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Assessment Of The Quality Of Natural Rain Water For Domestic Use In Jimeta-Yola Metropolis, Adamawa State.

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ABSTRACT: A Preliminary study to provide information on the physical and chemical properties of rain water which purity depends on the freedom of the atmosphere above the location of its fall and or collection from volatile impurities existing and or sent up there through natural and man-made activities was conducted in selected wards in Jimeta and Yola metropolis. Physical and chemical parameter determined include pH, Electrical conductivity (EC), Total dissolved solid (TDS), Temperature (T^0C), Colour (Hazen), Potassium (K) Calcium (Ca) Magnesium (Mg) Iron(Fe) and Zinc (Zn). Samples from the selected wards /Locations were analyzed using standard techniques. The levels of the parameter were found to be within the WHO, SON and NSDWQ limit for potable water except for turbidity value at Jambutu (8.33NTU), Gwadabawa (6.34NTU) and Temperature at Ngurore (28.20 ^0C) are slightly outside the guidelines values. The pH values of the samples show that rain water from the three wards (Namtari, Yolde pate and Gwadabawa) showed slight acidity. This shows that it is possible to have acidic rain in these wards / Locations. However, the rain water is safe for drinking and can be used for other purposes.
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1.0 INTRODUCTION

The atmospheric environment is a complex system, from the physical and chemical stand-point, the variable atmospheric mixing; the variable radiation and the nature of pollutants play important roles in determining the nature and rates of chemical transformation in the troposphere (Jannalagadda *et al.,* 1994).

Natural rainwater refers to rainwater or rainfalls from the atmosphere before it reaches the ground/soil. It is the purest form of water. The purity of the atmosphere and rainwater is determined by activities below it and by wind current and movement of clouds formed from one part of the sky and carried to another part of it. That is the purity of rainfall depends on the freedom of the atmosphere above the location of its fall and or collection from volatile impurities existing and or sent up there through natural and man-made activities such as gasses particles associated with traffic emission, road dust resuspension, nonferrous metals, production, fossil fuel combustion and dust from residential heating, industrial, agricultural and engineering activities and so on. (Guo *et al.,*2015: Dong *et al.,* 2017).

Rain is liquid precipitation that is the condensation of atmospheric water vapor that is falls down by gravity into drops of water heavy enough to fall and deposited on the earth surface (Robert, 2002). The formation of rainwater takes place in the atmosphere from precipitation of water evaporated from the earth's surface namely from rivers, streams, pound, likes, sea or ocean and underground water .More than $71^o/_o$ of the earth's surface is covered by water up of 16.37 x1012 m^3 and 1.60 x 1012 m^3 of the surface and ground water respectively totaling 17.97x 1012 m^3 (Parker, 1997).

Acid rain is blamed for forest damage, acidification of lakes and deterioration of marble structures and ancient monuments, Acid rains have been the consequential problems of anthropogenic emission as evidenced by forest degradation in highly industrialized regions such as North America, Europe and parts of Southern China (Jonnalagadda *et al.,* 1994). Acid rain is cause by emission of sulphur dioxide and nitrogen oxide which reacts with the water molecules in the atmosphere to produce acids, it can also be cause and thunder naturally by the splitting of nitrogen compounds through the energy produced by lightning strikes, or the release of sulphur dioxide into the atmosphere by volcano eruptions (Weathers and Likens, 2006).

Wet and dry atmospheric depositions are the major pathway of accumulation of heavy metals in aquatic ecosystems. Concentration of heavy metals in rain water depends on different factors such as vicinity of sources, the amount of precipitation and direction of air masses. Although the rain water removes the heavy metals and other pollutants yet deposition of heavy metals in the form of rain would be harmful for the ecosystem (Purnima and Vibhuti, 2018).

This research is to assess the level of quality of rainwater samples in selected locations/wards in Jimeta and Yola metropolis and to check the portability of the rainwater within the study area in comparison to World Health Organization (WHO) standard. Jimeta and Yola metropolis, where population and demand for water are increasing daily, most of the residents have resulted to different alternative source of water. An overall goal was to provide preliminary information, since the quality of rainwater broadly reflects the state of atmospheric pollution in that region.

2.0 MATERIALS AND METHODS

2.1. Description of the Study Area

The study area is a metropolis made up of the twin cities of Yola and Jimeta in the North Eastern Adamawa state of Nigeria. The Yola- Jimeta metropolis is located between 9°11ᴵN and 9°19ᴵN latitude and 12°12ᴵE and 12°30ᴵE longitude covering an area of about 1,213 km^2 (Adebayo and Tukur, 1999) and has a population of 344,154 (National Population Commission, 2006). Closely related to the population is varied land uses which are associated with the urban status of the area and the various urban land uses generate a high demand for water resources. The climate is tropical, characterized by dry and wet seasons. The dry seasons last from November to March, while the wettest months are August and September, with an average annual rainfall of 759mm. The relative humidity of the area drop from 82% to 92% between June and October to about 25% to 36% between November and December. The annual temperature ranges from 24.1^{o}C to 45^{o}C.The vegetation is that of sub-Sudan vegetation marked by short grasses with short trees (Brown *et al.,* 2005).

2.2. Chemicals and Reagents

All chemicals and reagents used were from reliable sources and of high analytical grade. Distilled water was used in rinsing of glassware's and preparation and dilution of reagent and standard solution.

2.3. Collection of Rain Water Samples

Samples of rainwater were collected throughout the month of August in 2015. A total of twenty-four samples were collected from Six different wards/locations namely (Namtari, Nassarawo (Jimeta market), YoldePate, Jambutu (motor pack), Ngurore, (trailer pack) and Gwadabawa of Yola and Jimeta, Metropolis. Care was taken to ensure that samples were representative of water to be examined and that no accidental contaminations occur during sampling. Sample collectors were trained and made aware of the need to send the samples to the laboratory for analysis without delay.

Rainwater samples were collected in clean plastic containers by placing the container on a raised platform concrete or fill environment in order to ensure that the water have no contact with any object before getting into the container. The samples were analyzed on the same day of collection to avoid possible contamination and chemical reactions that may occur in the samples.

2.4. Assessment of Physical Quality

The physical parameters were determined according to procedures outlined in the Standard Methods for the Examinations of Water and Wastewater (APHA, 1998). pH, Conductivity, Total dissolved solid and Temperature were determined by a portable pH, EC.TDS and Temp meter HI 9811-5 HANNA instruments, USA. pH meter was calibrated in a buffer solution of pH of 7 and 10 before measurement. The probe was immersed in water sample and readings were taken. After taking the reading, the probe was rinsed with distilled water. Turbiditimeter (model 2100P P, HACH, Colorado) was used to measure the turbidity. The turbidity meter was calibrated using 1, 10, 100, and 1000 NTU standards provided by the manufacturer. After calibration, the readings were taken. A comparator (Nessleriser Dis NSA) was to read the true color of the samples.

2.5.0 Chemical Analysis

2.5.1 Sample Collection for Chemical Analysis

According to Fifield and Haines (2000), the following steps were followed when sampling water for chemical analysis. Polyethylene or Teflon vessels were used, and before use, the containers were washed and stored in 10% nitric acid for two days and rinsed with double distilled water. Twelve samples were collected throughout the month of August 2015 for chemical analysis. The containers were completely full to avoid oxidation. Depending on the pH, the samples were stabilized with nitric acid.

2.5.2 Assessment of Chemical Quality

Chemical quality was assessed by checking the concentration of metals (cations) such as iron, magnesium and calcium. Atomic absorption spectroscopy was used to measure the concentration of cations such as iron, calcium and magnesium While Flame emission spectroscopy was used to measure potassium (corning, model 405).

3.0 RESULTS AND DISCUSSION

3.1 Physical and Chemical Characteristics of Rainwater

The results recorded during the assessment of physical and chemical parameters of the samples are presented in Table 1.0 while their statistical summary are presented in Tables 2.0 respectively.

The pH of Water determines the solubility and biological availability of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). The pH also determines whether aquatic life can use the nutrient. Also, metals tend to be more toxic at lower pH because they are more soluble. The pH value ranged between 6.20 to 7.20 with a mean value of 6.62 as against the range of 6.50 to 8.50 recommended by World Health Organization (WHO, 2006) and Nigerian Standard for Drinking Water Quality (NSDWQ, 2007) for potable water.

Temperature values ranged from 23.40 ^{0}C to 28.20 ^{0}C with a mean value of 25.70^{0}C. High temperature enhances the solubility and mobility of metals. Electrical conductivity in natural water is the normalized measure of the water ability to conduct electric current, it is mostly influenced by dissolved salts such as sodium chloride and potassium chloride.

The conductivity of the Rainwater analyzed ranged from 2.30 µS/cm to 14.30 µS/cm with a mean value of 8.11 µS/cm. The EC values of all the samples analyzed falls within the maximum permissible limit of 1000.00 µS/cm recommended by (WHO, 2006 and NSDWQ, 2007). The total dissolved solid (TDS) varied from 3.67 mg/L to 9.58 mg/L with a mean value of 5.75mg/L as against the maximum allowable limit of 500.00 mg/L (WHO, 2006; NSDWQ, 2007).

Turbidity is a measure of the cloudiness of water. It is used to indicate water quality. Higher turbidity levels are often associated with higher levels of disease-causing microorganism such as virus's parasite and some bacteria and dissolved chemicals. The turbidity value ranged from 2.37 NTU to 8.33 NTU with mean value of 5.01 NTU. The turbidity values of all the samples analyzed falls within the maximum permissible limit of 45.00 and 6.12 µS/cm recommended by (WHO, 2006 and SON 2007).

Table 1.0: Physico - Chemical properties of Rainwater from Different Wards/Locations in Yola-Jimeta Metropolis

Wards → Parameters ↓	Namtari,	Nassarawo,	Yolde Pate,	Jambutu,	Ngurore	Gwadabawa	SON	WHO
Turbidity (NTU)	5.50	3.00	4.54	**8.33**	2.37	**6.34**	45.00	6.12
EC (µS/cm)	7.40	2.30	6.30	7.33	11.00	14.30	778.00	857.00
Temp (^{o}C)	24.50	23.40	25.40	27.10	**28.20**	25.80	27.90	27.90
pH	6.2	7.2	6.4	6.9	6.7	6.3	6.97	6.96
TDS (ppm)	4.33	3.68	5.77	3.67	9.58	4.46	375.00	328.00
Colour (Hazen)	10.0	5.0	7.0	5.0	8.0	5.0	**-**	5.0 -35
Iron (mg/L)	0.10	0.20	0.09	0.30	0.06	0.07	0.80	0.45
Calcium (mg/L)	0.07	0.10	0.06	0.01	0.07	0.13	-	150
Magnesium (mg/L)	21.10	29.80	35.60	30.60	40.20	30.50	-	100
Potassium (mg/L)	3.20	3.14	3.08	3.08	3.10.	3.21	-	-
Zinc (mg/L)	0.09	0.02	0.06	0.06	0.12	0.08	-	3.00

Bold values indicate incidences where parameters are outside WHO guidelines

Colour in water could be due to several form of pollution –including decaying of organic matter, vegetable or soil organism and it may also be due to the presence of colloidal iron and manganese. Colour is pH dependent. The results of colour determination were expressed in whole number and recorded as Hazen units. Its value ranges from 5 Hazen to 10 Hazen with the mean for the six wards/locations analyzed as 7 Hazen.

Table 2: **Statistical Summary of Physico- Chemical Parameters of Rainwater from all the Selected Wards in Yola-Jimeta Metropolis**

Parameters (mg/L)	Minimum	Maximum	Mean	Median.
Turbidity (NTU)	2.37	8.33	5.01	5.02
Conductivity(µS/cm)	2.30	14.30	8.11	7.37
Temperature (^oC)	23.40	28.20	25.7	25.6
pH	6.20	7.20	6.62	6.55
TDS (ppm)	3.67	9.58	5.75	4.40
Colour (Hazen)	5.0	10.0	7.00	6.00
Iron (mg/L)	0.06	0.30	0.14	0.09
Calcium (mg/L)	0.01	0.13	0.07	0.07
Magnesium (mg/L)	21.10	40.20	31.2	30.3
Potassium (mg/L)	3.14	3.21	3.19	3.20
Zinc (mg/L)	0.02	0.12	0.07	0.08

The concentration of calcium ranged from 0.01 mg/L to 0.13mg/L with a mean value of 0.07 mg/L. The concentration of calcium in the samples analyzed were below the permissible limit of 150.00 mg/L postulated by WHO (2006). Calcium is beneficial element with respect to strong teeth and bone formation and its high concentration in water does not constitute any health hazard (Amadi *et al.,* 2014).

Magnesium concentration varied from 21.10 mg/L to 40.20 mg/L with an average value of 31.20 mg/L (Tables 1.0 and 2.0). The presence of calcium and magnesium ions in water is responsible for hardness of water. The concentration of iron ranged from 0.06mg/L to 0.30mg/L with a mean value of 0.14mg/L as against the maximum permissible limit of 0.30 mg/L (WHO, 2006; NSDWQ, 2007). High iron content in rainwater does not constitute any health problem except impairment of the colour, odour and taste.

Zinc has been identified as a cofactor in at least forty different system covering every major physiological function dependent upon enzymes. Without adequate Zinc for examples, Carbon dioxide exchanged in cell could not take place at a fast enough rate to sustain life. Zinc concentration range between 0.02 mg/L and 0.12 mg/L with a mean of 0.07 mg/L. All the boreholes passed WHO guideline at 3 mg/L for Zinc.

Potassium is a dietary requirement for nearly any organism but a number of bacteria because it plays an important role in nerve function and plant growth. An unusual application is increasing the amount of rain in dry region by potassium chloride, it is released just below the cloud from planes, rises up and doubles the amount of moist in clouds causing it to start raining harder. The concentration of potassium ranged from 3.14 mg/L to 3.21 mg/L with a mean value of 3.20 mg/L. Since Potassium has a role in our bodies and at the same time has negative health effects at high levels. It is weakly hazardous in water.

CONCLUSION

Rainwater appears to be one of the most promising alternatives for supplying freshwater in the face of increasing water scarcity and escalating demand even in a polluted area. The physico-chemical quality of rainwater in selected wards/location in Jimeta and Yola metropolis is quite satisfactory with no parameter being detected above the corresponding maximum permissible concentration for drinking purposes according to WHO and SON standard. In general, examination of the physico-chemical composition of the rainwater is a prerequisite before its utilization for drinking purposes.

RECOMMENDATION

Rainwater could be used in augmenting water supply especially in the face of increasing water scarcity, the following recommendations are suggested to properly harnessed rainwater.

(i) Care should be taken to keep rainfall collection covered to reduce invasion pests and organic matters(ii) If rainwater is to be used for drinking and other domestic purposes, chlorination is necessary in order to maintain its quality at the level where health risks are minimized. (iii) Where rainwater is to be used without treatment, users are advised to boil water before drinking.

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