QUALITY ASSESSMENT OF TREATED WATER SUPPLY: A CASE STUDY OF MINNA, NIGERIA

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Abstract
There is global call for sufficient water supply and sanitation as large percent of world population lack access to safe drinking water basic sanitation. This paper investigates the level of purity in public water supply in Minna. Treated water from a Minna water treatment plant was collected and analyzed for its physico-chemical properties, such as pH, Total Dissolve Solid (TDS), Electrical conductivity (EC), Temperature (°C), Turbidity (TB), Nitrate (NIT), Total Alkalinity(TAL), and Total Hardness (TOH). The study revealed that the water supply from the treatment plant was not wholesomely fit for consumption as some of the measured properties such as turbidity and iron content do not conform to the set standard by the World Health Organization (WHO) and the National Agency for Food and Drug Administration and Control (NAFDAC).

Keywords: Water Quality, Total dissolve solid, Conductivity and Suspended solid.

Introduction

Water is an indispensable component of human existence as it helps in sustaining its life. Water is also known to facilitate the process of photosynthesis and is vital for crop production (Olajire and Imeokparia, 2010 and Jagadeesh et al., 2012). The composition and concentration of substances in ground and surface water is as a result of two factors: the geological structure of the earth's crust, including the intensity with which it is leached and anthropogenic activity associated with agriculture, industry and public utilities. As water travels through the soil's profile, various water-soluble substances are released (Jagadeesh et al., 2012; Olajire and Imeokparia, 2010; and Adeniyi et al, 2005).

According to Hatti et al (2011) access to clean water and sanitation is generally improving, but at slow pace. Available data shows that access to sanitation and water supply in the country is still less than 50 percent. The authors added that access to adequate water supply is strongly associated to sanitation. The global call for satisfactory access to adequate water and sanitation is of fundamental concern as more than 1.2 billion people in the world lack access to safe drinking water and even basic sanitation. Water is said to be portable when all its properties conform to the notable national and international standards. To achieve such standards raw water is subjected to purification processes that ranges from simple long-term storage to enable sedimentation of some suspended solids to aeration, coagulation, flocculation, filtration and disinfection among other treatments.Variation in the combination of treatments required, vary with quality of the raw water (Hatti et al .2011). Sources of water are also many and varied, the level of contamination also varies, and consequently, a high degree of public health hazard can be associated with drinking water. The implication therefore, is that any drinking water pumped to the public must be made wholesome and must meet WHO standards (Onweluzo and Akuaghazie, 2010). It is against this background that this paper is aimed at assessing the quality of treated water from the treatment plant located in Minna, Niger state, Nigeria. Thus, the primary objective is to examine the chemical status and purity level.

Materials and Methods

Study area: Niger state metropolis is located between latitudes 8°20' and 11°30'North and longitudes 3°30' and 7°20' East. It lies within the northern central geopolitical zone of Nigeria otherwise known as middle belt and occupies a total land area of about 68,925sq kilometres. The metropolis has an estimated population of 3,950,249 (http://nodnl.org/Nigeria/nigeria_geography_content_articles.php?article_id=...). The major climatic seasons are rainy season or wet season (March or April to October) and dry season (November to March or April). And rainfall ranges varying from 1,100mm in the Northern part of the State to 1,600 mm in the southern parts (http://nigerstate.blogspot.com/).

For the purpose of this work, physico-chemical parameters of treated water such as the pH, Electrical Conductivity (EC), Total Dissolve Solid (TDS), hardness due to present of magnesium (Hmg), Total Alkalinity (TAL), turbidity (TAB), and temperature (° C). Temperature was measured using a portable mercury-in-glass thermometer according to the methods reported by American Public Health Association (APHA, 1998). Sample were collected into clear air tight container from the plant at the end of each month and immediately taken to Laboratory for analysis.

PH Determination

The pH values were determined using the calibrated pH meter. The probe was rinsed several times with distilled water and immersed in the water samples contained in the beaker. The pH readings was noted and recorded accordingly after stabilization of the sample in the beaker.

Turbidity Determination

Turbidity was measured using a turbidiometer containing cuvette. Firstly the cuvette was rinsed severally time with distilled water and then filled with the water sample. The cuvette was then placed into the turbidiometer light cabinet and covered with the light shield. The whole set up was allowed to stabilize before the turbidity value was noted and recorded accordingly.

Electrical Conductivity (EC) Determination

The cell was rinsed with one or more portions of sample. The sample temperature was then adjusted to about 25° C. The cell is then immersed into sample with the cell above the vent hole of the cell. The conductivity of sample was observed and noted. The temperature of sample was measured and recorded to nearest 0.1°C. Finally EC was calculated at 25 °C

$$\text{Calculate Electrical Conductivity (EC)} = \frac{C_m - K_c}{0.0191(t-25)+1}$$

K_c = the cell constant, cm^{-1} C_m = measured conductance of the sample, μmho

t = observed temperature of sample, °C

Total Dissolved Solids (TDS) Determination

The TDS was determined in the study using Gravimetric method as reported by APHA (1998) The water sample was shaken rapidly. This was followed by transferring measured volume of sample into a 100 ml graduated cylinder using a funnel. The sample was then filtered through a filter. The sample was washed with deionised water and suction continues for at least three minutes. The total filtrate was transferred (with washings) to a weighed evaporating dish and evaporated to dryness on a water bath. The evaporated sample was dried for at least one hour at 180°C. The dried sample was cooled in desiccators and weighed. Drying and weighing process was repeated until a constant weight was obtained.

(OH -) in water (Dallas and Day, 2004). This property has no adverse effect but plays a key role in microbial population growth (Sunday et al, 2011). Result presented in Figure 1 shows that the pH of all water sample collected between April – September varied from 6.7 – 7.2. The values obtained from this study were consistent with WHO/NAFDAC standard.

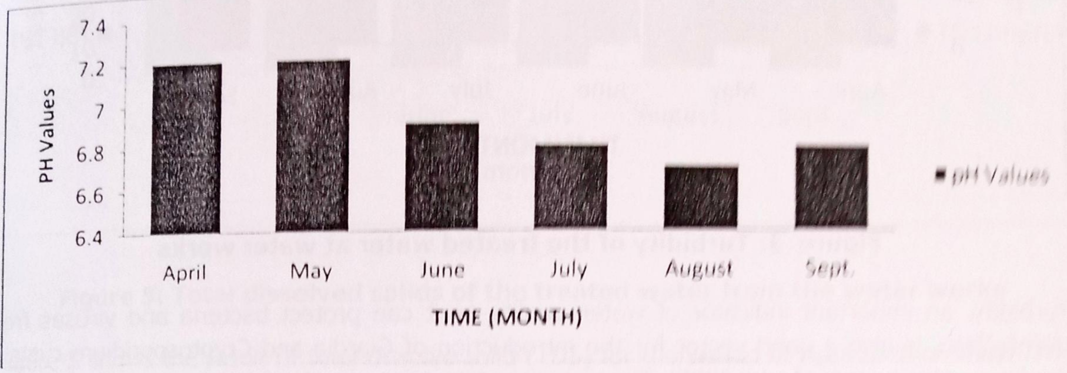

Figure 1: pH value of the treated water from the water works

The pH was observed to be high at the beginning but tends to decreases later. This could be attributed to the variation in the microbial organism which often produces either acidic or basic metabolic by-product. According to Olajire and Imeokparia, (2000) low pH are probably due to high content of acids in ground water while high pH value are due to exposure of surface water to air which result in loss of carbon (IV) oxide.

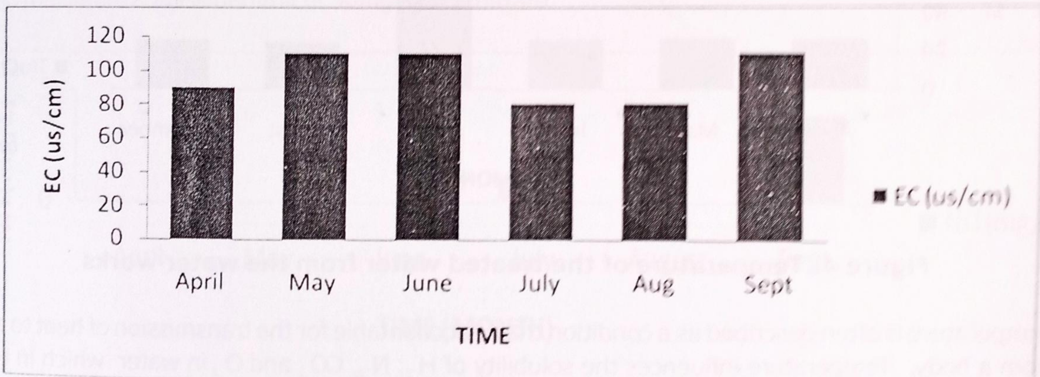

Figure 2: Electrical conductivity of the treated water at the water works

Electrical conductivity estimates total dissolved solids in water and is used to assess salinity effects on most aquatic fauna and flora (Bongumusa, 2010). The Conductivity of the treated water sample from the treated plant was determined to be within the range of 80-110μscm^{-1} for all the study period. However July and August have the least value of 80 μscm^{-1} while May, June and September recorded a value of 110 μscm^{-1} as shown in Figure 2. The value observed from this study was within the permissible level stipulated by WHO/NAFDAC standard. According to Adeniyi et al, (2005) high conductivity values are mostly attributed to increase in ionizable dissolved solid. The low value obtained in this study was very consistent with the report of water obtained from some treatment plant in other part of Nigeria (Hati and Ngueadom, 2011).

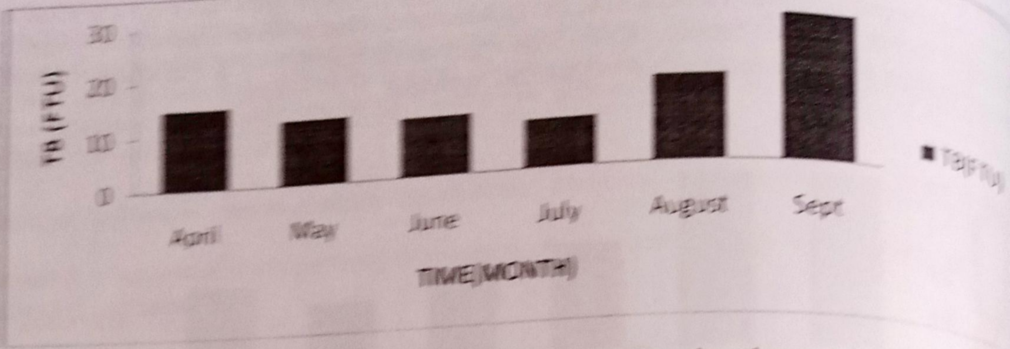

Figure 3: Turbidity of the treated water at water works

Turbidity, an important indicator of water quality as it can protect bacteria and viruses from disinfection, is also a good vector for the introduction of Giardia and Cryptosporidium cysts in drinking water system (Ando, 2005). The turbidity of the treated water from the treated plant were within the range of 9-16 NTU as shown in Figure 3.This values are considerably higher than the WHO standard of 6.5-8.5, high turbidity in water is directly linked to high suspended solids.

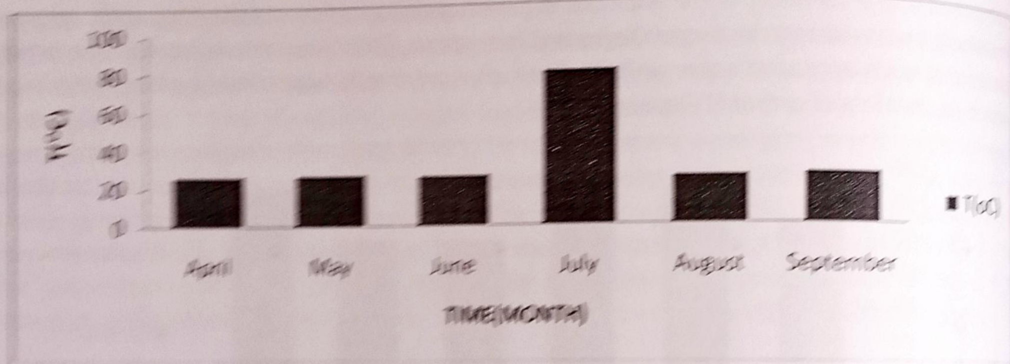

Figure 4: Temperature of the treated water from the water works

Temperature is often described as a condition that is accountable for the transmission of heat to and from a body. Temperature influences the solubility of H_2, N_2, CO_2 and O_2 in water which in turn plays an important roles in aquatic habitat (Gillooly et al., 2002). Its determination is important because of its effect on other physical phenomena such as rate of biochemical and chemical reaction in the water body, reduction in solubility of gasses and amplification of tastes and odors of water (Olajire and Imeokparia, 2000). The temperature of treated water between the periods of April to September from the plant as presented in Figure 4 were within the range of between 25.4-27.2°C which was less than the maximum permissible limit of 34°C. According to WHO (1996), the microbiological characteristic of drinking water are simply related to its temperature through its effects on water treatment processes and its effect on both growth and survival of microorganisms. Consequently, growth of nuisance microorganism is enhanced by warm water condition and could lead to the development of unpleasant taste and odors (Sunday et al.,2011).

Total dissolve solid is a measure of the level of dissolve solid in water which adversely affects the taste of drinking water (Oluwatuyi and Akpan-Aminu, 2010).

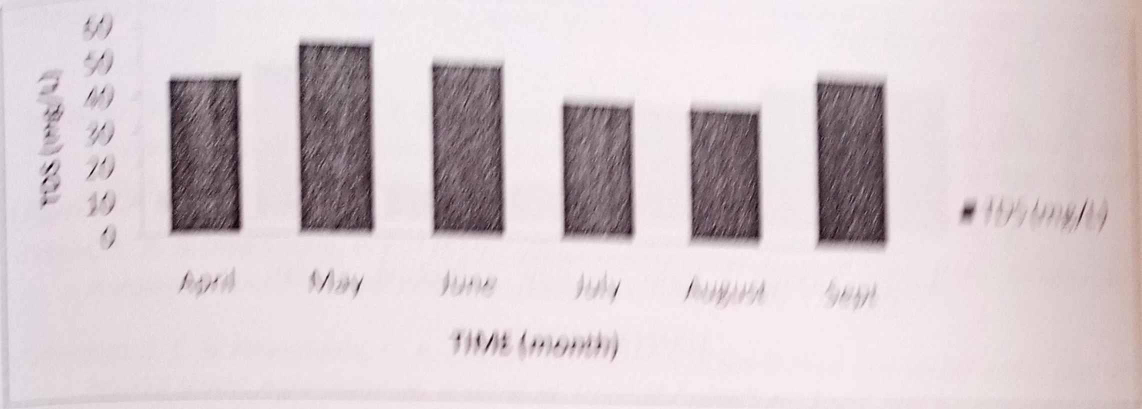

Figure 5: Total dissolved solids of the treated water from the water works

Figure 5 shows the result of total dissolve solid (TDS) for the period of April to September. The results in all cases met the standard (500mg/L) recommended by WHO and NAFDAC for appearance and taste. The highest and lowest value of TDS of 55mg/L and 40mg/L was recorded for the month of May, and the month of July and August respectively.

Olajire and Imeokparia, (2010) reported that WHO (1988) gave the maximum concentrations of nitrate and cyanide ions for public water supplies as 45.0 and 0.05mgdm^{-3} respectively. The guidelines for drinking water quality of European community provide reference value of 25mg dm^{-3} and maximum admissible limit of 50mgdm^{-3} for nitrate.

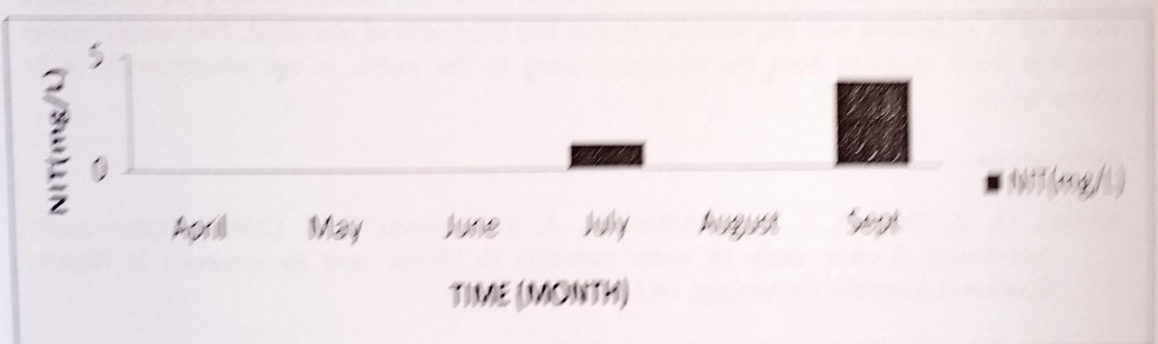

Figure 6: Nitrate value of the treated water from the water works

Nitrate (NO3-) is a water-soluble and is made up of nitrogen and oxygen. It is formed whennitrogen from ammonia or other sources combines with oxygenated water. Nitrate is a natural constituent of plants and is found in vegetables at varying levels depending on the amount of

fertilizer applied and on other growing conditions(WHO,1984). The nitrate concentration of April, May ,June and August were determined to be zero, while that of July and September are shown on Figure.6 to be 1.1 and 3.9 mg dm^{-3} respectively. These concentrations were within the maximum admissible limit of 50 mg/l. Evidently, all treated water at these period met the notable world standard and this is an indication that there was no danger due to nitrate to consumers (Olajire and Imeokparia, 2010).

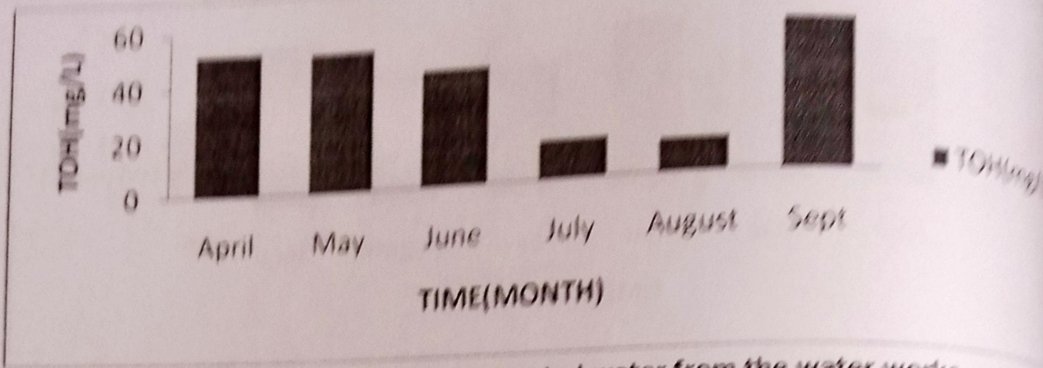

Figure 7: TOH value of the treated water from the water works

Figure 7 shows the total hardness ranges from 12-52.10 mg/l with August having a least value of mg/l while April had a high value of 52.10 mg/l. All values recorded for the period under investigation where appreciably in agreement with the WHO standard which stipulate a maximum limit of 100 mg/l for quality drinking water. However the iron content of the treated was not in conformity with the standards as the values ranges from 0.16 – 3.30mg/l as against the recommended by WHO standard.

Conclusion

This study focus on the quality assessment of treated water from a public water treatment plant in Minna. The result of this quality assessment shows that properties such as pH, temperature, total dissolved solid, total hardness and total alkalinity while properties such as turbidity and iron content were not in agreement with the notable national and international standard. This simply implies that the water supplied from the treatment plant to the public is not wholesomely fit for consumption.

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