Harvested Rainwater Quality: Roof Age and Types Perspective

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Abstract

Due to the increasing demand for good and safe drinking water, the use of water harvest to supplement the other sources of quality drinking water is on the rise. The contamination of the harvested roof water from collection to conveyance and storage is a source of concern. This research work evaluates the quality of harvested rainwater from new and aged corrugated zinc, aluminum roof, and open source. The methodology used involves a stratified sampling technique. Ten (10) samples from all categories were collected monthly for three (3) months. The physicochemical and biological properties of the harvested rain waters were analyzed. A simple percentage was used for the analysis. The results revealed that a total coliform count of 15-17 was determined which is above the WHO recommended value of 0 for safe drinking water. The findings further revealed that samples from new corrugated zinc roofs have an alkalinity of 70mg/l which is above the WHO recommended value of 50mg/l. fluoride, zinc, and aluminum concentrations are all below the WHO-recommended values. It was therefore recommended that harvested rainwater should be treated before drinking.

Keywords: Water Quality, harvested rainwater, and aged.

1.0 Introduction

Globally, about 2 Billion people lack good and safe drinking water, while about 50% of the developing world population lack access to safe and sustainable drinking water (World Health Organization, 2019). The continuous demand for safe drinking water has been characterized by population growth because the groundwater aquifers have been over-exploited (Sáncheza, Cohimb, & Kalidc, 2015). Other causes of the water shortage include frequent drought and changes in climate patterns. Groundwater has been the major source of urban water supply. The depletion of the groundwater aquifers has been fueled by climate change, man activity, and frequent drought (Chukwuma, . Nnodu, Okoye, & Chukwuma, 2014).

To meets the water demand, several other sources of water supply have been in use including recycling water, water harvest, and the use of water treatment plants that utilized water from rivers, ponds, and lake (Sáncheza, Cohimb, & Kalidc, 2015). The use of water treatment plants and recycled water requires a lot of technology and finance, coupled with losses of water supply due to leakages and the need for energy to power the water supply mechanism (OJO, 2019). This makes the system unsustainable in developing countries. Water harvest that used simple technology to collect rainwater from the roof for domestic use is gaining more attention. This is because it's a low-cost technique (Abegunrin, Sangodoyin, odeniyi, & Onufua, 2014).

Water harvest has been defined as any technology used to collect and store rainwater from the roof for domestic and agricultural uses (Texas Water Development Board , 2010). Ojo (2019) defined rainwater harvest as the technology used for the collection, conveyance, and storage of rainwater from clean roof material, land surface, and rock catchment for future use.

Even though water harvest is the cost-effective means of getting access to safe drinking water, however, contamination of the harvested water is possible through the collection, conveyance, and storage process (Texas Water Development Board , 2010). The contaminants will negatively affect the water quality. According to Osunkiyes, Olawunmi & Soyemi (2016) collected rainwater often contains organic and inorganic impurities. This contradicts the widespread belief that harvested rainwater is safe for drinking. However, the level of potential contamination depends on the general condition of the area which includes industrialization, urbanization, and the population (Sáncheza, Cohimb, & Kalidc, 2015).

The contamination might be from the environment or from the rooftop from which the water is collected. The fact that the rooftop is exposed to dust and, flying and nesting birds makes the water from this source less suitable for consumption (OJO, 2019).

The materials used for roofing purposes are also a source of concern. The roofing materials used are sources of dissolved iron, it includes galvanize iron, ceramics, metal sheets, anodized aluminum, and asbestos (Osunkiyesi, Olawunmi, Soyemi, & Okibe, 2016).

In the Damaturu metropolis, the major source of water used by the majority of the household for drinking purposes is groundwater. Currently, about 73 boreholes owned by the state government are in operational to serve a population of about 550,458 people. To supplement these rising demand, the residents of the Damaturu metropolis resort to the use of harvested rainwater during the rainy season. However, some of the roofing materials are aged. Therefore this research work is aimed to determine the chemical properties and bacteriological properties of the harvested water with regard to the age and type of the roofing materials. In this research work, roofs that are not more than 5 years are regarded as new, and roofs above five years are regarded as aged.

2.0 Methodology

The research work is conducted in Damaturu metropolis latitude 110 44' 55" N and longitude 110 57' 50" E. The study area was divided into four zones namely Maiduguri, Potiskum, Gashua, and Gujba Road. Samples were collected using stratified sampling techniques. The harvested rainwater was collected from new and aged corrugated zinc roofs, and aluminum roofs. The control samples were collected using an elevated sterilized container in an opened place. Ten samples from each category were collected monthly for 3 months. For all the samples collected first flush was first allowed for at least 5 minutes to wash the roof surface. Physico-chemical and biological properties of samples were tested. The properties tested include: total coliform count, turbidity, zinc, aluminum, chromium, silica, calcium hardness, copper, alkalinity, fluoride, and total hardness. The results obtained were compared with WHO-recommended values. A simple percentage was used in analyzing the data.

3.0 Results and Discussions

3.1 Physio-Chemical Properties

Table 3.1: Physico-Chemical Properties of the collected Rainwaters

Parameters.	WHO standard.	Water from new corrugated roofing sheets.	Water from aged corrugated roofing sheets.	Water from aged aluminum roofing sheet.	Control
Turbidity	5.0 NUT	0.96mg/l	1.52mg/l	0.63mg/l	0.46mg/l
Zinc	5.0 mg/l	0.70mg/l	0.70mg/l	0.01mg/l	0.01mg/l
Aluminum	0.2 mg/l	0.00mg/l	0.03mg/l	0.00mg/l	0.00mg/l
Chromium	0.05 mg/l	0.03mg/l	0.06mg/l	0.04mg/l	0.02mg/l
Silica	0.8 mg/l	2.15mg/l	3.20mg/l	0.02mg/l	0.00mg/l
Calcium hardness	30.0mg/l	6.0mg/l	31.0mg/l	6.0mg/l	5.0mg/l
Copper	1.0 mg/l	3.60mg/l	0.28mg/l	2.30mg/l	0.2mg/l
Alkalinity	50 mg/l	70mg/l	60mg/l	30.0mg/l	40.0mg/l
Fluoride	2.0 mg/l	0.80mg/l	0.80mg/l	0.00mg/l	0.00mg/l
Total hardness	30.0mg/l	30mg/l	20mg/l	0.00mg/l	10.0mg/l

Table 3.1 shows the chemical properties of the harvested rain waters from aged, new corrugated zinc roofing sheets, aged aluminum roofing sheets and control. The results revealed that turbidity of 1.52mg/l was obtained from harvested aged corrugated zinc roof, this is 58% higher than the water harvested from the new corrugated zinc roofing sheet, 1.4% higher than the aluminum roofing sheets and 2.3% higher than the control. However, the turbidity of all the samples collected is within the limits of WHO recommended values. Similarly, the zinc and aluminum concentrations of all the harvested samples and the control are below the WHO maximum values of 1.52mg/l and 0.2 mg/l respectively. The chromium content of 0.06mg/l

for harvested water from aged corrugated zinc roofing sheets is above the maximum value of 0.05 mg/l recommended by WHO. However, the chromium concentration of the harvested samples for new corrugated zinc and aged aluminum roofing sheets is below the WHO maximum value. The silica concentration of 2.15mg/l and 3.20mg/l for new and aged corrugated zinc roofing sheets was obtained as against the 0.02mg/l and 0.00mg/l obtained for aged aluminum roofing sheets and the control. New and aged corrugated roofing sheets have silica concentrations higher than the WHO maximum value of 0.8 mg/l.

Fluoride concentrations and total hardness of all the samples collected are below the maximum value specified by WHO of 2.0 mg/l and 30.0mg/l respectively. However, the alkalinity of 70mg/l and 60mg/l for samples collected from new and aged corrugated zinc roofing sheets were observed, these values are above the 50mg/l maximum value specified by WHO. The alkalinity of the control sample and sample from the aged aluminum sheet is below the maximum WHO value, this is in conformity with findings by Osei, Fredrick, & Nathaniel (2011). Samples collected from aged corrugated roofing sheets have a calcium hardness of 4% higher than the WHO recommended maximum value.

3.2 Biological Properties

A total coliform count (TCC) value of 0 cfu/ml for the control sample was observed against 15, 16, and 17 cfu/ml of new, aged galvanized roofing sheet and aged aluminum roofing sheet samples respectively. The results corroborate the findings by Abegunrin, Sangodoyin, odeniyi and Onufua (2014). The results further revealed that the contamination in the harvested rainwater was due to the nesting bird and other animals (rodents and bats) that defecate on the roofs, coupled with rotten leaves. The WHO recommended coliform value is 0 cfu/ml, which conformed with the value obtained for the control. The samples have a total coliform count range of 15-17, which made the harvested water potable but not safe for drinking. The findings further indicated that the harvested water requires treatments for biological contaminants before it will be safe for consumption.

4.0 Conclusions

From the outcome of this research work, it could be concluded that:

1. The turbidity is higher in a water samples collected from aged corrugated roofs than new corrugated roofs and aged aluminum roofing roofs.
2. Zinc and aluminum concentrations of all the sample tested were below the WHO maximum recommended value.
3. Fluoride concentration and total hardness are below the values specified by WHO
4. Samples from new and aged corrugated roofs have alkalinity above the WHO maximum recommended value.
5. The samples have a total coliform count greater than zero, this makes the harvested water not suitable for drinking without treatment.

It is therefore recommended that:

1. Boiling and the first flush should be adopted as a way of treating the water before consumption
2. Safe collection techniques for water storage should be employed to reduce contamination
3. A sensitization campaigns on the need for hygienic water storage should be encouraged.
4. Treatment of harvested rainwater before use is recommended.

References

Abegunrin, T., Sangodoyin, A., odeniyi, J., & Onufua, A. (2014). Roog Age Effect on the Quality of Harvested Rainwater and its Health Implication in Selected Locations, Southwest Nigeria. *International Journals of Water Resources and Environmental Engineering*, 261-266.

Chukwuma, J. N., . Nnodu, V. C., Okoye, A. C., & Chukwuma, E. C. (2014). Assessment of Roof Harvested Rainwater in Parts of Anambra State for Environmental Pollution Monitoring. *British Biotechnology Journal*, 1105-1114.

OJO, O. (2019). Effects of Roofing Materials on Harvested Rain Water Quality. *Journal of applied science, Environment and Management*, *23*(4), 735-738.

Osei, A., Fredrick, A., & B., N. O. (2011). Physicochemical Analysis of Roof Runoffs from the Obuasi Area. *Water Practice & Technology*.

Osunkiyesi, A. A., Olawunmi, M., Soyemi, O., & Okibe, O. (2016). Effects of Materials and The Age of Roofing Sheets on The Quality of Harvested Rainwater in Totoro Abeokuta, Ogun State Nigeria. *Journal of Applied Chemistry*, 64-69.

Sáncheza, A., Cohimb, E., & Kalidc, R. (2015). A review on physicochemical and microbiological contamination of roof-harvested rainwater in urban areas. *Sustainability of Water Quality and Ecology*.

Texas Water Development Board. (2010). *Effect of Roof Material on Water Quality for Rainwater Harvesting Systems.* Texas: Texas Water Development Board.

World Health Organization. (2005). *Guidelines for drinking-water quality. 4th ed.* Geneva, Switzerland: Who Press.

World Health Organization. (2019). *Drinking-Water*. United state of America: WHO Press.