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Evaluation of Heavy Metals Concentration in Harvested Rain Water in Aule Area of Akure, South Western Nigeria

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ABSTRACT

The concentration of heavy metals in harvested rainwater in Aule Area of Akure, South Western Nigeria was evaluated. Water samples were collected from 25 rain water storage tanks within the study area and a well was used as a control. The water samples were analyzed for heavy metals (Iron, Manganese, Copper and Zinc), and the results obtained was compared to World Health Organization (WHO) standard for drinking water. Three of the rainwater samples exceeded the recommended WHO standard of 0.3 mg/L for Iron while the well water sample fell within the WHO standard. Four of the rainwater samples exceeded the recommended WHO standard of 0.5 mg/L for Manganese, while the well water sample fell within the WHO standard. Only one rainwater sample exceeded the recommended WHO standard of 2 mg/L for Copper with a Copper content of 2.342 mg/L, while the well water sample fell within the WHO standard. The results obtained from this study reveal that the well water, that served as a control was of better quality than the sampled rainwater. The presence of heavy metals in the rainwater samples in concentrations that exceed WHO permissible limits is an indication of high contamination of the water samples, hence, it is recommended that the rainwater samples should be suitably treated before human consumption.

Key words: *Heavy Metals, Rainwater Samples, Well Water, Human Consumption*

1. INTRODUCTION

Water is essential for life and is a basic human need, every living soul requires water for its survival, it is also essential for health and sanitation. Adequate provision of safe drinking water remains a major challenge to many people worldwide, especially those living in less-developed regions. Without water, man cannot live and industry cannot operate, hence, every country has to take preventive measures to avoid careless pollution and contamination of the available water resource. According to UNESCO (2003) report, about 1.2 billion people globally lack safe drinking water, and 50% of the populace in developing countries still has no reasonable access to safe and sustained water supplies. The situation is at its worst in Sub-Saharan Africa where only around 16% of the population have access to safe and adequate water supply through improved piped systems (WHO/UNICEF, 2012).

Rainwater harvesting (RWH) in urban areas is a strategy that brings many benefits and may serve to cope with current water shortages, urban stream degradation and flooding (Fletcher *et al*., 2008; van Roon, 2007; Zhu *et al*., 2004). RWH is a common practice in the countries and areas where the annual precipitation is high and pure drinking and usable water is scarce. RWH, in its broadest sense, is a technology used for collecting and storing rainwater for human use from rooftops, land surfaces or rock catchments using simple techniques such as jars and pots as well as engineered techniques. It is not a modern concept, according to Mahmud *et al.* (2008), in ancient Egypt and Rome, rainwater was harvested by reservoir and canal, and was used for domestic purposes, cultivation, irrigation and in primitive small industries.

Freshwater quality and availability remain one of the most critical environmental and sustainability issues of the twenty first century (WHO, 2006). Contaminated water still threatens the wellbeing of the population, particularly in under-developed and developing countries. Water quality and quantity are inextricably linked, but quality deserves special attention because of its implication on health and life**.** The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Heavy metal is a general collective term that applies to a group of metals and metalloids with an atomic density greater than 5g/cm^3. Heavy metals are chemical elements with a specific gravity that is at least 5 times the specific gravity of water. The specific gravity of water is 1 at 4°C (39°F). Simply stated, specific gravity is a measure of density of a given amount of a solid substance when it is compared to an equal amount of water. Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g. copper, selenium, zinc) are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning.

Most heavy metals in water supply cannot be detected by sight, smell or taste. The only way to detect the presence of heavy metals is through a water test. Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time. Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver, and other vital organs. Long-term exposure may result in slowly progressing physical, muscular, and neurological degenerative processes. Allergies are not uncommon and repeated long-term contact with some metals or their compounds may even cause cancer. Examples of heavy metals/metalloids include Mercury (Hg), Lead (Pd), Cadmium (Cd),Arsenic (As),Copper (Cu),Manganese (Mn) and so on. The aim of this study is to evaluate the presence of heavy metals in rainwater samples harvested in Aule area of Akure, South-western Nigeria.

2. METHODOLOGY

The study was carried out in Aule in Akure. Akure is the capital of Ondo state, which is located in the South-western part of Nigeria. Akure lies on latitude 7º 15′ North of the Equator and on longitude 5º 15′ east of the Greenwich meridian. Water samples were collected from 25 rain water storage tanks within the study area and a well was used as a control. All the collected samples were taken to the laboratory within two hours of collection and refrigerated at 4°C in laboratory till the analysis was carried out. Great care was taken to ensure the integrity of the samples. The water extracts were analyzed for the heavy metals [Iron (Fe), Manganese (Mn), Copper (Cu) and Zinc (Zn)] by Atomic Absorption Spectrometer.

3. RESULTS AND DISCUSSION

The results obtained from the laboratory analysis for the concentration of heavy metals in the water samples is presented on Table 1.

Table 1: Results of Heavy Metals Analysis carried out on the water samples.

Sample	Heavy metals concentration (mg/L)			
	Iron (Fe)	Manganese (Mn)	Copper (Cu)	Zinc (Zn)
RW1	0.104	0.358	0.167	0.001
RW2	0.056	0.344	0.936	0.000
RW3	0.044	0.562	2.342	0.005
RW4	0.078	0.003	1.845	0.000
RW5	0.004	0.011	1.256	0.002
RW6	0.059	0.034	1.328	0.001
RW7	0.021	0.045	0.103	0.000
RW8	0.001	0.001	0.009	0.000
RW9	0.148	0.711	0.452	0.001
RW10	0.032	0.004	0.072	0.000
RW11	0.356	0.511	0.579	0.001
RW12	0.032	0.034	0.562	0.002
RW13	0.002	0.005	0.004	0.001
RW14	0.003	0.001	0.003	0.000
RW15	0.016	0.034	0.078	0.000
RW16	0.013	0.026	0.045	0.000
RW17	0.004	0.001	0.002	0.000
RW18	0.464	0.523	1.945	0.005
RW19	0.352	0.045	0.758	0.001
RW20	0.001	0.002	0.001	0.000
RW21	0.001	0.003	0.000	0.000
RW22	0.038	0.004	0.005	0.000
RW23	0.001	0.001	0.000	0.000
RW24	0.005	0.004	0.001	0.001
RW25	0.001	0.000	0.004	0.000
WELL	0.020	0.001	0.004	0.001
WHO Guideline	0.3	0.5	2.0	Nil

RW – Rainwater
mg/L- Milligram per litre
Iron

Iron is a heavy metal of concern, particularly because ingesting dietary iron supplements may acutely poison young children. Ingestion accounts for most of the toxic effects of iron because iron is absorbed rapidly in the gastrointestinal tract. The corrosive nature of iron seems to further increase the absorption. It can cause a rusty red or brown stain on fixtures or laundry and/or cause your water to develop a metallic taste. The graphical illustration of the Iron content of the water samples is presented in Figure 1. Three of the rainwater samples exceeded the recommended WHO standard of 0.3 mg/L. The well water sample fell within the WHO standard.

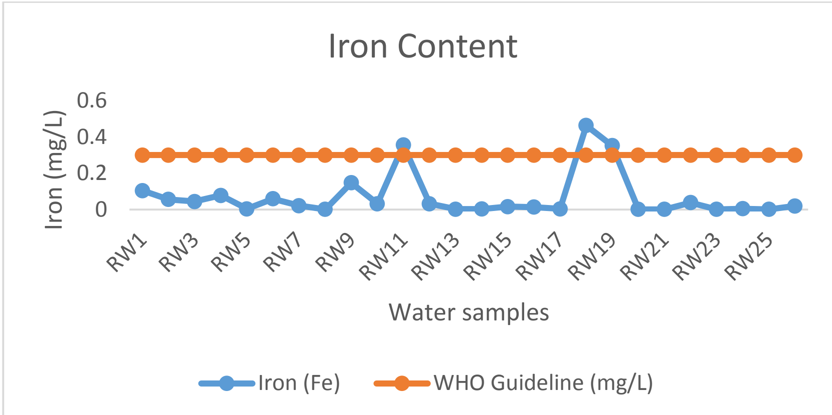

Figure 1: Iron content of water samples.

Manganese

The graphical illustration of the Manganese content of the water samples is presented in Figure 4.10. Four of the rainwater samples exceeded the recommended WHO standard of 0.5 mg/L. The well water sample fell within the WHO standard.

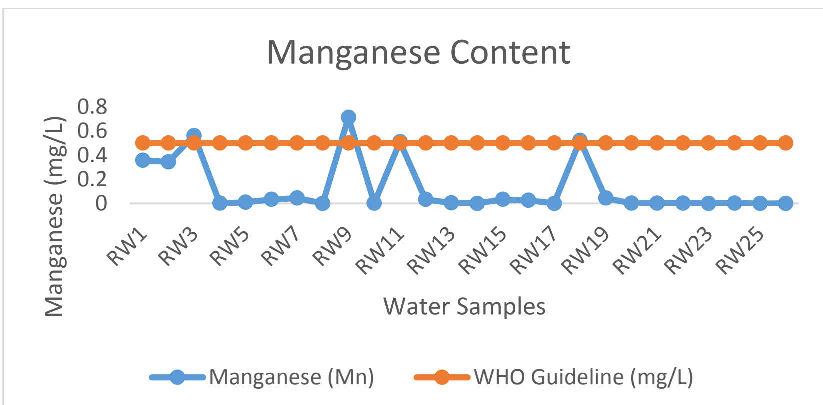

Figure 2: Manganese content of water samples.

Copper

Copper is nutritionally essential but higher values can lead to gastrointestinal disturbances. Copper at very high levels is toxic and can cause vomiting, diarrhea, loss of strength or, for serious exposure, cirrhosis of the liver. The graphical illustration of the Copper content of the water samples is presented in Figure 3. Only one rainwater sample exceeded the recommended WHO standard of 2 mg/L with a copper content of 2.342 mg/L . The well water sample fell within the WHO standard

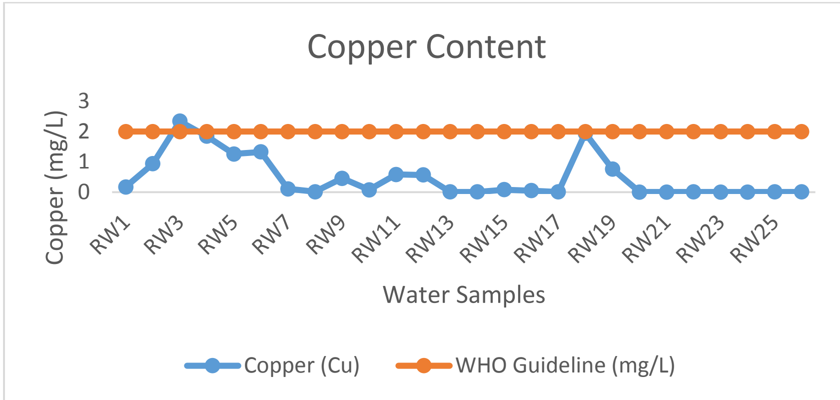

Figure 3: Copper content of water samples.

4. CONCLUSION

Most heavy metals in water supply cannot be detected by sight, smell or taste, hence regular tests have to be done in order to detect the presence of heavy metals and consequently to determine the potability of the rainwater samples. The rainwater harvesting system should be clean and hygienic in order to promote safety of the water. Generally, the results of this study are indicative of high contamination of the water samples as a result of heavy metals in concentration that exceed WHO permissible limits. Hence, caution is required in the use of the water for domestic purposes. Water treatment should be explored as a means of improving the quality of the rainwater samples.

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