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# QUALITY ASSESSMENT OF GROUNDWATER FROM HADEJIA LOCAL GOVERNMENT AREA OF JIGAWA STATE, NIGERIA

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***ABSTRACT***
***The physicochemical and trace metal levels of groundwater (borehole) from Hadejia Local Government Area of Jigawa State used for drinking and other domestic purposes were analyzed to assess its equality. A total of 20 sampling points were selected for the study, the groundwater samples were collected and analyzed for physicochemical and trace metals values. Levels of various physicochemical parameters which include Temperature, pH, Electrical conductivity(EC), Total Dissolved Solids(TDS), Total Hardness, Magnesium, and Calcium were determined using standard analytical methods. The concentration of $NO_3^-$, $Cl^-$, Fe, Cu, Zn, Mn, Cr, and Pb were determined spectrophotometrically using CHEMetrics Model V-2000spectrophotometer which is pre-programmed to measure 30 analytes automatically, using CHEMetrics Vacu-Visuals self-filling ampoules. The results showed that concentration of Mn, Cr, and Pb are found to be slightly higher above the maximum permissible limit of Nigerian Standard for Drinking Water Quality 0.2, 0.5 and 0.01mg/L respectively, while Fe, Cu, and Zn concentration are below or within the permissible limit of 0.3, 1.0, and 3.0 mg/L respectively set by NSDWQ in majority of the boreholes. The values for physicochemical variables EC, pH, Temperature, TDS, Total Hardness, Ca, Mg, $Cl^-$, and $NO_3^-$ were found to be below or within the permissible limit set by the NSDWQ. Thus, it is concluded that the current status of the water in most of the boreholes considered for this study is fit as a source of drinking for the community; it is recommended that those boreholes with higher level of Mn, Cr, and Pb should be closed and new ones constructed to enhance good drinking water delivery to the community.***
***Keywords: Groundwater, Hadejia, Physicochemical Parameters.***

## INTRODUCTION

The quality of groundwater is very serious concern today. The World Health Organization reports that 80% of diseases are waterborne. The percentage mostly lies in the developing and underdeveloped nations. Hence for safe drinking water a regular assessment and monitoring of water resources is required. Water contamination and its sustainable management need our attention because of far reaching impact on human health.

UNESCO (2003) estimates that globally, groundwater provides about 50% of current potable water supplies, 40% of the demand of self-supplied industry and 20% of water use in irrigated agriculture. Over much of Africa, groundwater is the most realistic water supply option for meeting water demand. However, increasing demand and withdrawal, significant changes in land use pattern, vast industrial and agricultural effluents entering the hydrological cycle as well as seasonal variations, affect the quality and quantity of groundwater (Idoko, 2010). The determination of groundwater quality for human consumption is important for the wellbeing of the ever increasing population. Groundwater quality depends, to some extent, on its chemical composition (Idoko and Oklo, 2007); Wadie and Abdulalil, 2010) which may be affected by natural and anthropogenic factors. Changes in groundwater recharge, due to seasonal variation, also affect the concentration of water parameters.

Regular drinking water monitoring is essential for supplying people with a high quality and healthy water meeting all requirements of legal regulations. According to Asanye *et al*. (2007), availability of safe and reliable source of water is an essential prerequisite for sustained development. Due to the lack of guidelines governing groundwater exploitation being not properly enforce in Nigeria (Eduvie *et al*., 2003), and inadequate and inefficient tap pipe borne water supply has resulted to construction of boreholes that have close proximity to pit latrines, household trash, gutters and therefore prone to storm water.

This study is aimed at analyzing the physicochemical parameters and trace metals levels in groundwater samples (borehole) from twenty sampling locations in Hadejia L.G.A. of Jigawa State to examine the effect of seasonal variation in quality and to compare with the standards for drinking water of Nigerian Standard for Drinking Water Quality (NSDWQ, 2007); World Health Organization (WHO, 2011).

## MATERIALS AND METHODS

**Study Area:** Hadejia Local Government lies on the northern- bank of the River Hadejia which drained into Lake Chad, it lies in the north eastern corner of Jigawa State latitude $12^0$ $13^l$ – $13^060^l$N and longitude $9^022^l$ – $11^000$E.

The area is underlain by rock and younger sediments of the Chad formation. The climate of the area is semi-arid. It is characterized by a long dry season and a short wet season from June to September. The average annual temperature is 27.2$^oC$, while the total annual rainfall ranges from 600mm to 762mm, the regional vegetation falls within the Sudan Savannah type with extensive open grassland with few scattered trees (Abubakar, 2009).

**Sample Collection and Analysis**

Groundwater samples for the analysis were collected from 20 different sites monthly in June, July, and August 2013 during the wet season. All the samples were collected and treated in accordance with the APHA, 2005; ASTM, 2004. The borehole were allowed to flow for about 3 minutes before the water is collected, and the containers were thoroughly washed and rinsed with the water to the collected.

Parameters such as Temperature, pH, Electrical conductivity, Total Hardness, Ca, Mg were determined using standard methods for the examination of water samples quality (ASTM, 2004). Temperature, pH, Electrical conductivity and Total Dissolved Solids were measured using Hanna pH 210 model microprocessor , EQ-660 digital conductivity meter and Hatch446600 model TDS meter respectively. Total Hardness, Ca, Mg were determined using titrimetric method. $NO_3^-$, $Cl^-$, Fe, Cu, Zn, Mn, Cr and Pb were determined using CHEMetrics Vacu-Visual self filling ampoules water testing kits with CHEMetrics photometric multi element analyzer modelV-2000. The samples were chemically analyzed at the Centre for Energy, Research and Training, ABU Zaria.

**RESULTS AND DISCUSSION**

The statistical summary of the chemical parameters are presented in Table 1 above. The pH values obtained were in the range of 6.12 and 7.97, with Kasgayama having the least pH values of 6.12 while Matsaro gives the highest values of 7.90. It was observed that pH values for the groundwater is slightly higher, this is because groundwater recharge occurs during the wet season due to continues rainfall and deep percolation, increased dilution occurs yielding the acceptable pH during the wet season (Akpan, 1993). The values generally were found to be within the recommended range for WHO (2011) and NSDWQ (2007). Abnormally low pHs are not common in Nigeria, but where observed to occur it may cause it may causes accelerated corrosion of the various metal medium which the water may be stored for future use (Musa and Ahanonu, 2013). The result shows temperature range between 26.90$^oC$ and 27.60$^oC$. The temperature values of all the water samples are within the WHO (2011) and NSDWQ (2007) prescribe acceptable limit for drinking water, this is not unconnected with the ambient environment of the boreholes. The Electrical Conductivity values ranges between 163-1706 µs/cm, Oliya had the least values of 163 µs/cm, while Dikila had the highest value of 1706 µs/cm. Total Hardness values ranges between 112- 553mg/L. similarly concentration of Ca and Mg ranged between 22.0 mg/L – 136.0 mg/L and 19.0 – 76.0 mg/L respectively. The higher value of Electrical conductivity, Total hardness is obvious because of the solvent action on the rain water coming in contact with soil and rock is capable of dissolving Ca, Mg and other ions the promote EC and hardness. Majority of the boreholes had total hardness values above WHO (2011) and NSDWQ (2007) permissible limit, this may be traced to the local environment of the water points in term of geology, soil and land use activities.

From the result, TDS ranged between 98-799 mg/L, similarly Dala having the least value of 98mg/L while Gagulmari had the highest value of 799 mg/L. the observed TDS may be due to rainfall and run-off which help waste and waste waters from residential to be discharges into pit, ponds enabling the waste to migrate down to the water table thereby increasing the TDS. Nitrate concentration are recorded to be below the WHO(2011) and NSDWQ(2007) permissible limit of 50 mg/L in all the boreholes except Majema and Matsaro which have values of 43.0 and 47.7 mg/L respectively, this may be trace due to the agricultural activities taking place near the study area. Chloride concentration ranged between 2.05 – 27.11mg/L. all the boreholes are reported to have value far below the WHO (2011) and NSDWQ (2007) permissible limit of 250 mg/L.

The results showed that the concentration of Fe, Cu and Zn are 0.18-0.89, 0.03 – 5.59 and 0.02 – 2.39 mg/L respectively majority of which are below or slightly above the WHO(2011) and NSDWQ(2007)permissible limit. Both Fe and Cu are not considered hazardous, instead they are considered as essential elements for good health. While Zn values though a below the WHO (2011) and NSDWQ (2007) limit, it still indicates pollution. However, the concentration of Mn, Cr and Pb is 0.33-19.79, 0.09- 0.30 and 0.02- 0.99 mg/L respectively, these concentrations is observed to be higher than the WHO (2011) and NSDWQ (2007) permissible limit. Though no health implication for higher concentration of Mn, but excessive concentration could result in taste and precipitation problem, higher concentration of Cr could be sourced to be from garbage or refuse damp sites which is common in all the various sampling areas and could be linked to the rate of run-off and infiltration activities within the various sampling sites, while higher concentration of Pb could be linked to the effect of run-off from contaminated land areas, atmospheric fallout and infiltration activities from sewage effluents.

**Table 1: Physic-chemical Parameters of Groundwater of Hadejia L.G.A.**

| **Parameters** | **Range** | **NSDWQ 2007** | **WHO 2011** |
|---|---|---|---|
| pH | 6.12 – 7.97 | 6.5-8.50 | 6.5-8.50 |
| Temperature($^oC$) | 26.90-27.60 | Ambient | Ambient |
| Conductivity (µs/cm) | 163-1706 | 1000 | 1000 |
| Total Hardness(mg/L) | 112-553 | 150 | 150 |
| TDS(mg/L) | 98-799 | 500 | 500 |
| Fe(mg/L) | 0.19-0.89 | 0.30 | 0.30 |
| Cu(mg/L) | 0.03-5.59 | 1.0 | 1.0 |
| Zn(mg/L) | 0.02-2.39 | 3.0 | 3.0 |
| Mn(mg/L) | 0.33-19.79 | 0.20 | 0.20 |
| Cr(mg/L) | 0.09-0.30 | 0.05 | 0.05 |
| Pb(mg/L) | 0.02-2.99 | 0.01 | 0.01 |
| Ca(mg/L) | 22.0-136.0 | NS | 75 |
| Mg(mg/L) | 19.0-76.00 | 50-150 | 50-150 |
| Cl-(mg/L) | 2.05-27.11 | 250 | 250 |
| NO3-(mg/L) | 1.71-47.70 | 50 | 50 |

Table 1: mean value of physicochemical parameters of borehole groundwater of Hadejia L.G.A.

| Sampling site | Site Code | pH | Temp($^oC$) | EC(µs/cm) | Total Hardness(mg/L) | TDS(mg/L) |
|---|---|---|---|---|---|---|
| Makera | 1 | 6.59 ±0.06 | 26.90± 0.00 | 565 ± 14.14 | 326 ±9.17 | 231 ±5.11 |
| Oliya | 2 | 6.76 ±0.02 | 27.10 ±0.12 | 163 ±2.77 | 128 ±8.77 | 352 ±1.99 |
| K/Kofa | 3 | 6.91± 0.17 | 27.20 ±0.14 | 436 ±12.11 | 301 ±10.57 | 153 ±2.67 |
| T/Yahai | 4 | 6.57 ±0.03 | 27.20 ±0.00 | 402 ±15.21 | 260 ±6.90 | 258 ±1.73 |
| Kasgayama | 5 | 6.12 ±0.01 | 27.40 ±0.12 | 1441 ±44.11 | 342 ±11.32 | 422 ±9.11 |
| Dikila | 6 | 6.40 ±0.00 | 27.10 ±0.12 | 1706 ±29.22 | 553 ±3.77 | 309 ±3.12 |
| Fantai | 7 | 6.51 ±0.04 | 27.10 ±0.00 | 603 ±15.33 | 327 ±9.10 | 279 ±5.65 |
| Garko | 8 | 7.82 ±0.09 | 27.60 ±0.13 | 1394 ±98.67 | 419 ±8.32 | 152 ±3.77 |
| Dala | 9 | 7.51 ±0.24 | 27.00 ±0.00 | 1203 ±60.12 | 112 ±2.23 | 98 ±1.19 |
| Agumau | 10 | 7.81 ±0.08 | 27.30 ±0.01 | 310 ±17.78 | 263 ±3.21 | 189 ±5.12 |
| Majema | 11 | 6.98 ±0.00 | 27.00 ±0.02 | 228 ±11.11 | 433 ±6.12 | 547 ±11.70 |
| Rumfa | 12 | 7.04 ±0.01 | 27.20 ±0.00 | 265 ±9.66 | 216 ±2.99 | 254 ±8.44 |
| Hudu | 13 | 6.77 ±0.01 | 27.20 ±0.00 | 297 ±12.15 | 411 ±2.65 | 704 ±12.12 |
| Matsaro | 14 | 6.97 ±0.03 | 27.00 ±0.00 | 696 ±14.41 | 476 ±4.42 | 763 ±14.21 |
| Gagulmari | 15 | 7.13 ±0.01 | 27.20 ±0.01 | 454 ±7.07 | 363 ±11.32 | 799 ±9.77 |
| U/Mu'azu | 16 | 6.57 ±0.21 | 27.00 ±0.02 | 409 ±7.09 | 195 ±1.98 | 230 ±2.49 |
| S/Garu | 17 | 6.48 ±0.27 | 27.50 ±0.00 | 613 ±12.12 | 218 ±4.11 | 310 ±1.94 |
| M/Huta | 18 | 7.97 ±0.00 | 27.20 ±0.01 | 450 ±10.10 | 231 ±1.73 | 398 ±9.79 |
| K/Yamma | 19 | 7.00 ±0.22 | 27.10 ±0.01 | 948 ±30.30 | 242 ±2.27 | 475 ±12.51 |
| Dallah | 20 | 6.79 ±0.01 | 27.00 ±0.03 | 926 ±19.88 | 312 ±2.88 | 347 ±11.22 |
| NSDWQ,2007 | | 6.5 – 8.5 | Ambient | 1000 | 150 | 500 |
| WHO,2011 | | 7.0 – 8.5 | Ambient | 1000 | NS | 500 |

**Table 1 continued: mean value of physicochemical parameters of borehole groundwater of Hadejia L.G.A.**

| Sampling site | Site Code | $Ca^{2+}$(mg/L) | $Mg^{2+}$(mg/L) | $Cl^-$(mg/L) | $NO_3^-$(mg/L) |
|---|---|---|---|---|---|
| Makera | 1 | 136 ±1.66 | 53 ±0.33 | 15.07± 12.00 | 7.80 ±2.22 |
| Oliya | 2 | 51 ±0.77 | 45 ±1.12 | 21.31 ±10.10 | 12.50 ±3.91 |
| K/Kofa | 3 | 69 ±0.12 | 58 ±0.20 | 2.05± 1.52 | 2.50 ±0.12 |
| T/Yahai | 4 | 79 ±1.11 | 52 ±0.44 | 4.11 ±1.99 | 13.50 ±0.02 |
| Kasgayama | 5 | 38 ±0.02 | 46 ±0.22 | 18.13 ±3.12 | 6.10 ±2.99 |
| Dikila | 6 | 47 ±0.22 | 32 ±0.19 | 6.70 ±2.66 | 6.50 ±1.11 |
| Fantai | 7 | 52 ±0.52 | 36 ±1.02 | 9.99 ±3.10 | 8.5 ±3.11 |
| Garko | 8 | 51 ±0.07 | 28 ±1.55 | 3.77 ±2.00 | 4.10 ±0.91 |
| Dala | 9 | 22 ±0.04 | 35 ±2.00 | 5.89 ±3.01 | 5.75 ±2.44 |
| Agumau | 10 | 26 ±1.01 | 39 ±3.00 | 4.45 ±1.88 | 12.00± 4.11 |
| Majema | 11 | 65 ±1.15 | 28 ±2.12 | 3.95 ±0.22 | 43.01 ±8.77 |
| Rumfa | 12 | 49 ±0.52 | 66 ±0.90 | 27.11 ±12.21 | 14.80 ±7.23 |
| Hudu | 13 | 90 ±1.19 | 52 ±0.55 | 25.05 ±10.50 | 32.50 ±14.70 |
| Matsaro | 14 | 71 ±2.22 | 32 ±2.02 | 9.00 ±0.30 | 47.70 ±11.12 |
| Gagulmari | 15 | 34 ±0.02 | 76 ±0.32 | 24.12 ±14.11 | 31.00 ±8.88 |
| U/Mu'azu | 16 | 47 ±0.25 | 32 ±0.41 | 6.66 ±2.77 | 2.35 ±1.11 |
| S/Garu | 17 | 33 ±0.05 | 50 ±0.50 | 13.50 ±9.11 | 1.71 ±1.56 |
| M/Huta | 18 | 119 ±0.09 | 19 ±0.11 | 11.41 ±5.77 | 16.10 ±5.51 |
| K/Yamma | 19 | 69 ±0.03 | 39 ±1.33 | 16.05 ±8.88 | 24.05 ±8.12 |
| Dallah | 20 | 45 ±1.11 | 47 ±0.90 | 13.44 ±1.45 | 1.79 ±0.90 |
| NSDWQ,2007 | | NS | 50 - 150 | 250 | 50 |
| WHO,2011 | | 75 | 50 - 150 | 250 | 50 |

**Table 2: Mean value of Heavy Metals of borehole groundwater of Hadejia L.G.A.**

| **Sampling site** | **Site Code** | **Fe(mg/L)** | **Cu(mg/L)** | **Zn(mg/L)** | **Mn(mg/L** | **Cr(mg/L)** | **Pb(mg/L)** |
|---|---|---|---|---|---|---|---|
| Makera | 1 | 0.44± 0.018 | 0.07± 0.01 | 2.39 ±0.90 | 0.48± 0.01 | 0.12 ±0.01 | 1.92 ±0.11 |
| Oliya | 2 | 0.56 ±0.05 | 1.80 ±0.12 | 0.37 ±0.01 | 0.81 ±0.00 | 0.14 ±0.00 | 2.01 ±0.01 |
| K/Kofa | 3 | 0.25 ±0.03 | ND | 0.06 ±0.03 | 0.79 ±0.01 | 0.09 ±0.01 | 2.99 ±0.02 |
| T/Yahai | 4 | 0.27 ±0.07 | 0.17 ±0.02 | 0.09 ±0.01 | 0.51 ±0.02 | 0.30 ±0.01 | 1.51 ±0.11 |
| Kasgayama | 5 | 0.39 ±0.09 | ND | 0.03 ±0.01 | 1.67 ±0.11 | 0.23 ±0.02 | 0.66 ±0.01 |
| Dikila | 6 | 0.19 ±0.009 | ND | 0.06 ±0.01 | 0.82 ±0.40 | 0.19 ±0.01 | 0.72 ±0.02 |
| Fantai | 7 | 0.28 ±0.08 | ND | 0.25 ±0.02 | 0.66 ±0.12 | 0.24 ±0.01 | 1.99 ±0.12 |
| Garko | 8 | 0.25 ±0.06 | ND | 0.06 ±0.01 | 0.52 ±0.08 | 0.29 ±0.02 | 2.90 ±0.19 |
| Dala | 9 | 0.37 ±0.012 | 0.03 ±0.01 | 0.08 ±0.02 | 0.87 ±0.01 | 0.25 ±0.08 | 0.41 ±0.01 |
| Agumau | 10 | 0.29 ±0.08 | 0.05 ±0.02 | 0.03 ±0.00 | 0.44 ±0.01 | 0.18 ±0.01 | 0.77 ±0.02 |
| Majema | 11 | 0.48 ±0.05 | 1.76 ±0.12 | ND | 0.60 ±0.02 | 0.17 ±0.02 | 1.79 ±0.12 |
| Rumfa | 12 | 0.47 ±0.02 | 0.37 ±0.01 | 0.02 ±0.00 | 0.57 ±0.01 | ND | 2.99 ±0.01 |
| Hudu | 13 | 0.31 ±0.04 | 5.59 ±0.02 | 0.14 ±0.01 | 2.90 ±0.02 | 0.09 ±0.02 | 1.33 ±0.20 |
| Matsaro | 14 | 0.22 ±0.09 | 2.82 ±0.02 | ND | 0.33 ±0.03 | 0.11 ±0.03 | 1.90 ±0.11 |
| Gagulmari | 15 | 0.42±0.07 | 4.51 ±0.11 | 0.05 ±0.01 | 19.79± 0.90 | 0.14 ±0.01 | 1.42 ±0.21 |
| U/Mu'azu | 16 | 0.49 ±0.01 | 0.05 ±0.03 | 0.02 ±0.00 | 0.95 ±0.01 | 0.19 ±0.07 | 2.96 ±0.30 |
| S/Garu | 17 | 0.51 ±0.02 | 0.07 ±0.02 | 2.05 ±0.01 | 1.42 ±0.08 | 0.18 ±0.02 | 2.74 ±0.24 |
| M/Huta | 18 | 0.89 ±0.01 | 0.19 ±0.02 | 0.07 ±0.00 | 1.59 ±0.02 | 0.22 ±0.02 | 1.86 ±0.11 |
| K/Yamma | 19 | 0.74 ±0.20 | 2.31 ±0.11 | 0.15 ±0.00 | 0.97 ±0.01 | 0.210±.04 | 0.02 ±0.01 |
| Dallah | 20 | 0.32 ±0.01 | 0.59 ±0.02 | 0.59 ±0.02 | 1.11 ±0.01 | 0.29 ±0.03 | 1.27 ±0.02 |
| NSDWQ,2007 | | 0.3 | 1.0 | 3.0 | 0.2 | 0.05 | 0.01 |
| WHO,2011 | | 0.3 | 1.0 | 3.0 | 0.05 | 0.05 | 0.01 |

**CONCLUSION**

Underground water is believed to the purest form of water because of the purification properties of the soil, however, source of contamination could be due to improper design and construction of wells, shallowness, and proximity to toilets, refuse dump sites, and agricultural farm sites which serve as source of contamination.

It was observed that the boreholes were all located within the residential area of the study area; traces of agricultural chemical contaminants were seen, which most were still within the WHO (2011) and NSDWQ (2007) limits. Thus, it is concluded that the current status of the water in most of the boreholes considered for this study is fit as a source of drinking water for the community, it is recommended that those boreholes with higher level of Mn, Cr, and Pb should be closed and new ones constructed to enhance good drinking water delivery to the community.

**Author's contributions**

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