Vol. 6 No. 3, November (2023)
JOURNAL OF ENVIRONMENTAL AND TOURISM EDUCATION
ISSN: 2659-0794 (PRINT) ISSN:2659-0808(ONLINE)
Content Available at: **https://jeate.net/index.php/Jete/issue/archive**

Physiochemical Properties of Well Water In Some Residential Areas Close To Auto-Mechanic Facilities In Bauchi Local Government Area, Bauchi State, Nigeria

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Keywords
Residential areas, well water, water quality, auto-mechanic and physiochemical properties.

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Received: 31/10/23
Revised: 1/11/23
Accepted: 1/11/23
Published: 24/11/23

Abstract

One of the most indispensable resources in the world is water for both animal and plant lives' existence. The aim of this research is to ascertain the physiochemical properties of water samples collected from residential areas near auto-mechanic workshops located within Bauchi Local Government area, in Bauchi State. The physiochemical parameters of temperature, pH, electrical conductivity, color, total dissolved solids and turbidity were accessed using well water samples randomly selected from residential areas near auto-mechanic workshops. The workshop clusters are located at NTA along Turum road, Gombe road, opposite FGGC, Dass park, along Dass road, Nasarawa Jahum. Three well samples were used for each location, making 12 well water samples. The result of the study shows pH range (6.02 to 7.12), colour (0.0 to 12.0pt-Co), electrical conductivity (EC) (503 to 918µS/cm), turbidity (0.0 to 2.01NTU), total dissolved solids (TDS) (240 to 460mg/l), respectively. The pH values of most of the water samples is below the World Health Organization WHO (2011) and the Nigerian Standard for Drinking Water Quality (NSDWQ 2007) which makes them unfit for drinking. TDS and EC were also on the high side even though they are within the recommended limits.

Introduction

Groundwater places a dominant role in sustaining life and economic activities on earth and should therefore be protected. It is the source of drinking water to approximately 2.2 billion people all over the world and to over 90% of the population in Nigeria (Ajibade, 2011; Andrade

et al., 2018). It is therefore imperative that water meant for drinking and other domestic purposes must not fall short of both local and international laid down standards to avoid serious health risk to consumers as a result of water borne diseases (Nwankwoala and Nwagbogwu, 2012).

Artisans' activities within automobile mechanic workshops have been reported as major sources of environmental contamination in the Nigerian ecosystem. Activities conducted in these workshops involves the indiscriminate spilling of wastes such as spent oils, greases, petrol, diesel, battery electrolyte, paints and other materials which contain heavy metals and other pollutants unto bare soil (Demie, 2015; Okeke et al., 2017; Nkanu et al., 2020; Soni and Amarnath, 2021). Unfortunate these wastes end up polluting productive soils, natural water system as well as ground water.

Many of these mechanic workshops are located within residential areas, where individuals without adequate sources of portable drinking water could dig wells or even sink boreholes to access water for different purposes. In most cases, artisans also dig wells as sources of water within their workshops. The quality of the groundwater within these facilities may be compromised and the safety of its consumers is therefore not guaranteed. Studies have shown that the levels of pollution in auto-mechanic facilities are very high, resulting in heavy metal contamination of well water around these workshops (Adelekan and Abegunde, 2011; Usman et al., 2014; Sadick *et al*., 2015). According to Usman et al. (2014), major sources of well pollution include proximity of wells to drainages of sewages, refuse dumps, small scale industries and mechanic villages.

Pollution of groundwater is an impairment of water quality by chemicals, heat or bacteria to a degree that does not necessarily create public health hazards, but does adversely affect such water for domestic, farm, municipal or industrial use (Muasa *et al*., 2013). Studies carried out in different parts of Nigeria have revealed that various sources of drinking water have been contaminated at varying scales by human activities (Adewoyin *et al*., 2013; Popoola and Ayodele, 2016). Abundance of organic compounds and toxic chemicals find their way into potable water and may cause adverse effects, such as cancer, chronic illness and malfunction of the human body (Federal Government of Nigeria, 2000). In 1997, the World Health organization (WHO) reported that 40 % of deaths in developing nations occur due to infections from water related diseases. Diseases contacted through drinking water kill about 5 million children annually. Also an estimated 500 million cases of diarrhoea occur every year in children below 5 years in parts of Asia, Africa and Latin America (WHO, 2004a, 2004b, 2004c, and 2011).

Physiochemical properties of Water

To determine the physio-chemical properties of water, several parameters are to be examined. These include electrical conductivity, pH, color, turbidity and total dissolved solids (WHO, 2011). In this study the following parameters was assessed, they include; the temperature, pH, electrical conductivity, color, total dissolved solids and turbidity.

Temperature

Temperature affects the usefulness of water for many purposes. Generally, users prefer water of uniformly low temperature. Temperature of ground water tends to increase with increasing depth to the aquifer (USEPA, 1996). Temperature at which samples are collected and at which physico-chemical measurement are made is important for data correlation and interpretation purposes (Ogunfowokan *et al*., 2007). An increase in any solutions' temperature will cause a decrease in its viscosity and an increase in the mobility of its ions in solution, resulting in an increase in the number of ions in solution due to the dissociation of molecules (John *et al*., 2006). High temperature may therefore increase the toxicity of many substances such as heavy metals in water for domestic use (Fatoki and Awofolu, 2003).

Electrical Conductivity (Ec) and Total Dissolved Solid (Tds)

Electrical conductivity measures the ability of water to conduct an electric current and varies with temperature. It therefore gives a relative measure of the amount of ions present in groundwater, since the quantity of current conducted by a ground water sample is directly proportional to its ionic concentration, and degree of ionization of dissolved constituents. Thus the higher the dissolved material in a water sample, the higher the EC in the sample investigated (Ohio EPA, 2012). Based on this relationship, total dissolved solid concentrations may be calculated from EC data available (Hem, 1992; Walton, 1989; Anna, 2018). High readings may indicate contamination, especially if the readings are elevated compared to background. TDS may indicate the salinity behavior of groundwater. While, water with extremely low concentrations of TDS may also be unacceptable to consumers because of its flat and insipid taste, excessive TDS in water imparts a bad taste in the water due to mineralization of various salts, thus affecting the quality of water. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500 mg/L is also allowed (Murhekar, 2011)

pH

pH is a measure of the effective concentration (or activity) of hydrogen ions and is expressed as the negative base-10 logarithm of the hydrogen ion activity in moles per liter. Uncontaminated ground water typically exhibits a pH ranging from 5 to 9 (Ohio EPA, 2003 and 2012). pH measurements are important for the interpretation of ground water quality data, as it indicates the relative solubility of metals and speciation of many other chemicals (Puls and Barcelona, 1996; Garner, 1988). pH measurements reflect chemical reactions that produce or consume hydrogen ions (Hem, 1992), and therefore, changes in pH from background samples may indicate the presence of ground water contamination or that existing contamination has spread.

The solubility of these metals in soils and groundwater is largely controlled by pH (Massod *et al*., 2009; Murhekar, 2011). pH of 7.0 indicates a neutral solution, pH values smaller than 7.0 indicate acidity, water with pH values larger than 7.0 indicate alkalinity and tends to affect the taste of the water. Water generally becomes more corrosive with decreasing pH; however, excessively alkaline water also may be corrosive. (USEPA, 1994a). Testing for the pH of well water is crucial for evaluating the potential for the water to contain leached metals such as copper, lead, iron, cadmium, and zinc (John *et al*., 2006).

Turbidity

Turbidity is due to the presence of colloidal particles and extremely fine dispersions arising from clay and silt during rainfall, or from discharges of sewage and industrial waste. It is a physical characteristic of water and an expression of the optical properties that causes light to be scattered and absorbed by particles and molecules rather than transmitted in straight lines through a water sample. It is a test used to indicate the quality of waste discharge with respect to colloidal matter (Murhekar 2011; Ezeribe *et al*., 2012; Esan *et al*., 2015). Ground water samples collected from monitoring wells may contain noticeable amounts of sediment. This sample "turbidity" is an important field concern for samples to be analyzed for metals (e.g., cadmium, nickel, zinc) or metalloids such as arsenic, selenium (Ohio EPA, 2012).

Materials and Methods

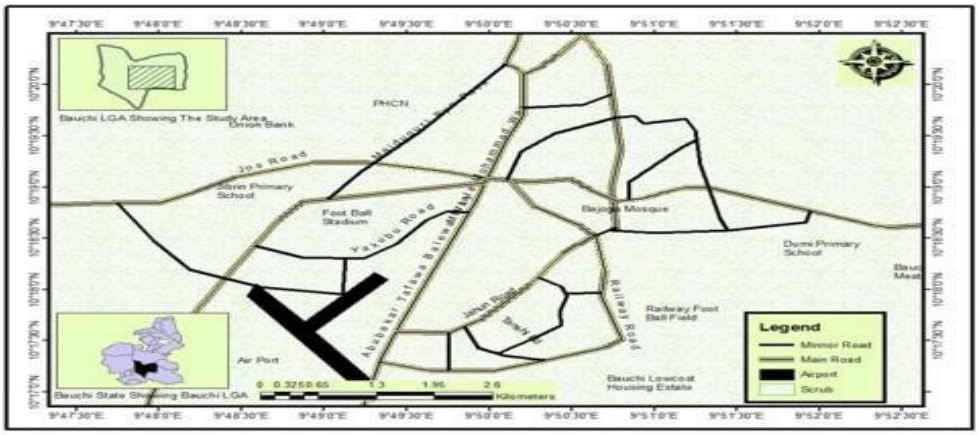
Instruments

The temperature of each sample will be measured and recorded using a thermometer calibrated in degree Celsius. The pH of the sample will be determined using pH meter, after calibrating with standard buffer solutions (10 and 4). Electrical conductivity and total dissolved solid of the samples will be measured with an EC/TDS meter calibrated to a 1413 μScm^{-1} calibration standard at 25°C while the turbidity of the samples will be determined using the turbidity meter (Khan *et al*., 2010).

Sampling sites

Three partially protected shallow wells in each of the four communities around mechanic workshop clusters will be assessed in order to ascertain the physio-chemical properties of the well water. The workshop clusters are located at NTA along Turum road, Gombe road, opposite FGGC, Dass park, along Dass road, Nasarawa Jahum within Bauchi Local Government of Bauchi State.

Figure 1 showing site location



Pre-treatment and Sterilization of Apparatus

Prior to sampling, all glassware and sample bottles will be washed with liquid detergents, rinsed with tap water and soaked in 10% HNO_3 for 48 hours. They will thereafter be rinsed with distilled water to preclude trace metal contaminations, before oven drying. The plastic

bottles meant for sampling will further be rinsed thrice on site with well waters being sampled **(**Ogunfowokan *et al*., 2013; Usman *et al*., 2013).

Samples collection

The composite water sampling method will be used in collection of sample in each sampling sites and water samples drawn with a plastic bucket. A 2 litre wide mouth polyethylene container thoroughly cleaned will be used to collect about 2 L well water sample for physical and chemical parameters determination from each sampling location within three months. Samples collected will be adjusted to pH 2 to prevent further microbial degradation and stored below 4^0C in a refrigerator before analysis (Ogunfowokan *et al*., 2013). Control samples will similarly be collected from wells, 200 meter away from the sample sites.

Results and Discussion

Physiochemical properties of well water in residential areas near automobile workshops

Well	pH	Colour	Temp	TDS	Turbidity	EC
Turum R1	6.80	0.00	27.7	332	0.50	705
Turum R2	6.78	0.30	27.6	310	0.62	712
Turum R3	6.67	0.00	27.3	305	2.01	715
Gombe R1	6.50	0.00	27.9	300	0.00	630
Gombe R2	6.31	00.0	27.8	340	0.00	645
Gombe R3	6.60	0.00	28.2	327	0.00	714
Dass P1	6.32	4.00	26.6	401	0.37	820
Dass P2	6.23	3.00	26.5	384	0.59	766
Dass P3	6.02	0.00	27.3	419	0.07	840
Nasarawa1	7.01	12.0	29.0	460	0.72	834
Nasarawa2	6.70	0.00	28.7	240	0.50	503
Nasarawa3	7.12	5.00	28.5	403	1.01	918
Mean	6.59	2.03	27.8	352	0.53	734
NSDWQ	6.5 – 8.5	15.00	27 – 29	500	5.00	1000

The result of the physicochemical properties of each auto-mechanic workshops well water samples collected from at NTA along Turum road, Gombe road, opposite FGGC, Dass park, along Dass road, Nasarawa Jahum. That is, three samples each, from three auto-mechanic workshops each, from Bauchi Local Government areas. The World Health Organization WHO (2011) and the Nigerian Standard for Drinking Water Quality (NSDWQ 2007) was used as the baseline to compare the water quality from the different sources.

pH:

The pH values of the water samples recorded varied between 6.02 and 7.01 with sample from Dass park 3 and Nassarawa 3 haviving the lowest and highest pH values, respectively. Which most were below the maximum permissible limit of 6.5-8.5 set by World Health Organization and the Nigerian Standard for Drinking water quality. The result for pH in this study concurs with the findings of Adediji, Adesina, Adenji and Chikezie, (2020) in their study titled "Open Shallow Wells Water Qualities Located Around Auto-mechanic Workshops in Some Ilorin

Metropolitan". In which the study revealed that pH values of Open Shallow Wells Water Qualities Located Around Auto-mechanic Workshops samples were very low.

Electrical Conductivity: In this study the conductivity value ranges between 503 – 918 ϑS/cm, with Nassarawa 2 having the lowest score and Nassarawa 3 having the highest value, which falls within the maximum permissible limit of 1000 ϑS/cm set by World Health Organization and Nigerian Standard for Drinking Water Quality. Even though the values are within the standard, they are at the high limits close to the maximum level with an average value of 734.

TDS: In this study the TDS value for all the well water samples ranges between 240-460mg/l, with Nassarawa 2 and Nassarawa 1 having the lowest and highest values respectively, which falls within the maximum permissible limit of 500mg/l set by WHO (2011) and NSDWQ (2007). This result is similar to that of the electrical conductivity. The values even though within the acceptable limits but within the high limits with an average value of 352.

Turbidity: In this study, the turbidity value for all the water samples ranges between 0.00-2.01 NTU, with sample from Dass park having the lowest value while that of Turum road have the highest value. With an average value of 0.53 the turbidity is very low compared to the maximum permissible limit of 500 NTU set by WHO (2011) and NSDWQ (2007). The result of turbidity in this study varies from the findings of Adediji, Adesina, Adenji and Chikezie, (2020) in their study titled "Open Shallow Wells Water Qualities Located Around Auto-mechanic Workshops in Some Ilorin Metropolitan". In which the study revealed that turbudity values varies between those at the higher and lower limits.

Temperature: Cool water is generally more palatable, very low temperature decrease the efficiency of treatment process such as disinfections. Although high temperature enhances the growth of micro-organism taste, colour, odour and corrosion problem may be increased. From the analysis result, all temperature value were within the limit of temperature of Bauchi State within the month of August to October when the study was carried out.

Colour: The colours from the wells are far below limits with the exception of few isolated cases, which were high but still falls within the W.H.O limit level for drinking water.

Conclusion and Recommendation

The results of the water samples above showed that some of the parameters, for example; electrical conductivity, Total Dissolved Solid, temperature, colour and temperature were within the maximum permissible limits WHO and NSDWQ recommended standards. However the pH in most cases was below the permissible limit as recommended by WHO and NSDWQ, which suggest the affected water is acidic and unfit for drinking. High values of electrical conductivity and Total Dissolved Solid, close to the maximum limit as recommended by WHO and NSDWQ suggest need for further studies to determine the nature of dissolved solids in the affected water.

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This work is sponsored by
Tertiary Education Fund (TETfund).
Internally based research (IBR)