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Elemental Constituents of Rain Waters Harvested in Benin City between Two Consecutive Years and Their Health Significances

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Abstract:
There is currently scarce documentations in literature the studies on the chemical analysis of rain waters in Benin City. This work was therefore aimed at generating data and examining the benefits of the elements detected in rain water harvested between April and October of 2014 and 2015 respectively. The rain waters were collected on weekly basis and analysed with Atomic Absorption Spectrophotometer. Results revealed that eleven elements were detectable in the rain waters harvested in 2014 and 2015. Significant differences were observed amongst the parameters detected. Overall, the concentration of the various elements detected were below the toxicity level recommended by the World Health Organization (WHO) for domestic water. In conclusion, the waters harvested during the periods are suitable for domestic purposes.

Keywords: *Rain water, Elements, Atomic Absorption Spectrophotomenter*

1. Introduction

Benin City, Nigeria, is located between 6.39 latitude and 5.63 latitude and it is situated at elevation 88 meter above sea level. In winter, there is much less rainfall than in summer. There are two main seasons in Nigeria, the dry and rainy seasons. The rainy season starts from April and ends in October.

Water is the most abundant compound in living organisms. It has high freezing point, boiling: and heat of vaporization due to hydrogen bonding which binds the molecules together [1]. Without water, no living organism can survive. Water is the most important resource. Water from various sources contains dissolved gases, minerals, organic and inorganic substances. Water in its pure form is colourless, odourless, tasteless and sparkling in nature [2].The total water system surrounding the planet earth is called the hydrosphere. It includes fresh water systems, oceans, atmosphere vapour and biological waters. Hydrosphere processes are steps by which water cycle on the planet earth. These processes include sublimation of ice, evaporation of liquid, transportation of moisture by air, rain, snow, river, lake and ocean currents. These processes are related to the physical and chemical properties of water. Dust particles and ions present in the air are nucleation center of water drops. Water from rains and river contain several cations such as Ca^{2+}, Mg^{2+}, Na^{+} K^{+}, NH^{4+}, which are also balanced by anions, HCO^{3-}, SO^{4-}, NO^{2-}, Cland NO^{3}. The pH of rain water is between 5.5 and 5.6. Rainwater usually contains dissolved gases like oxygen and carbon dioxide. The rainout process takes place within the cloud, though occurs below the clouds, where large solid aerosol is removed [1]. Minerals are inorganic nutrients usually required in small amounts from less than 1 to 250omg per day, depending on the mineral [2]. Mineral play significant roles in the body for construction and maintenance of bones and normal function of nerves and muscles. Though minerals do not contribute to energy to the body, but they are essential in physiological processes which are important to life [3]. There is limited information on the on the trace elements content of water and numerous plant foods consumed in some less developed countries [2]. It has been well documented that minerals play significant roles in health and diseases states of man and domestic animals.

The literature is currently scarce on the mineral characteristics of rain waters harvested in Benin City. Consequently, this research is set to fill the above gap.

2. Materials and Methods

2.1. Sample Collection

The water samples were collected between April and October of 20014 and 2015 respectively on weekly basis.

250 ml polyethylene plastic bottles that were previously washed and rinsed with deionised water were used in the collection.

2.2. Experimental

Atomic Absorption Spectrophotometer was used for the analysis of eleven elements in the rain waters collected [4].

3. Results and Discussion

Month	Na	K	Ca	Mg	C1	Fe	Mn	Zn	Cu	Pb	Ni
April	0.30±0.00	0.25±0.00	0.35±0.01	0.10±0.00	0.10±0.00	10.20±0.01	1.18±0.10	0.04±0.00	0.03±0.00	0.06±0.10	0.03±0.01
May	1.10±0.00	0.15±0.01	0.20±0.02	0.11±0.02	0.11±0.01	10.00±0.00	1.00±0.00	0.04±0.01	0.02±0.00	0.04±0.00	0.03±0.00
June	1.20±0.00	0.21±0.00	0.20±0.00	0.13±0.00	0.10±0.00	9.00±0.01	1.10±0.01	0.04±0.01	0.01±0.00	0.03±0.01	0.02±0.00
July	1.15±0.01	0.17±0.01	0.21±0.01	0.10±0.01	0.11±0.10	9.00±0.10	1.00±0.00	0.04±0.01	0.02±0.00	0.05±0.01	0.04±0.01
August	1.31±0.02	0.20±0.00	0.25±0.02	0.10±0.01	0.11±0.00	8.00±0.00	1.00±0.10	0.15±0.00	0.20±0.01	0.03±0.01	0.05±0.00
Sept	1.10±0.00	0.15±0.21	0.15±0.00	0.12±0.00	0.10±0.02	9.00±0.01	1.00±0.12	0.02±0.01	0.02±0.00	0.02±0.00	0.04±0.00
Oct.	1.15±0.01	0.17±0.00	0.30±0.00	0.05±0.00	0.12±0.01	8.00±0.00	1.10±0.00	0.01±0.00	0.04±0.01	0.05±0.01	0.04±0.00

Table 1: Elemental Data (Mean/Month, Mg/l) of Rain Water in Benin City-2014

Month	Na	K	Ca	Mg	Cl	Fe	Mn	Zn	Cu	Pb	Ni
April	0.70±0.00	0.40±0.00	0.25±0.01	0.10±0.01	0.13±0.00	7.00±0.00	1.00±0.02	0.0250.00	0.05±0.01	0.04±0.00	0.05±0.00
May	0.70±0.00	0.30±0.01	0.20±0.00	0.10±0.00	0.10±0.00	6.50±0.00	1.20±0.01	0.06±0.00	0.03±0.00	0.05±0.00	0.05±0.00
June	0.60±0.00	0.40±0.00	0.15±0.01	0.20±0.01	0.10±0.00	7.00±0.00	1.50±0.01	0.05±0.00	0.05±0.01	0.05±0.01	0.06±0.01
July	0.55±0.01	0.30±0.01	0.20±0.00	0.12±0.00	0.10±0.00	6.00±0.01	1.40±0.02	0.01±0.00	0.04±0.00	0.04±0.00	0.04±0.00
August	0.60±0.02	0.40±0.00	0.20±0.00	0.11±0.01	0.09±0.00	7.10±0.00	1.70±0.01	0.02±0.00	0.04±0.00	0.06±0.01	0.06±0.01
Sept	0.35±0.01	0.3 5±0.01	0.22±0.01	0.07±0.00	0.08±0.01	6.50±0.00	1.65±0.02	0.01±0.00	0.05±0.00	0.05±0.01	0.05±0.01
Oct.	0.89±0.01	0.25±0.00	0.20±0.00	0.08±0.01	0.06±0.00	7.00±0.01	1.50±0.00	0.04±0.00	0.06±0.00	0.06±0.01	0.06±0.00

Table 2: Elemental Data (Mean/Month, Mg/l) of Rain Water in Benin City- 2015

The results for the analyses are presented in Tables 1 and 2.

Eleven elements were assayed for in rain waters. The results indicated that, the elements were in varied concentrations and were below the permissive levels recommended by [5].

The mean concentrations of calcium in the rain waters ranged between o.35 ± 0.15 and 15.00 ± 0.00mg/1 in 2014 and 0.25±0.01 and 0.15± 0.01mg/l in2015. The world Health Organization [5] recommended 75mg/1 of calcium as safe concentration in drinking water. Calcium, like phosphorus forms the major part of the mineral content of bone. Calcium is very abundant in the human body. Non-Skeletal calcium plays important roles in a wide variety of essential functions in body metabolism [6]. Calcium exists in two forms that have quite different functions. Most of the calcium in the body is found as calcium phosphate crystals in the bones and teeth, forming the cement that contributes to the physical strength of these structures. Calcium is also found in an unbound ionic form (Ca^{2+}) that performs critical functions in muscle concentration, nerve impulse transmission, ion transport, and transmission of signals across membranes [7]. Reduction in the extracellular blood calcium increases the irritability of nerve tissue and very low levels may cause spontaneous discharges of convulsions [8, 2]

The mean concentration of magnesium in the rain waters was between 1.13± 0.00 and 0.05±0.00 mg/1 in 2014 and 070±0.00 and 0.02±0.00mg/l in 2015.The range of 50-150mg/1 is permissible in drinking water [5]. Concentrations above the recommended levels in drinking water might cause hazardous effects to health. Magnesium has many diverse physiological functions. It is essential for the integrity of bones and teeth. It is the second most plentiful caution after potassium. Magnesium is an active component of several enzymes systems in which thiamine pyrophosphate (TPP) is a cofactor [7]. It also plays significant role as an activator of enzymes [6]. Additionally, magnesium plays active roles in protein synthesis and in neuromuscular transmission. Toxicity disease in human include depressed deep tendon relapses and respiration [8]

The mean concentrations of manganese in the rain waters ranged between 1.18±0.10 and 1.00±0.00mg/1 in 2014 and1.70±0.02 and1.00±0.01mg/l in 2015. The permissible concentration recommended for domestic water is 0.05mg/1 [5]. However, it has been reported that if some minor elements like manganese occur above certain limits, they become hazardous to health or impact sensory effect to water and thus makes it objectionable to the consumer. Additionally, manganese toxicity in humans is associated with several psychiatric disorder (LocuraMarganica) resembling Schizophrenia, followed by permanently crippling neurological disorder clinically similar to Parkinson's disease [7,9]. The element can function both as an enzyme activator and as a constituent of metalloenzymes, like other essential trace elements.

The mean concentrations of iron in the rain waters ranged between 10.20 ± 0.00 and 7.10 ± 0.00 mg/1 in2014 and7.10±0.00 and 6.00±0.01 in 2015. The recommended permissible level of iron in drinking water is 0.30 mg/1[5]. The concentrations of iron detected in the river waters are higher than the permissible level. Iron plays a key role in many biological reactions. It is present in several enzymes responsible for electron transport (cytochromes), for activation of oxygen and oxygen transport (haemoglobin, myoglobin). It is also an essential cofactor in the synthesis of neurotransmitters such as dopamine, norepinephrine and serotonin. The deficiency of iron results in a disease known as anemia. Additionally, iron plays significant role in the triacarboxylic acid cycle(TCA), as the 24 enzymes in the cycle contains iron either at their active sites or act as cofactor [6,10].

The mean concentrations range of zinc detected in the rain waters was between 0.15 ± 0.00 and 0.01 ± 0.00mg/l in 2014 and 0.06±0.00 and 0.01±0.00mg/l in 2015.Though zinc is essential in the diet of human, too little zinc intake can cause health problems, just as too much intake is harmful. The quantities detected in the rain waters were below the toxicity levels recommended for drinking waters [5]. Hypogonadism, growth failure, impaired wound healing and decreased taste and smell acuity are part of the deficiency disease of zinc [6].

The mean concentration range of Nickel, in the rain waters was between 0.05±0.00 and0.02±0.00 in 2014 and 0.06±0.01 and0.04±0.00mg/l in 2015. The concentration is lower than the toxicity level recommended by WHO in drinking water.

The mean concentration range of copper in the rain waters was between 0.04 ± 0.01and 0.01 ± 0.00 mg/1 in 2014 and 0.05±0.00 and 0.05±0.00mg/l. These values are lower than the toxicity level recommended by WHO in drinking water [5]. In human cells, copper is involved in a number of biochemical reactions. Wilson's disease is a genetic disorder in which the body cannot rid itself of copper, thus resulting in deposition in organs and serious consequences, such as liver failure and neurological damage Copper is necessary for the hematologic and neurologic system [11].

4. Conclusion

The elemental examinations of the river waters have revealed that the values obtained are below the toxicity concentrations recommended by WHO in drinking water. They are therefore suitable for human consumption from the elemental constituent's point of view. The elements detected play significant roles in the human body either as structural components of organs or tissues. The elements are also involved in biochemical reactions (metabolism) in humans.

Additionally, the inorganic elements detected serve numerous functions as cofactors in enzymes, in the regulation of acid-base balance in body fluids. Besides, each of the elements detected in the river waters are required in specific amounts to meet the Recommended Dietary intakes in man

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