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Assessment of rainwater quality of Bichi Local Government Area of Kano State, Nigeria

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The physiochemical and bacteriological quality of rain water in Bichi Local Government Area of Kano State was studied using standard method of analysis. The result obtained indicated that the mean and standard deviation of temperature, pH, turbidity, total alkalinity, calcium, and magnesium were found to be 25.03 ± 0.82°C, 6.08 ± 0.34, 3.13 ± 0.64 NTU, 22.85 ± 6.45 mg/l, 5.76 ± 3.41 mg/l, 1.70 ± 0.65 mg/l, and 0.61± 0.00 mg/l, respectively. The value of other parameters such as chloride, free carbon dioxide, and conductivity was found to be 5.41±1.98 mg/l, 4.53 ± 2.27 mg/l, 27.71 ± 11.81 s/cm, respectively, while coli form and *Escherichia coli* were absent. It was observed that the rainwater samples as at collection were within WHO's standard. The study is significant in order to establish campaign and creating awareness for possible cautions to minimize environmental pollution that could contaminate rainwater and to reduce the incidence of water borne diseases in and around environment and Kano State in general.

Key words: Assessment, bacteriological, Bichi, drinking, properties, rainwater, water.

INTRODUCTION

Rainwater is an important source of fresh water especially for those living in rural areas, where portable water is scarce or where surface and underground water quality is poor (Chukwuma et al., 2012). As a natural occurrence, it is seasonal. Although it is always available in season, it can be a source of water for domestic, agricultural and industrial purpose when harvested and stored when in season (Dinrifo et al., 2010).

Developments in science and technology have brought improved standard of living, but have also unsuspectingly introduced some pollution into our environment. In a limited number of areas, specific industries or very heavy traffic emissions may affect the chemical quality of rainwater, (Abdul et al., 2009). The prevailing activities occurring from local industries, uncontrolled refuse disposal, drying up of rivers, and ponds at times regulated by negative ecological distribution could contribute immensely to the occurrence of the diverse chemical and microbial contaminations observed in water (Bernard and Nurudeen, 2012; RAIN, 2008).

Many researchers have considered the effect of acid rain on human health. These acid pollutants can be deposited in a dry form through dust. Pollutant that contributes to acid rain may be carried hundreds of miles before being deposited on the earth. Because of this, it is sometimes difficult to determine the specific sources of these acid rain pollutants. However, excessive amounts of acid gases like SO_2, NO_2 and CO_2 that can dissolve in rainwater as it is falling from atmospheric cloud are responsible for acid rain (Dinrifo et al., 2010; Olobaniyi

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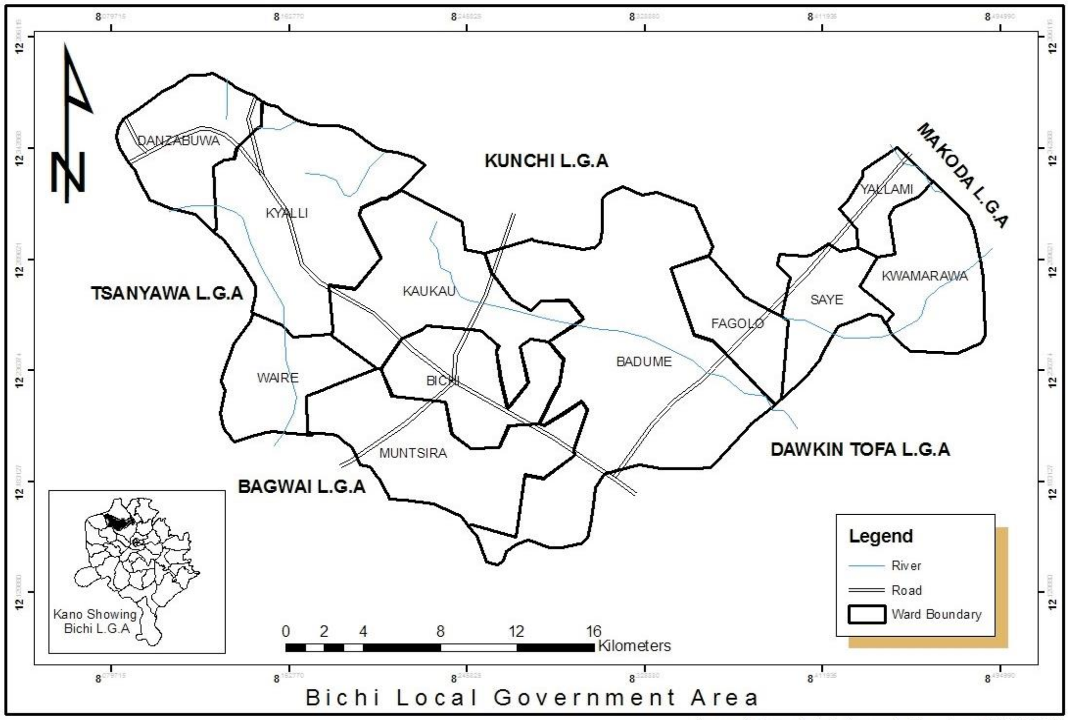

Source: Cartography Lab Geography Department B.U.K (2013)

Figure 1. Map of Bichi Local Government Area of Kano State of Nigeria.

and Efe, 2007).

Rainwater harvesting for domestic use is becoming increasingly popular as the availability of good quality water is declining. This is further aggravated by the adverse impacts of climate change on water supply sources. Consequently, water authorities around the world are keen to explore alternative water sources to meet ever-increasing demands for potable (that is, drinking) water (Abdul et al., 2009; Gardner et al., 2011).

Previous studies on the quality of water resources in the tropical African environment have largely been restricted to surface and groundwater to the negligence of rainwater. This is predicated on the assumption that rainwater is usually very pure and therefore needs very little investigation. However, studies have shown that rainwater quality can be significantly impaired in industrialized districts, Akharayi et al. (2007) from Ondo State, Ubuoh (2012) from Akwa Ibom State, and Olowoyo (2011) from Delta State.

Kano State remains Nigeria's second commercial city and the commercial hub of the sub-Sahara Africa.

Many of the commercial outfits and factories freely release their effluents and emissions into the environment. This study is aimed therefore at evaluating the properties of rainwater being collected for use in Bichi Local Government Area of Kano State for possible database and creating awareness of possible cautions to minimize environmental pollution that could contaminate rainwater and reduce the incidence of water bone diseases.

MATERIALS AND METHODS

Description of study area

Bichi Local Government Area covers an area of 612 km² with a population of over 277,099 at the 2006 census and lies between latitude 12°35' and 36.5°N and longitude 7°48' and 06°E. It is about 45 km from the commercial centre and hosted by Kano State which is ranked second in population with about 9.0 million people and lies between latitude 11°30' and 11.5°N and longitude 8°30' and 8.5°E. Nigeria is located approximately between latitude 4° and 14° North of the equator and between longitude 2° 2' and 15° East of the Greenwich meridian (Figure 1).

Collection/Treatment of water samples

The rainwater samples were collected between May and September in an open space on an elevated platform in order to ensure that the water have no contact with any object before getting into the plastic container. This was transferred into 200 ml capacity poly propylene containers, which had been previously washed with detergents and soaked for 24 h in 1% HNO_3. Few drops of concentrated nitric acid (analytical grade) were then added to the samples for metallic ions determination. This is to maintain the stability of the oxidation state of the various elements in solution and prevent precipitation to ensure metals remained in solution. Measurement of parameters were made using various corresponding meters (e.g. Luvibond 1000, pH Comparator), DR 3 Spectrophotometer model HACH Drel/5 and titrimetric method as described in standard analytical procedures as earlier reported by APHA (1998). The media used for microbiological analysis included multiple tube technique and violet red bile agar-media for *Escherichia coli* determination and the coliform counts were carried out by means of the standard plate count technique using

Table 1. Mean and standard deviation values of physicochemical/microbiological parameters of rainwater in Bichi Local Government Area of Kano State.

Parameter	Mean	Std. Deviation	WHO Limit
Temperature (℃)	25.03	0.82	20.0 - 32.0
pH	6.08	0.34	6.5 - 9.5
Turbidity (NTU)	3.13	0.64	5
Alkalinity-Methyl Orange (mg/l)	22.85	6.45	30.0 - 50.0
Calcium, Ca^{2+} (mg/l)	1.70	0.65	100 - 300
Magnesium, Mg^{2+} (mg/l)	0.61	0.00	100
Chloride ion, Cl^- (mg/l)	5.41	1.98	250
Free carbon dioxide, CO_2 (mg/l)	4.53	2.27	6.0 - 60.0
Conductivity (ìs/cm)	27.71	11.81	1000
Coliform (cfu/ml)	0.00	-	-
E. coli (cfu/ml)	0.00	-	-

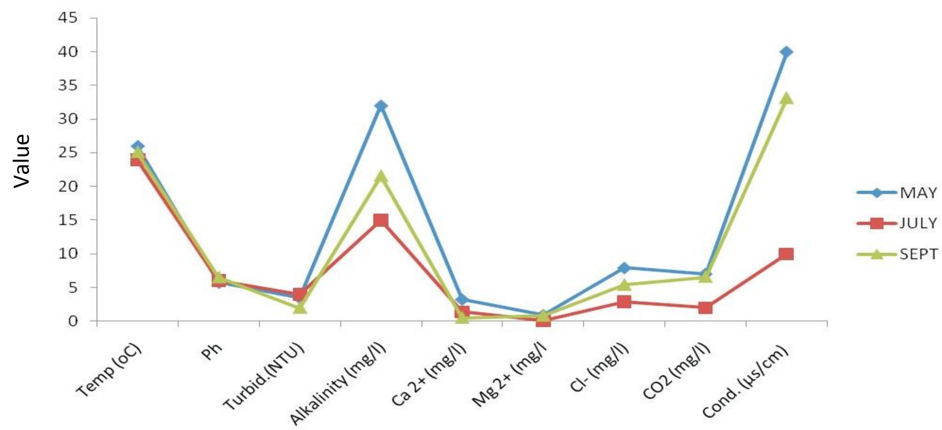

Figure 2. Variation of the physicochemical properties with time under the studied period.

MacConkey agar (APHA, 1998).

RESULTS AND DISCUSSION

The results obtained from the physicochemical and microbiological analysis of rainwater samples collected from Bichi Local Government Area are shown in Table 1.

From the result presented, it can be seen that the temperature of the rain water was found to be mean and standard deviation of 25.03 ± 0.82. This value was within WHO's permissible limit. The values obtained are as expected as the area under study is not an industrial area. According to Bhatia (2009), areas prone to discharge of industrial wastes usually have temperature ranges above those of their surrounding environments; this was played out in oil producing areas were higher temperature values of 30.4°C in Delta State (Dami et al., 2012) and 31°C in Bayelsa State (Ezenwaji et al., 2013) were reported.

The pH values of rainwater samples collected varied between 5.7 and 6.5 with a mean and standard deviation of 6.08 ± 0.34, it was within the limit prescribed by WHO. Similar results were reported by Ubuoh (2012), Olowoyo (2011) and Akharayi (2007) for Akwa Ibom State, Delta State and Ondo State of Nigeria, respectively. However, lower values were recorded (5.46 to 5.98) for Anambra State, a commercial city with high vehicular and industrial pollutants (Chukwuma et al., 2012) and 5.10 to 6.35 in oil producing area of Nigeria (Olobaniyi and Efe, 2007). However, more acidic value range of 4.20 to 4.94 was report in highly industrial areas of Lagos State by Igwo-Ezikpe and Awodele (2010). pH is an important operational water quality parameter (WHO, 2011). In the study area, the lowest pH value of 5.7 was below the acceptable limit, this value was observed from the early rain collections.

The values for turbidity obtained for the study area had a mean and standard deviation of 3.13 ± 0.64 NTU, which was within WHO prescribed limits. Lower range of 2.42 to 1.19 NTU was reported by Dami et al. (2012) and Olobaniyi and Efe (2007) from their study obtained higher range of 3.45 to 7.00 NTU from the oil producing area. High turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites, bacteria and dissolved chemicals in most waters; it may also be due to colloidal and extremely fine dispersions and is a measure of the extent to which light is either absorbed or scattered by suspended materials in water (Gardner et al., 2011).

Total alkalinity values for samples were found to be of mean and standard deviation of 22.85 ± 6.45 mg/l which is within permissible thresholds. Dami et al. (2012) from Delta State reported a range value of 6.70 to 8.90 mg/l which was less than the reported value. Alkalinity of water is its capacity to neutralize a strong acid and it is normally due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium. Hydroxide ions are always present in water, even if the concentration is extremely small (Dami et al., 2012).

Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) are directly related to hardness. From Table 1, calcium concentration ranged was with mean and standard deviation of 1.70 ± 0.65 mg/l and magnesium content in the investigated samples had a mean standard deviation of 0.61 ± 0.00 mg/l. Both were found to be below WHO limit. Dami et al. (2012) reported similar ranges of 1.22 to 1.93 mg/l for Ca^{2+} and 0.65 to 1.08 mg/l for Mg^{2+}, respectively. Hardness is the property of water which prevents lather formation with soap and increases the boiling points of water. It mainly depends upon the amount of calcium or magnesium salts or both, their absence may indicate that nutrient supplement is of great need if the water is harvested for the purpose of human consumption (Chukwuma et al., 2012). However, there is insufficient scientific information on the benefits or hazards of long-term consumption of very low mineral waters to allow any recommendations to be made (WHO, 2011). The values obtained were far less than the WHO prescribed limit for drinking water. However, such water is best and excellent where hardness is not needed as in the case of soap production.

In the present analysis, chloride concentration was found with mean and standard deviation values of 5.41 ± 1.98 mg/l and range of 2.94 to 7.89 mg/l. Dami et al. (2012) reported lower range of 0.10 to 0.20 mg/l, but Chukwuma et al. (2012) and Olobaniyi and Efe (2007) reported higher value of 8.00 to 16.00 mg/l and 19.50 to 26.95 mg/l, respectively. The values were all within the limit accepted and this can be attributed to the mode of sample collection.

The level of carbon (IV) oxide (CO_2) in the rain water samples had a mean and standard deviation of 4.53 ± 2.27 mg/l and range 2.00 to 7.00 mg/l, the value was in agreement with Chukwuma et al. (2012) of 3 to 4 mg/l. Although, this is still within the WHO upper limit, it however showed that there were appreciable emissions of CO_2 gas from vehicles and domestic activities.

The conductivity concentrations range was 10 to 40 ìs/cm with a mean and standard deviation of 27.71 ± 11.81 ìs/cm which were below the standard for drinking water. Electrical conductivity is a measure of water capacity to convey electric current. Olobaniyi and Efe (2007) reported similar value range of 14.05 to 42.10 ìs/cm from Delta State and 76 ìs/cm was reported by Ezenwaji et al. (2013).

The micro-biological parameters assessed showed negative confirmation test to coliform and *E. coli*, suggesting that it was devoid of pathogens as earlier highlighted by Olobaniyi and Efe (2007), Chukwuma et al. (2012) and Dami et al. (2012) in their research.

The absence of coliforms, *E. coli* and low concentration of parameters can partly be explained by the mode of collection. Rainwater samples were collected directly into containers as it fell through the atmosphere. Usually, serious microbial contamination only begins after contact with collection surfaces (Olobaniyi and Efe, 2007; Gardner et al., 2011).

Rainwater needs to be monitored since safe rainwater can be easily contaminated after collection. Hygiene education and monitoring of the operation and maintenance of the system, along with sanitary practices, are essential if rainwater supplies are to provide clean water. Creating awareness on personal and environmental hygiene and issues related to rainwater is crucial (Olowoyo, 2011; UNESCO, 2002).

From Figure 2, it was observed that the first few rainfalls at the beginning of raining season in the month of May contained the highest proportion of the pollutant load. This may be attributed to the deposition and accumulation of pollutants during dry season periods. The longer the dry period, the greater the probabilities of higher pollutant load in the first rain (Chukwuma et al., 2012; WHO, 2011). The month of September equally had values higher than those of the month of July when there were more frequent rains, and this can be attributed to the break during the month of August leading to accumulation of pollutants.

Conclusion

Rainwater is relatively clean and the quality is usually acceptable for many purposes with little or even no treatment. In this study, the quantities of parameters recorded were within WHO's standard. It was not high enough to cause health hazard but as industrial and vehicular traffic grows in number and age, the quantity of gas pollutants that will be released in the near future will probably be high enough to make a difference.

To solve the problem of little or no portable drinking water in urban and rural communities, the chemicals, physical and biological study of available water sources is of paramount importance, for establishing campaign and creating the awareness of possible cautions to minimize environmental pollution that could contaminate sources of water to reduce the incidence of water borne diseases.

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