**EFFECT OF RUSTED ROOFING SHEETS ON HARVASTEDTED RAINWATER IN JALINGO METROPOLIS**

**Abstract**

*This study examines the impact of rusted roofing sheets on the quality of harvested rainwater, addressing its chemical composition, microbial contamination, and potential health risks. Rainwater harvesting is a crucial water source in many regions, but contamination from rusted metal roofs can compromise its safety. Furthermore, the study provides an introduction to the research, highlighting the problem statement and the significance of understanding how rust affects rainwater quality. The study aims to analyze chemical leaching from rusted roofs, assess microbial contamination, and compare water from rusted and non-rusted surfaces. The study highlights key studies on the effects of iron, lead, and microbial contaminants leaching from corroded metal sheets, and regulatory standards by WHO and NSDWQ. Water samples were collected from Jalingo, Nigeria, focusing on free-fall rainwater and water in contact with rusted roofs. Various analytical techniques were used, including pH measurement, turbidity assessment, heavy metal spectrophotometry, and microbial culture analysis. Findings indicate elevated levels of iron and lead in roof-contacted rainwater, exceeding WHO and NSDWQ standards. Microbial contamination was significantly higher in water collected from rusted roofing sheets, raising concerns about public health risks. Therefore, rusted roofing sheets negatively affect rainwater quality, emphasizing the need for proper filtration and treatment before consumption. Recommendations include using corrosion-resistant roofing materials, regular roof maintenance, and public awareness programs to mitigate health hazards.*

***Keywords****: Rainwater Harvesting, Rusted Roofing Sheets, Water Quality, Heavy Metal Contamination, Microbial Analysis.*

**1.0 Introduction**

Rainwater harvesting is an ancient practice that involves collecting and storing rainwater for future use [1]. This sustainable method of water collection is crucial in areas facing water scarcity, providing an alternative source of water that can be used for various purposes, including drinking, irrigation, and household activities [2]. The importance of rainwater harvesting lies in its numerous benefits, which include water conservation [3]. It helps reduce the demand on conventional water supply systems, conserving groundwater and surface water [4], cost-effectiveness: Rainwater harvesting can reduce water bills and the need for expensive water infrastructure [5], flood control: Minimizes runoff and reduces the risk of floods by capturing rainwater [6], environmental benefits: Lessens soil erosion and the impact on rivers and streams by reducing runoff [7], water quality: Provides a relatively clean source of water, particularly in areas with limited access to potable water [8].

However, the introduction of rust and associated contaminants from rusted roofing materials can create an environment that is conducive to the growth and proliferation of microorganisms, including potential pathogens [9]. This can pose significant health risks if the collected rainwater is used for drinking, cooking, or other domestic purposes without proper treatment [10]. Studies have shown that rusty roofing sheets can increase the concentration of dissolved iron and manganese in rainwater, exceeding recommended limits for drinking water quality [11]. Furthermore, the presence of zinc and lead, leached from rusted surfaces, poses additional health risks if consumed regularly over time [12]. Apart from chemical contaminants, rusted roofing sheets can harbor microbial growth, including bacteria and fungi, which thrive in moist and oxidizing environments [13]. These microorganisms can further degrade water quality, potentially leading to gastrointestinal illnesses and other health concerns among consumers relying on harvested rainwater for drinking and cooking [14].

Therefore, it is crucial to consider the potential risks associated with rainwater harvesting from rusted roofing materials and implement appropriate treatment methods to ensure the safety and quality of the collected rainwater before its use for domestic purposes [15].

**2.0 Materials and Methods**

**2.1 Study Area**

The research was conducted in Kasuwan Bera ATC Jalingo, the capital of Taraba State, Nigeria, located between latitude 8°53'N and longitude 11°22'E. Jalingo experiences a tropical climate, characterized by high rainfall between May and October, making rainwater harvesting a common practice in the area. The reliance on rainwater, particularly during the rainy season, underscores the importance of assessing its quality for domestic and drinking purposes. The TAWASCO Central Laboratory served as the primary facility for testing.

**2.2 Sample Collection**

Two types of Rainwater samples were collected and analyzed:

No contact with roof rainwater: Collected directly into sterile containers without contacting any surface. Roof-contact rainwater: Collected after passing over rusted roofing sheets into sterile containers. The catchment area (roof surface) was clean prior to a significant rain event to remove loose debris and dust. The first flush diverter was ensured to be functioning properly to discard the initial runoff, which typically contains higher levels of contaminants [16].

**2.3 Control Samples**

**2.3.1 No-rusted Roofing Materials**

Rainwater was collected from systems with non-rusted roofing materials to serve as control samples. This helped in comparing the levels of contamination from rusted and non-rusted roofs.

**2.3.2 Environmental Controls**

Rainwater was collected directly from the atmosphere using clean, open containers placed away from any potential sources of contamination to provide baseline data on atmospheric deposition.

**2.4 Physical Tests**

**2.4.1 pH Measurement**

The pH, which indicates the acidity or alkalinity of water, was measured using a digitalpH meter (Hanna Instruments HI 98129). A pH range between 6.5 to 8.5 is considered acceptable according to the Nigerian Standard for Drinking Water Quality (NSDWQ).

**2.4.2 Turbidity**

Turbidity, indicating the clarity of water, was determined using a nephelometric turbidity meter (Hach 2100N).

**2.4.3 Temperature**

Temperature was recorded using a digitalthermometer at the point of collection to assess its influence on chemical and biological parameters

**2.5 Chemical Tests**

**2.5.1 Total Dissolved Solids (TDS)**

TDS, which reflects the concentration of dissolved inorganic and organic substances, was measured using an electrometric method with a TDS meter.

**2.5.2 Electrical Conductivity (EC)**

EC was measured to assess the water's ionic content using a conductivity meter. The acceptable limit is 1,000 µS/cm.

**2.5.3 Iron and Zinc**

Iron content was measured using the Ferro Ver method, while zinc was quantified using the Zincon method. Both were analyzed using a UV-Vis spectrophotometer (Hach DR 6000).

**2.5.4 Lead**

Lead was analyzed using the PAR (4-(2-pyridylazo) resorcinol) spectrophotometric method due to its toxicity.

**2.5.5 Potassium, Magnesium, Calcium, Sodium**

These metals were quantified using Atomic Absorption Spectrophotometry(AAS). Their permissible levels were compared to NSDWQ standards.

**2.5.6 Color**

Water color was evaluated spectrophotometrically. Significant color changes indicate possible contamination from metals or organic compounds.

**2.6 Microbiological Tests**

**2.6.1 Total Bacterial Load**

The membrane filtration method was used to determine the bacterial load. This method involves filtering a measured volume of water through a membrane and incubating it on nutrient agar to count colony-forming units (CFUs).

**2.6.2 Residual Chlorine**

Chlorine residual was tested using the DPD (N,N-diethyl-p-phenylenediamine) method to ensure adequate disinfection.

**3.0 Results and Discussion**

**Table 1. Result of physio-chemical and bacteriological analysis of rain water**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameters** | **Method** |  | |  |
| **No contact with roof** | **Contact with roof** | **Maximum permissible limit (NSDWQ)** |
| pH | pH meter | 6.89 | 7.62 | 6.5-8.5 |
| Temperature (0C) | Thermometer | 26.4 | 26.7 | Ambient |
| Turbidity (NTU) | Nephelometric | 3.5 | 2.64 | 5 |
| T.D.S (mg/L) | Electrometric | 8.8 | 9.0 | 500 |
| E. conductivity (µS/cm) | Electrometric | 12.7 | 38.5 | 1000 |
| Iron (mg/L) | Ferro Ver | 2.10 | 3.16 | 0.3 |
| Zinc (mg/L) | Zincon | 0.00 | 0.18 | 3 |
| Copper (mg/L) | Cuprizone | 0.0 | 0.0 | 0.05 |
| Lead (mg/L) | PAR | 0.0 | 3.0 | 0.01 |
| Potassium | Spectrometry | 0.06 | 0.13 | 10 |
| Magnesium | Spectrometry | 0.13 | 0.31 | 30 |
| Calcium | Spectrometry | 1.62 | 4.48 | 100 |
| Sodium | Spectrometry | 0.17 | 0.34 | 200 |
| Color | Spectrometry | 0 | 3 | 15 |
| Total Bacteria Load | Membrane | 13 | 20 | 10 |
| Chlorine | DPD | 0.0 | 0.0 | 0.2-0.25 |

The pH values for no contact with roof and roof-contact water samples were 6.89 and 7.62, respectively, falling within the acceptable NSDWQ range of 6.5–8.5.The slight increase in pH for roof-contact water indicates a basic shift, possibly due to leaching of metal ions like zinc and iron from the rusted surfaces.The measured temperatures were 26.4°C (no contact with roof) and 26.7°C (roof contact), reflecting typical ambient conditions. Temperature variations had minimal impact on water quality.

Turbidity levels were 3.5 NTU (no contact with roof) and 2.64 NTU (roof contact), both below the maximum permitted limit of 5 NTU.The lower turbidity in roof-contact water might indicate reduced suspended particulates, potentially due to metal deposits acting as flocculants.

TDS levels were 8.8 mg/L (no contact with roof) and 9.0 mg/L (roof contact), significantly below the NSDWQ limit of 500 mg/L.Minimal TDS levels suggest limited dissolution of solids from the rusted roofs.

EC values were 12.7 µS/cm (no contact with roof) and 38.5 µS/cm (roof contact), within the permissible range of 1,000 µS/cm.The increase in EC for roof-contact water suggests the introduction of ionic species such as iron and lead.

Iron concentrations were 2.10 mg/L (no contact with roof) and 3.16 mg/L (roof contact), both exceeding the permissible limit of 0.3 mg/L.

Elevated iron levels in roof-contact samples are attributed to rust leaching, posing risks of staining and metallic taste.

Zinc was detected at 0.18 mg/L (no contact with roof) and 0.00 mg/L (free fall), while copper was absent in both samples, below the respective NSDWQ limits of 3 mg/L and 0.05 mg/L.

Lead levels were 0.0 mg/L (no contact with roof) and 3.0 mg/L (roof contact), far exceeding the permissible limit of 0.01 mg/L.

This result indicates severe contamination from lead, which is highly toxic and poses significant health risks.

All values for the metals (Potassium, Magnesium, Calcium, Sodium) were within permissible limits, with roof-contact water showing slightly elevated levels compared to free-fall samples.

Roof-contact water exhibited 3 units, while free-fall samples were colorless (0 units). The NSDWQ limit is 15 units.

Total bacterial counts were 13 CFU/mL (no contact with roof) and 20 CFU/mL (roof contact), exceeding the NSDWQ limit of 10 CFU/mL.Elevated bacterial loads in roof-contact water highlight contamination risks from environmental exposure and biofilm on rusted surfaces.

No chlorine was detected in either sample, falling short of the recommended range of 0.2–0.25 mg/L.Absence of residual chlorine indicates a lack of disinfection, necessitating treatment before consumption.

**4.0 Conclusion**

The study reveals that rusted roofing sheets significantly impact the quality of harvested rainwater. Key findings include: Elevated iron and lead levels in roof-contact water, posing health risks such as organ damage and neurological disorders. Increased bacterial load, which may lead to gastrointestinal infections if consumed untreated. Although pH, turbidity, and other parameters mostly meet NSDWQ standards, the high levels of toxic metals and bacteria render roof-contact water unsuitable for direct consumption.

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