Rain Water from Different Roofings in Osogbo, South West Nigeria

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***Abstract*—The research work is predicated on the challenge posed by recent innovations on the varieties of roofing sheet materials from which a sizeable number of the population conventionally obtain their drinking water in form of roofing sheet intercepted rain water. The rain water samples were collected from three different roofing sheet types and 'ages' at Dada Estate in Osogbo, Osun State. The different roofing sheets evaluated were iron zinc, Aluminum, asbestos (Adex). The samples were collected and analyzed using standard methods with adequate quality control measures. The ranges of values of the investigated parameters were; pH (6.545-7.20), Hardness (0.250-3.775mg/l), TDS (0.004-0.023mg/l), TSS (0.580-0.740mg/l), Alkalinity (0.01-0.28mg/l) and T.S (0.586-0.763mgmg/l). The heavy metals determined include lead and chromium ranging from (0.036mg/l-0.184mg/l) and (0.049mg/l-0.393mg/l) respectively while cadmium was not detected in any of the roofing sheets type and 'age' examined. It was concluded from the findings, that rain water from any of the above intercepted roofing sheet should not be regarded as potable water hence, periodical analysis and treatment of rain water is recommended.**

***Index Terms*—Heavy metals, Osogbo, rainwater, roofing.**

I. Introduction

Wind, fire and water are the fundamental elements of the earth, only oxygen is more essential than water in sustaining life of all living things According to [1], man can survive for some weeks without food but not without water, we only need to lose 1 – 2% water for our bodies to start registering thirst if we lose more than 20% of water there is a severe damage to our health. Developing countries are located in all geographic regions; problems of water supply and sanitation are common in all these countries. Areas of water scarcity and stress are increasing African nations are more affected as the continent presently has the lowest access to water supply, lowest level of development and utilization of water resources relative to its needs and the lowest capacity to address these challenges [2].

According to W.H.O [3], 1.1 billion people lack access to improved drinking water supply, 88% of the 4 billion annual cases of diarrheal disease are attributed to unsafe water and inadequate sanitation and hygiene, and 1.8 million people die from diarrheal diseases each year. The WHO estimates that 94% of these diarrheal cases are preventable through modifications to the environment, including access to safe water. Simple techniques for treating water at home, such as chlorination, filters, and solar disinfection, and storing it in safe containers could save a huge number of lives each year [3].

Rain water known as the purest form of water are being contaminated by the atmosphere and environmental pollution, dust, roofing sheets on which it passes through. The quality of water falls when it is contaminated and our health is harmed. Rain water comes in contact with heavy metals (e.g. lead), making it non-potable for drinking and associated with disease and illness, it also distresses us emotionally, limit us socially and challenges us intellectually and spiritually to become more active steward of our environment. Rain water on its own is microbiologically pure and uncontaminated, but as it descends unto rooftops, collecting gutters or channels and cisterns, it gets loaded with dust and fine particles in suspension which may include airborne viruses and bacteria. Moreover, flying birds sometimes pass their fecal dropping unto roof of houses, which get mixed in the rainwater thereby exposing the consumers to some bacterial contaminants and pathogens. The processes controlling the composition of rain are complex and influenced by both natural and anthropogenic sources.

The recent improvement in the building industries and varieties in roofing sheet materials call for investigation on the physiochemical quality of roof intercepted rain water in our homes thus this research work is predicated on this challenge.

II. Materials and Methods

A. Samples Collection

The rain water samples used for this research work were collected from three different types of roofing sheet materials at Dada estate in Oshogbo, Osun state Nigeria. The different roofings evaluated are Iron zinc, Aluminum and Adex/Asbestos

B. Samples Preparation for Analysis

Three samples from each of the different roofing sheets were collected in washed and dried empty plastic bottles which were pre-rinsed with the rain water sample, coded, refrigerated and immediately taken for analysis in the department of Agronomy of university of Ibadan Nigeria within 48hours.

C. Determination of pH

Rain water sample was pipette into a measuring cylinder and measured up to 50ml before pouring it in a dispenser

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arranged in a dispenser holder. The pH meter used was calibrated by dipping its electrode into a buffer solution of pH 4 and pH 7 after which it was dipped into the samples while the reading was recorded. The Meter electrode was rinsed with distilled water in a wash bottle before dipping it into another sample. The readings were recorded when the figures were stable. The result obtained was recorded.

D. Acidity Determination

Sodium hydroxide was poured into the burette via a funnel. The base was measured up to 10ml at meniscus. 25ml of the sample was pipette into a flat-bottom flask which has been rinsed with the sample. 4 drops of phenolphthalein +Ethanol was added to the samples and it was titrated with standard NaoH from a 10ml burette with a continuous shaking until a colour change was observed. Difference in volume of the NaoH in burette was recorded as the titre value and it was multiply by the dilutor factor [4].

E. Alkalinity Determination

25ml of samples were transferred by pipetting into a flat-bottom flask; 3drops of indictor (methylred + ethanol) was added to the samples. The samples were titrated with standard HCL from a 10ml burette with continuous shaking until colour changes are observed. The volume of the acid used was recorded for each sample. Alkalinity content was later calculated as Alkalinity in mg/l [5].

F. Digestion of Samples

About 5ml of samples were pipette in a beaker which has been pre-rinsed with each sample and distilled water. 5ml of Nitric di-chloride acid was added to the sample and covered immediately with watch glass to avoid inhaling of the evolved gas. The samples were placed in a fume cupboard until it boils and a yellow colour was observed.

The samples were withdrawn from the fume cupboard and allowed to cool for some hours. During the course of cooling, it was observed that the yellow colour changed to colourless. The heavy metal content of the digested samples was than determined using AAS-Atomic Absorption spectrophotometer [5].

G. Determination of Heavy Metals Using (AAS)

Distilled water was used to wash the watch glass into the beaker containing the digest and was diluted to 25ml before it was pipette into a plastic storage container. 1ml of the samples was pipette into an analytical container that is filled with the dilutor. Heavy metals lead (pb), cadmium (cd) and chromium (Cr) were analyzed from the samples in an AAS machine. Distilled water was used to rinse the machine before use and after each sample test, to avoid error of sample contamination. A graph of concentration against absorbent was shown before testing each metal (using the known to determine the unknown). Appropriate hallow cathode lamp for each heavy metals were fixed into AAS machine before analyzing the samples. The value for each sample was determined and recorded.

H. Determination of Conductivity

The conductivity meter was switched on and left to stand for about 30 minutes to stabilize. The electrode was rinsed with distilled water and cleaned with soft clean tissues with proper rinsing and cleaning of the electrode after testing of each sample

I. Determination of Hardness

50ml of the samples was pipette into a clean conical flask; 1ml buffer solution was added with gentle swirting of the flask. 0.25g of NaCN was added with proper mixing then 2 drops of eriochrome black 9 indictor was added and mixed thoroughly. The resulting mixture was then titrated with standardized EDTA until the last reddish tinge disappeared

J. Determination of Total Suspended Solid

The total suspended (TSS) was determined according to the method of [5]. A filter paper was weighed and later wet with distilled water. The sample was stirred homogenously to ensure low precipitation. The sample was measured accurately and poured through the filter paper. The filtering was transferred into the oven for drying at 103^0c for 24hrs. The filter paper was left to cool before being weighed.

K. Determination of Total Dissolved Solids

The dissolved solids are those that pass through a water filter. They include some organic materials, as well as salts, inorganic nutrients, and toxins. A filter paper was weighed and later wet with distilled water. The sample was stirred homogenously to ensure low precipitation. The sample was measured accurately and filtered through the filter paper into a glass beaker. The filtered water was transferred into the oven for drying at 103^0c for 24hrs. The beaker was left to cool before being weighed.

L. Determination of Total Solids

The total solids is a measure of the suspended and dissolved solids in water thus the sum of the suspended solids and suspended solids was determined as the Total solids for each of the samples.

III. Results and Discussions

The results obtained from the physicochemical analysis on the roof intercepted rain water are as presented in the Table I. The colour and taste of all the water samples analysis were satisfactory thus; there was no significant difference in the colour and taste of the water in contact with any of the roofing sheets material studied.This result shows that there were no significant organoleptic alterations of the water in contact with any of the roofing sheets materials investigated This satisfactory organoleptic result may be due to the fact that the samples were collected when rainfall was well established i.e. in the month of May. Although the fact that the organoleptic qualities are satisfactory does not necessarily guarantee the safety of water due to some other contaminants which may not impart any negative organoleptic attributes to the water. The pH values range (6.45 -7.20) obtained for the water samples indicates that all the water samples are within the standards set by NAFDAC and WHO for potable water except B_2 (6.45). The result also showed that the Adex intercepted rain water (D_{1-3}) tends towards neutral pH while that of Aluminum tends toward acidity especially B_2 (the dull type). The lower values obtained for the hardness of the water samples showed that

rain water is extremely soft with values range of 0.250mg/L-3.775mg/L expressed as calcium and magnesium content of the water. Higher values were however obtained for Adex roofing sheets except for D_2 (0.067mg/L).

Alkalinity of natural water is typically a combination of bicarbonate and hydroxide ions [6]. The alkalinity content of the rain water sample is very low thus, the bicarbonate, carbonate and hydroxide ions are also low the values obtained showed that values of sample D (0.16-0.28) is higher than that of A and B.The alkalinity content of B_1 is the lowest while that of D_2 is the highest this implies that new aluminum intercepted rain water is less alkaline while that of dull Adex is more alkaline

The high acidity values obtained (16mg/l -22mg/l) proved that rain water is highly acidic and thus can be corrosive. According to [7] Rain water is classified as soft water which means that it is acidic and therefore likely to corrode anything that is metallic.

Conductivity is a measure of the conductance of an electric current in water [7]. It is an easy measurement to make and relates closely to the total dissolved solids content of water the conductivity of all the water samples collected range from85-17μs/cm the conductivity of the sample D (D_1 and D_3) are very high followed by sample A_1 and sample B_1 which has the lowest value for conductivity. The TDS value obtained for the water sample ranged from 0.010mg/l -0.023mg/l. From the result, A_2 has the lowest TDS (0.004) which correspond to its low conductivity. Rain water sample from new and dull aluminum (type B) has the same value of TDS irrespective of their "ages" While sample D (D_2) has the lowest TDS which also corresponds to its low conductivity. The result proved that conductivity is directly proportional to TDS. The total suspended solid present in sample D_1 and D_3 are very high compared to other sample. These means there are more suspended particles in sample D than the other samples. The particles present in the sample are as a result of chemical composition in the materials made up of the Adex roofing sheet. The TSS value obtained for sample A ranges from 0.610-0660mg/l, A_2 has the lowest value of 0.610mg/l which correspond to its lowest conductivity for sample A. Sample B_1 has the lowest TSS (0.580mg/l) which correspond to its lower conductivity for sample B. Sample D_2 has the lowest TSS (0.610mg/l) which corresponds to its lowest conductivity for sample D.

The result of the heavy metals determined showed that all the rain water samples are free of cadmium contamination. It can therefore be inferred that Iron zinc, Aluminum and Adex roof do not pollute rainwater with cadmium metal

However, there is significant lead pollution in the rain water samples from all the roofing sheets studied based on NAFDAC standard highest values were obtained from Adex roof (D_1, D_2) (0.184mg/l and 0.11mg/l) respectively. The value was higher for the new type Adex roofing sheet and decrease with the dull and rusty type. The values of lead content for Iron zinc was highest for rusty type (0.134mg/l) followed by the new type (0.11mg/l).

The value of lead obtained for dull type aluminum (0.0-86mg/l) was higher than the new aluminum type (0.036mg/l) this high concentration is probably due to commencement of rusting in the dull Aluminum.

The result revealed that rain water from Aluminum roof intercepted has the lowest lead pollution compared to Iron zinc and Adex though the values of the latter are also above the maximum acceptable for NAFDAC standard, they are below the maximum of 0.1mg/l specified by WHO which makes the water acceptable for human consumption based on W.H.O standard for potable water. Lead content of rusty Iron zinc was higher than the new type which makes drinking water from rusty Iron zinc harmful. However water samples from Aluminum roofing sheet (new and dull) seems to have satisfactory lead concentration based on WHO standard.

TABLE I: PHYSICOCHEMICAL PROPERTIES AND HEAVY METAL CONTENTS OF RAIN WATER

Parameter	Sample								
	A_1	A_2	A_3	B_1	B_2	B_3	D_1	D_2	D_3
Taste	Unobjectionable	Unobjectionable	unobjectionable	unobjectionable	unobjectionable	unobjectionable	Unobjectionable	Unobjectionable	unobjectionable
Colour	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
pH value	6.75	6.65	6.50	6.60	6.45	6.70	7.10	7.20	6.95
Hardness (mg/l)	1.180	0.250	0.855	0.350	0.533.	0.425.	3.775	0.670	3.700
Acidity (mg/l)	20.0	20.0	16.0	8.0	18.0	19.0	20.0	16.0	22.0
Alkalinity (mg/l)	0.20	0.12	0.12	0.10	0.12	0.19	0.26	0.28	0.16
Conductivity (μS/cm)	38.0	19.0	36.0	17.0	21.0	22.0	81.0	24.0	85.0
TDS (mg/l)	0.014	0.004	0.010	0.006	0.006	0.006	0.023	0.009	0.022
TSS (mg/l)	0.660	0.610	0.630	0.580	0.610	0.650	0.740	0.610	0.710
Total solid (mg/l)	0.674	0.614	0.640	0.586	0.616	0.656	0.763	0.619	0.732
chromium (mg/l)	0.393	0.041	0.049	0.152	0.069	0.072	0.068	0.050	0.050
Cadmium (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead (mg/l)	0.110	0.081	0.134	0.036	0.086	0.079	0.184	0.117	0.470

{Iron Zinc}; A_1 – New A_2 – Dull A_3 – Rusty; {Aluminum} –B_1 – New B_2 - Dull B_3 - Rusty; {Adex/abestor} –D_1-New; D_2-Dull; D_3-Rusty ; ND – Not detected.

The values obtained for the chromium content of the samples from new roofing sheets showed that the chromium value of the new roofing sheets type were highest for all the roofing sheets classes studied 0.393mg/l,0.152mg/l and 0.068mg/l for Iron zinc, Aluminum and Adex class respectively and decreased gradually with the ''age'' of all the roofing sheets. Highest value of (0.393mg/l) was obtained for new Iron Zinc while the lowest (0.049mg/l) was

from the dull iron Zinc.

From the results obtained it can be confirmed that Roof intercepted rain water is therefore not adequately safe for human consumption depending on the intercepted roofing sheets especially in their lead metal concentration hence caution must be taken in drinking roof intercepted rain water without considering its physicochemical and heavy metals quality.

IV. Conclusion

It was discovered that the occurrence of cadmium poisoning may not be a problem in rain water consumption while lead and chromium could be a problem especially in any newly established (installed) roofing sheet (Iron Zinc, Aluminum, Adex).hence, The populace, particularly the people in the rural areas should be enlightened on the risk associated with consumption of roof intercepted rain water which regrettably is their major and safest source of drinking water.

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