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Assessment of water quality parameters and trace metal contents of drinking water sources in Minna, Niger State

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Abstract

This study assessed the physico-chemical parameters and heavy metal concentration of tap and borehole water in Minna metropolis. The experiment lasted over a period of three months from May to July 2012. Six (6) locations were identified within Minna metropolis Bosso, Kpagungu, Chanchaga, Mobil, Maitumbi, and Tunga where water samples were randomly taken once every month. Hydrogen ions concentration, chloride, Sodium and Potassium were determined by the method of American Public Health Association (1995) while temperature was measured with thermometer. Air and Water temperature were determined in situ, while Hydrogen ions concentration (pH), Ionic conductivity, Alkalinity, Hardness, Chloride, Sodium, Potassium and Heavy Metal concentration, copper, zinc, Iron and Lead were determined in the laboratory. The parameters measured showed marked variation across months and locations. Mean values of physico-chemical and concentration of heavy metals in Tap and Borehole water variables studied showed that parameters measured fell within the recommended ranges for aquaculture and drinking water. Water temperature showed significant difference ($p<0.05$) while conductivity, hardness, alkalinity, sodium and potassium showed no significant difference ($p>0.05$) amongst the months. The physico-chemical parameters assessed, indicated that most of the parameters fell within standards set by the Federal Ministry of the Environment. Comparison between tap and borehole water of each location in Minna metropolis did not show significant difference in temperatures of the locations ($p>0.05$). However, significantly difference was observed in conductivity of the various locations ($p<0.05$).

Keywords: Water quality parameters, trace metals, Minna metropolis.

Introduction

Water is a wonder of nature. "No life without water" is a common saying depending on the fact that water is one of the natural occurring essential requirements of all life supporting activities. Since it is a dynamic system, containing living as well as non-living organic, inorganic, soluble and insoluble substances, its quality is likely to change day by day and from source to source. Interest in water analysis is due to the enormous importance of water to all categories of living things. It is necessary for the healthy development of man, animals and plants. Developing countries are witnessing changes in ground water, which constitute another source of portable water. The preference for ground water to surface water must be due to the purification of the latter prior to distribution (Adeyeye and Abulude, 2004). Although it is easily accessible from lakes, rivers, streams and springs, but borehole water is of better quality. Even though some trace elements are essential to man, at elevated levels essential as well as non-essential element can cause morphological abnormalities: reduce growth, increase mortality and mutagenic effects (Adeyeye and Abulude, 2004). Water pollution has been a subject of active investigation for a long time; any change in the natural water quality may disturb the equilibrium system and would become unfit for designated uses. The availability of water through surface and groundwater sources has become critical day by day. Drinking water must be of international standard, that is, free of contaminants in terms of physico-chemical parameters and organism load (Ojutiku and Kolo, 2011).

The groundwater is believed to be comparatively much cleaner and free from pollution than surface water. However, prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the groundwater pollution and create health problems. The rapid growth of urban areas has further affected groundwater quality due to overexploitation of resources and improper waste disposal practices. Hence, there is always a need for concern over the protection and management of surface water and groundwater quality. Good drinking water quality is essential for the well-being of all people. Contaminants such as bacteria, viruses, heavy metals, nitrates and salt have found their way into water supplies due to inadequate treatment and disposal of waste (human and livestock), industrial discharges and over-use of limited water resources.

Even if no sources of anthropogenic contamination exist there is potential for natural levels of metals and other chemicals to have harmful effects on the population. This problem arose chiefly because groundwater is extracted for drinking without detailed chemical investigation. The natural water analyses for physical and chemical properties including trace element contents are very important for public health studies. Heavy metals are priority toxic pollutants that severely limit the beneficial use of water for domestic and industrial application. Moreover, there has being no published report concerning the trace metals and other possible contaminants in drinking water sources of these communities. Hence, this study was conducted to assess and report the water quality parameters and trace metals present in the drinking water sources in the chosen locations.

Materials and Methods

The study areas are located in Minna, Niger state. The state lies on the Guinea savanna zone at latitude 9°37 N and longitude 6°33 E. The water samples were collected from six locations: Bosso, Kpagungu, Chanchaga, Mobil, Maitumbi, and Tunga.

The water samples were collected and analyzed once every month for a period of three months (May–July 2012). Hydrogen ions concentration (pH), ionic conductivity, alkalinity, hardness, alkalinity, sodium, potassium and heavy metals (lead, copper, zinc, iron and manganese) were determined in the laboratory by the method of APHA, (1995). Mercury in bulb thermometer was used to determine air and water temperature in situ, while conductivity was determined using conductivity meter.

Results

Figure 1 showed variation in the mean values of the temperatures recorded in the various locations but are not significantly different ($p > 0.05$). Figure 2 on the other hand showed variations in the mean values of conductivity in both borehole and tap water between the locations with significant difference ($p < 0.05$) occurring only in the values of borehole water. In figure 3 the values indicated that water pH did not vary significantly between the locations ($p > 0.05$). The low values of standard deviation showed the uniformity of the pH over the period of study. There was significant different in alkalinity ($p < 0.05$), the high value of standard deviation exhibits the non-uniformity of alkalinity during the period of study as shown in the figure 4. Figures 9,10,11,12 and13 indicated that the heavy metals: zinc, copper, iron and manganese concentration of water samples from the various locations were not significantly different ($p > 0.05$).

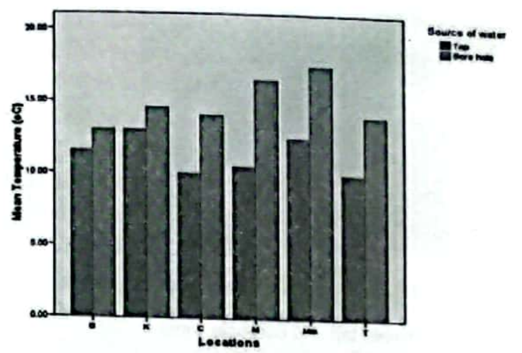

Fig. 1: Comparison of water quality parameters (temperature) between tap and borehole water in Minna Metropolis, 2012

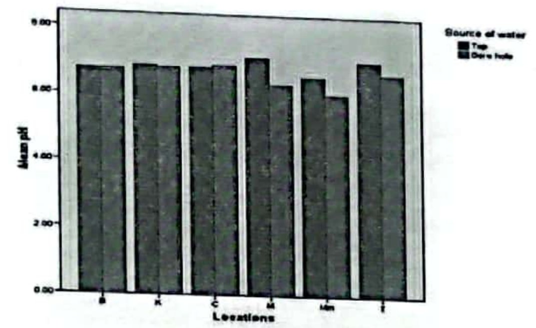

Fig. 2: Comparison of water quality parameters (conductivity) between tap and borehole water, 2012

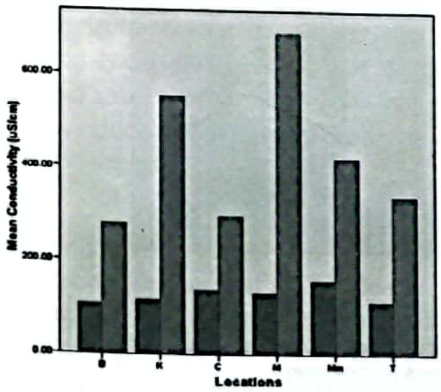

Fig. 3: Comparison of water quality parameters (pH) between tap and borehole water, 2012

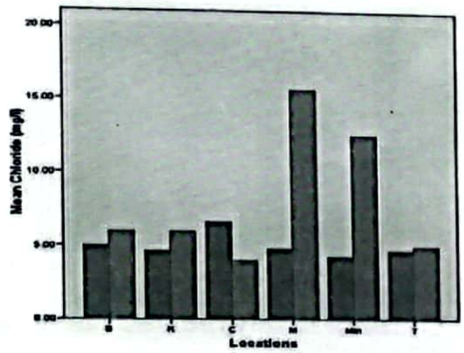

Fig. 4: Comparison of water quality parameters (Chloride) between tap and borehole water, 2012

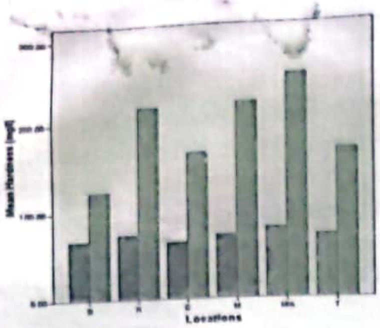

Fig. 5: Comparison of water quality parameters (Hardness) between tap and borehole water, 2012

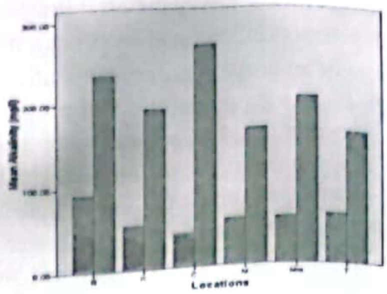

Fig. 6: Comparison of water quality parameters (Alkalinity) between tap and borehole water, 2012

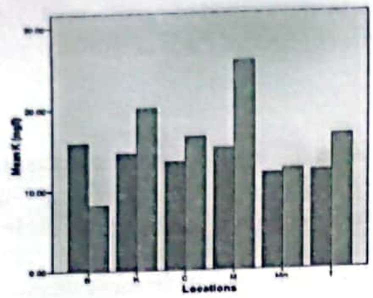

Fig. 7: Comparison of water quality parameters (Potassium) between tap and borehole water, 2012

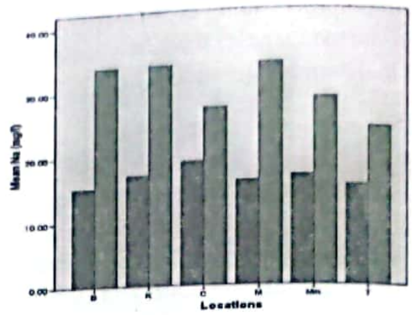

Fig. 8: Comparison of water quality parameters (Sodium) between tap and borehole water, 2012

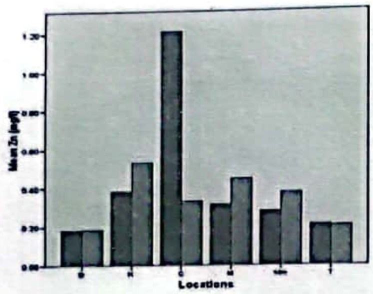

Fig. 9: Comparison between tap and borehole water in heavy metal contents (zinc)

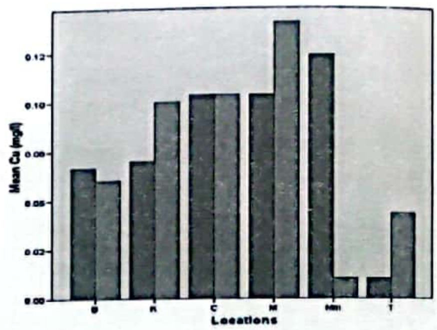

Fig. 10: Comparison between tap and borehole water in heavy metal contents (copper)

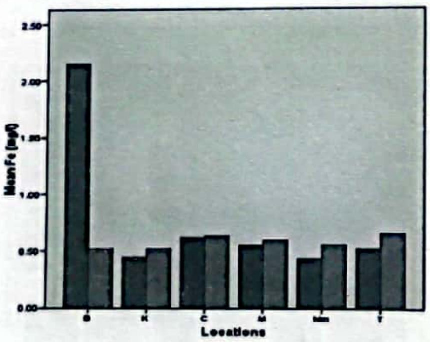

Fig. 11: Comparison between tap and borehole water in heavy metal contents (iron)

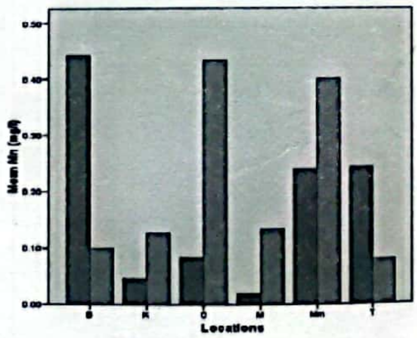

Fig. 12: Comparison between tap and borehole water in heavy metal contents (manganese)

Keys: *B= Bosso, K= Kpagungu, C= Chanchaga, M= Mobil, Mn= Maitumbi and T= Tunga.*

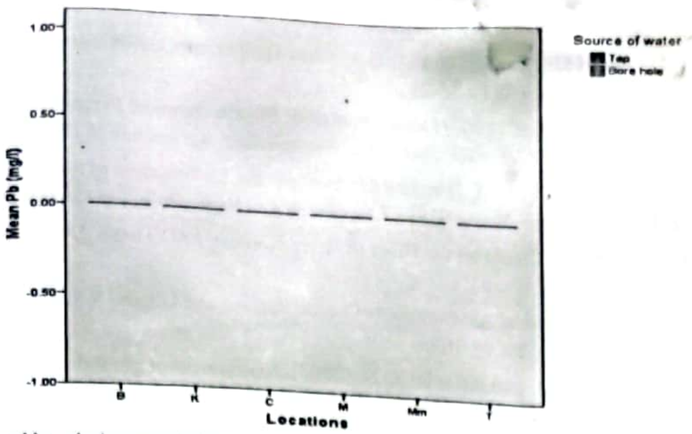

Fig. 13: Comparison between tap and borehole water in heavy metal contents (lead) in Minna.

Discussion

The results obtained from the study clearly indicated temporal variation over three months period of the study. The sources of pollutants into the water could be through domestic sewage from surrounding houses, industrial and agricultural chemicals from fertilizers with the increase in population and urbanization of Minna metropolis. The condition is worsened. This observation agreed with the views of Bolufawi (2000) and Goel (2001) which claimed that the major sources of water pollutants include domestic sewage, human and animal wastes, and industrial effluents; eroded sediments, other solid waste and petroleum-products.

The water temperature range between 20°C to 25°C, which could be associated with the weather of study period (May–July 2012); low temperature of 7°C to 10°C of the water was recorded between June, 2012 and July, 2012. This could be attributed to cold weather which could reduce fish catch at that particular period of time. Dupree and Hunner (1984) reported that warm water fish grow best at temperature between 25°C to 32°C. There was significant difference (P□0.05), in temperatures from May-June, 2012. This could be due to presence of ions and particulate in water which absorbed heat from the sun thus rising temperature of the water.

The pH range of 6.70–7.0 obtained (figure 3) in this study agreed with the recommended range of 6.5 to 9.0 which suitable for fish production, (Abulude et al., 2007). Therefore, pH supports good crop of fish. Abowei (2010) noted that a pH of 5.0 to 9.5 was suitable for aquatic life.

The mean values for alkalinity range of 75.5mg/L to 128.7mg/L also fell within the recommended normal range of 75mg/L to 200mg/l for productive warm water (Adekunle et al., 2007). The values of alkalinity obtained are indication of good buffering capacity of the water in the locations, but do not indicate high productivity. Awanda (1987) pointed out that greater production does not come directly from high alkalinity but on high level of phosphorus and other essential elements, which increase along alkalinity.

The mean range value of 36.0 to 38.98 mg/L was recorded for hardness in this study. This shows water at the locations in the month of July, 2012 is soft according to the classification by Thurston et al. (1979), 0-75mg/L was considered soft water and 75–150mg/L recorded as moderately hard water (alkaline). Hard water are said to be more productive biologically than soft water. Although, Chakroff (1978) recommended a range of 50-300mg/L hardness to be good for aquatic life production in the tropical climate, the finding of the study is not within the range of values for hardness.

The range of mean values of heavy metals in all the months were carefully compared with standard value required for domestic and agricultural water supplies Federal Ministry of Environment. It was observed that there was no lead in all the water samples analyzed that is, the value of lead was 0.00mg/L.

The mean value range of 0.13 to 0.12mg/L was recorded for copper in the study (Fig. 10). It was observed that the value copper was slightly higher than permissible level (0.2mg/L) for water supplies. This could suggest erratic allochthonous input from to human activities.

Conclusions

The results of this study indicated a temporal variation in the parameters measured over the three months study period. The results also indicated that most of the physic-chemical parameters and heavy metals fell within the tolerable and permissible levels recommended. From the results obtained on heavy metals, it was discernible that the water samples from the different locations and months do not contain concentration of lead. However, zinc, copper and manganese are predominantly present during the months in each location in Minna metropolis.

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