maintains that good quality drinking water should conform to the following characteristics: (i) Free of pathogenic organisms; (ii) clear (i.e. low turbidity or colorless); (iii) not tasty; iv) Free of compounds that cause an offensive taste or odor; v) Free of compounds that may have adverse effects on human health; vi) low in concentrations of compounds that are acutely toxic or that have serious long- term effects such as lead; and seven (vii) free of chemicals which may cause corrosion of water supply system of staining clothes washed in it.

Thus, drinking-water should be suitable for human consumption and the WHO has set guidelines for the lower and the upper limits of certain inorganic compounds usually found in drinking water (WHO, 1997). In addition, inorganic contaminants, concerning both health and aesthetic aspects, can be present in the waters. Fluoride and arsenic are a great health problem worldwide. The public health burden of these two chemicals far exceeds that of other chemical contaminants in drinking-water, but globally it is masked by the public health impact of microbial contamination (WHO 2013). Since the discovery of arsenic in Bangladesh, many countries have done at least some chemical testing, but in many cases there is little or no information about arsenic and fluoride in drinking-water (WHO 2013). Also other physical-chemical parameters can deteriorate water quality. Heavy metals, like lead, chromium (VI), cadmium and mercury are dangerous for human health, since they are toxic and can be carcinogenic.

However, inadequate provision of potable water supplies in the metropolis by Sokoto State water board had forced people living along the lowland areas of the metropolis near river Rima and Sokoto to embark on drilling of tube wells groundwater to source for water for drinking and other domestic purposes. Since the deep bore hole is very expensive to drill.

It is against this background that this study will examine the most important physical and chemical parameters of water quality from tube wells in Sokoto metropolis in order to find out if the water is safe for drinking and prevent ill health. The analyses were guided by WHO guidelines on the maximum admissible concentrations of elements in drinking water and Nigerian standard for drinking water quality.

2. Study Area and Research Methods

2.1 The Study Area (Sokoto Metropolis)

2.1.1 Location, Size and Extent

The Sokoto metropolis cover a circular area of 20 kilometers radius from Shehu Kangiwa Square km² and it is located between Latitude 12°58'N to 13° 40'N and Longitude 5°10'E to 5°18'E, an average elevation of 272metres above the sea level (Sani 2012). Sokoto metropolis comprises of two major local government councils areas, namely; Sokoto North and Sokoto South respectively and some parts of Dange Shuni, Kware, Bodinga and Wamakko local governments areas all within the state (Sokoto, 2006), (Figure 1:). It also approximately covers a total land area of about 108.178 square kilometers and it's near the confluence of Sokoto River and the Rima River, as well as the modern day capital of Sokoto state (Figure 2: map showing important location in Sokoto Metropolis). However, the metropolis is part of Sokoto state and the state is located to the extreme North-

West of Nigeria and it shares boundaries with the Republic of Niger to the North, Kebbi State to the West and South-West, and Zamfara State to the East (Sokoto, 2006).
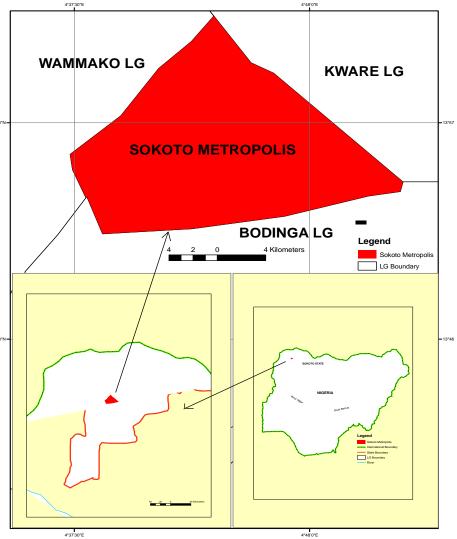

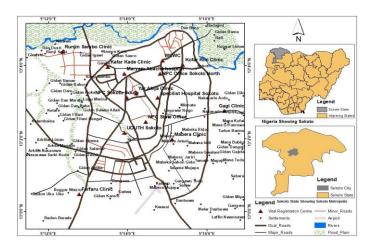**Figure 1:** Sokoto State and Its Metropolis

Figure 2: Sokoto Metropolis
Source: GIS Laboratory, Department of Geography, UDUS (2019)

it has a total population estimated at 1.1 million people based on 2006 population census with an average density of 1000 person per square kilometers km^2 (NPC, 2006). The major sources of water supply in Sokoto metropolis include both surface sources such as river Sokoto and Rima

and ground water sources through boreholes, tube wells and hand dug wells.

The climate is largely influenced by the interactions between two air masses; the tropical maritime air mass originating from the Atlantic Ocean and the tropical continental air mass from the Sahara Desert. The climate is characterized by rapid change in temperature and humidity. Temperatures are generally high in the month of March up to May, with the highest recorded mean monthly temperature of about 40°C in April (Mohsin et al 2013; Ismail, Jibril, Umar, 2019 and Sani 2021)

2.2 Research Methods

The data were generated from primary sources, where water samples from 30 tube wells were collected along the lowland areas of Sokoto metropolis using purposive sampling techniques. Meanwhile the areas sampled are Mana, Gagi, Nakasari, Tudun wada, More, Sokoto Cinema, Kofar Marke and Sokoto round all within the metropolis.

Moreover, from each of the selected tube well, two samples of water were collected; one during dry season from February to March, 2021 and the other during wet season from August to September, 2021. Similarly, from each season, two samples of water were collected, for physiochemical analysis using, clean sterilized bottles obtained from the market. The basis for the selection of two different seasons is to examine the variability of water parameters in terms of its physico-chemical quality in line with the recommended standards. Meanwhile, three (3) physiochemical parameters were used for the

analysis. The physiochemical parameters are pH, chloride content, and nitrate (NO_3). Similarly, the global positioning GIS were used to identify the location of samples tube wells for the mapping. Furthermore, Nigerian standard for drinking water quality put forward by SON (2015) and the WHO (2017) guidelines on water quality for drinking were used as a basis for analysis and interpretations.

2.2.1 Method of Data Analysis and Presentation

The data collected were analyzed and presented using both descriptive and inferential statistics methods. Descriptive statistics were used to present frequency distributions, tables, graph and charts in relations to the WHO guidelines and Nigerian standard for drinking water quality.

3. Results and Discussion

3.1 Physical and Chemical Analyses of Tube Wells Drinking Water Quality and Its Health Implication in Sokoto Metropolis

The chemical parameters of collected samples of water from different tube wells across the study area were tested in the chemistry laboratories of Usmanu Danfodio University, Sokoto. The important physical parameter tested was pH, of the water while the most important chemical parameters tested were chloride (Cl), and nitrate (NO_3) the result were then compared and discussed in relations to WHO water quality guidelines and Nigerian standard of drinking water quality (see Table 1).

Table 1: Laboratory Analysis of Physical and Chemical Parameters

	Parameters and permissible limit set by WHO Guidelines (2013) and SON (2015)			
	WHO 2013	**pH (6.5-8.5)**	**Cl (250 mg/l)**	**NO_3 (10 mg/l)**
	SON 2015	**Ph (6.5-8.5)**	**Cl (250 mg/l)**	**NO_3 (50 mg/l)**
S/N	**SAMPLES**	**pH mg/l**	**Cl mg/l**	**NO_3 mg/l**
1	A1	6.8	3.4	1.0
2	A2	6.7	2.9	0.8
3	A3	6.8	3.5	1.0
4	A4	6.7	1.7	1.0
5	A5	6.8	3.3	0.6
6	A6	6.7	2.7	0.6
7	A7	6.7	1.8	1.0
8	A8	6.9	3.5	1.0
9	A9	6.8	3.1	1.0
10	A10	6.8	1.9	1.0
11	A11	6.8	1.9	1.0
12	A12	6.8	2.1	1.0
13	A13	6.8	1.7	1.0
14	A14	6.8	2.3	1.0
15	A15	6.7	1.9	1.0

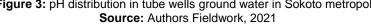| 16	A16	6.8	3.4	1.0
17	A17	6.7	2.9	0.8
18	A18	6.8	3.5	1.0
19	A19	6.7	1.7	1.0
20	A20	6.8	3.3	0.6
21	A21	6.7	2.7	0.6
22	A22	6.7	1.8	1.0
23	A23	6.9	3.5	1.0
24	A24	6.8	3.1	1.0
25	A25	6.8	1.9	1.0
26	A26	6.8	1.9	1.0
27	A27	6.8	2.1	1.0
28	A28	6.8	1.7	1.0
29	A29	6.8	2.3	1.0
30	A30	6.7	1.9	1.0

Source: Authors Fieldwork, 2021

1. pH

The pH of pure water refers to the measure of hydrogen, ions concentration in water, it ranges from 0-4. In general water with pH of 7 is considered neutral while lower of it referred to acidic stage and a pH greater than 7 known as basic. However, the result of tube wells analysis as can be seen in figure 1 and table 1show that all the thirty (30) sample of tube wells are within the neutrality state because the highest concentration is 6.9 and the lowest concentration was 6.7, while the remaining falls in between. This is in line with the WHO 2017 guidelines and Nigerian standard for drinking water quality (SON, 2015) that stated the range of 6.5- 8.5 permissible limit. A greater percentage of the samples (60%) have the pH of 6.8 concentrations, indicating healthy pH levels of tube wells in Sokoto metropolis for drinking. Mohsi *et al,* (2013) explain that water with low pH value indirectly affects human health, since it can increase metal leaching from pipes and fixtures such as copper and lead.
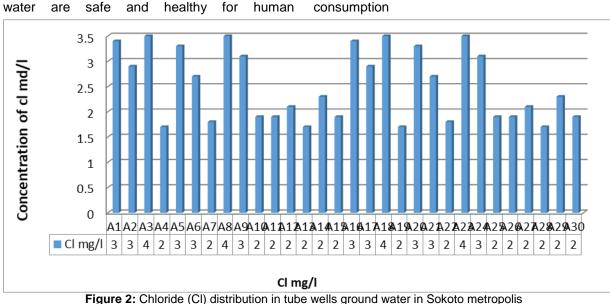

Figure 3: pH distribution in tube wells ground water in Sokoto metropolis
Source: Authors Fieldwork, 2021

2. Chloride (Cl)

Chloride is mainly obtained from dissolution of salts of hydrochloric acid as table salt (NaCl) in industrial waste, sewage, sea, water etc. Some literature explained that ground water have higher concentration of chloride as compared to surface water, for example, Sorlini, (2013) Morton, Puncheon and Squires (2017) maintained that it has key importance for metabolism activity in human body and other main physiological process. While high concentration of chloride damage metallic pipes and structures as well as harm plants and animals. According to WHO, (2017) guidelines and Nigerian standard for drinking water quality (2015), the concentration of chloride in water should not exceed 250 mg/l. However, the result of the analysis shows that there was very low concentration of chloride in the tube well ground water, because the highest concentration is 3.5 mg/l and the lowest was 1.7 mg/l which is very low when compared with the Nigerian standard for drinking water quality, which signifies that the

water are safe and healthy for human consumption

Figure 2: Chloride (Cl) distribution in tube wells ground water in Sokoto metropolis
Source: Authors Lab Work 2021

3. Nitrate (NO₃)

Nitrate (NO_3) is one of the most important diseases causing parameters of drinking water quality, particularly, blue baby syndrome in infant. The most typical sources of nitrate are nitrogen cycle, industrial waste, nitrogenous fertilizer etc. However, the results of the analysis show the low concentration of nitrate in the tube wells ground water in the area in which the highest concentration is 1.0 mg/l which is very low compared to maximum permissible limit put forward by WHO 2017 guidelines 2017 and SON (2015) of 10 mg/l and 50 mg/l respectively. This shows that the concentration of nitrate is at lower stage and water has no any health implication with regard to nitrate (NO_3) concentration.
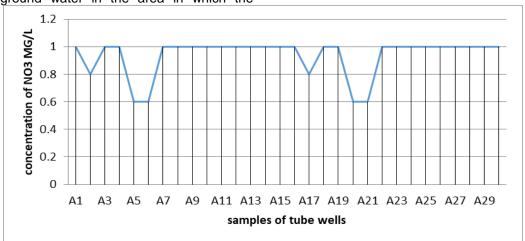

Figure 3: Nitrate (NO_3) distribution in tube wells ground water in Sokoto metropolis
Source: Authors Fieldwork, 2021

4.   Conclusion

This paper describes a survey carried out on tube wells ground water in Sokoto metropolis of Sokoto state. The result of physical and chemical analysis shows that the water are safe and health for human consumption. The pH concentration of all the 30 samples are within the neutral state, ranges between 6.7-6.9 which is in line with WHO, 2017 guidelines and Nigerian standard for drinking water quality of 6.5-8.5 permissible limit. Similarly, the result of chloride Cl) analysis show lower concentration of chloride in all the samples with the highest concentration of 1.7 mg/l which is very low compared to WHO and SON maximum permissible limit of 250 mg/l.

5.   Recommendations

1. The tube wells should be situated far away from the soak a ways and toilets to avoid contaminations
2. Government should note that tube wells ground water are of high quality physical and chemically and it has no health

implications and can also be another alternative source of water in the metropolis

Conflict of Interest

Acknowledgements

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