



INTERNATIONAL JOURNAL OF SCIENCE FOR GLOBAL SUSTAINABILITY
**Physicochemical Analysis of Well Water Utilized in Gusau Metropolis,
Zamfara State**

Jafar Usman^{1,*}, Nasir Anka Garba¹, Yusuf Muhammed¹, Rilwanu Muhammad², Sadiq Musa³, Bello Abdur-Rahman Eneye^{3,B}

¹ Department of Biochemistry, Federal University Gusau, Zamfara, Nigeria

² Department of Chemistry, Federal University Gusau, Zamfara, Nigeria

³ Department of Biochemistry, Usmanu Danfodiyo University, Sokoto, Nigeria

^B Department of Biochemistry, University of Ibadan, Oyo, Nigeria

Corresponding Authors Email Address: jafarusman50@gmail.com

Received on: March, 2020

Revised and Accepted on: June 2020

Published on: July 2020

ABSTRACT

The physicochemical parameters of water from five (5) different wards in Gusau metropolis of Zamfara state has been studied for the purpose of ascertaining the water quality inside the well. Five wellwells each from five different ward within Gusau metropolis (T/Wada ward, S/Gari ward, Mayana ward, Madawaki ward, Galadima ward) were sampled, the parameters sampled include Temperature, Turbidity, pH, Total dissolved solid (TDS), Total suspended solids (TSS), Color, Odor, Taste, Total hardness, Chloride content and Conductivity. The results obtained when compared with the WHO standards for drinking water showed that temperature, pH, TSS, TDS, total hardness and electrical conductivity are within the maximum permissible limits recommended by WHO. The mean turbidity values for T/Wada, S/Gari, Mayana, and Madawaki (2.3 ± 1.0 , 1.0 ± 3.50 , 4.50 ± 0.08 , 3.0 ± 0.08 NTU respectively) are lower than the WHO recommended value (5.00 NTU) while that of Galadima ward (15.7 ± 0.077) is higher than WHO recommended value. Also the chloride content in the well of Madawaki ward (317 ± 1.7) was found to be greater than the maximum 250mg/l concentration recommended by WHO. Therefore, not all the well investigated had parameters that conforms to the WHO 2006 recommended permissible limits for drinking water hence possible adverse effect due to consumption of the water containing high level of these parameters may occur among the inhabitants of this study area.

Keywords: Water, Turbidity, Total Dissolved Solid, Total Suspended Solids, pH

1.0 INTRODUCTION

Water is a crucial nutrient and most essential basic necessity of life. The human body is composed of approximately 70% of water by mass (Enger and Smith, 2004). An adequate supply of safe and portable drinking water assist in preventing the spread of gastrointestinal diseases, support domestic and personal hygiene and improved the standard of living, however, much of the world's population does not have access to safe drinking water. Lack of portable water threatens the economy of a nation and the people and people's health in different ways (Kangpe *et al.*, 2014). In 2018, World Health Organization reported that about 2 billion people use a drinking water from contaminated sources which can transmit diseases such as diarrhea, cholera, typhoid, dysentery and polio, contaminated drinking water is estimated to cause 502,000 diarrhoeal

deaths each year. In Nigeria UNICEF 2017 reported that about 70million out of a population 171 million, lack access to safe drinking water, and over 110 million lacked access to improved sanitation.

Well water is the main source of water for domestic use in Gusau metropolis, on several occasions, the well water is pumped into the houses or fetched manually. Generally, the water are used for washing, cooking, and even for drinking. The determination of the metal content of the samples is of great importance; because, despite the fact that trace elements are essential to man, at elevated levels, these elements can cause morphological abnormalities, reduce growth, increase mortality and mutagenic effect (Adeyeye, 2000; Asaolu, 2002). Adejo *et al.*, (2013) were able to assess the physicochemical quality of borehole

water within Gusau Metropolis in which they reported no significant risk. Considering well water as an open system unlike boreholes, well water is more subjected to pollution. It's pertinent therefore to assess the physical and chemical parameters of well water to enable us to know the portability of well water samples in Gusau metropolis. In view of

2.0 MATERIAL AND METHODS

2.1 Sample Collection

Samples for physicochemical analysis was collected from three different Wells in each Ward of Gusau metropolis (Tudun Wada, Sabon Gari, Galadima, Mayana, and Madawaki ward) using sterilized plastic sample bottles. From each of the Wells, three replicates of the water sample were collected, which make a total of 9 water samples in each ward. The samples were collected using a well water fetcher (Guga) and then transferred by immersing the sample containers slowly allowing them to fill. After collection, the sample bottles were covered and transported to the laboratory, Sample is then preserved by addition of chemical preservatives and by lowering the temperature and stored at room temperature for further analysis.

2.2 Physical Parameters

2.2.1 Temperature

Temperature was determined using mercury in glass thermometer LET-50/50, DIN 12778 calibrated in degree centigrade (°C) as described by Shewaye (1999)

2.2.2 Turbidity

The turbidity of the sample was determined using a turbidity meter HACH 2100P and the results obtained were expressed in Nephelometric Turbidity Unit (NTU) (APHA, 2005). Water samples were poured into the tube and allowed to stand for 5 minutes; the values were recorded.

2.2.3 Total Dissolved Solid (TDS)

Water sample was filtered through a rinsed and dried glass fiber filter, the filtrate (liquid) and the rinsed water were collected in a flask, weight of the container and volume of the filtrate was also recorded, the filtrate was then added to a container and the sample was allowed to stay in the oven at 103 °C for 24 hours, the container was then removed and allow to cool, the container was reweighed,

this, the present study was aimed to determine the physicochemical and mineral composition of well water in Gusau metropolis of Zamfara state. And the specific objectives of the study were to determine the physicochemical properties of well water and comment on the portability of well water.

then the initial weight of the container is subtracted with the dried residue to obtain the increased in weight.

$$\text{TDS mg/L} = \frac{B-A}{C} \times 1000 \text{ mg/g} \times 1000 \text{ ml/L}$$

Where A= weight of clean dried container

B= weight of container and residue

C= Volume of the water sample

2.2.4 Total Suspended Solid (TSS)

The sample were collected in a 1 litre container, the vacuum pump was connected to the side arm of the vacuum flask, a ProWeight filter was place in the filter holder, water sample was filtered as much as possible in 10 minute up to 1 liter, initial weight and the total sample volume filtered were recorded, the filter was washed and the solids was collected wit 3 successive 10mL portions of reagent water, the filter is placed back in its span and also placed in a drying oven se at 14° C at 1 hour, filters is then removed from the oven, and weight on a balance and their weight were recorded, the total suspended solid was calculated using the following equation

$$\text{TSS mg/L} = \frac{\text{Weight}_{\text{final}}^{\text{(g)}} - \text{Weight}_{\text{initial}}^{\text{(g)}}}{1000,000 / \text{Sample Volume (mL)}}$$

2.2.5 Colour, Odour and Taste

Color, odor and taste were analyzed with sense organs

2.3 Chemical Parameters

2.3.1 pH

The pH was determined using PHS-3C pHmeter as described by Shewaye (1999). The sample was poured into 50ml beaker and the meter was dipped inside for about one minute. The pH reading was taken directly from the meter.

2.3.2 Total Hardness

A 50 cm³ mineral water was pipetted into a conical flask, 2 cm³ buffer solution was added followed by 3 drops of Eriochrome Black T indicator solution. It was then titrated with 0.01 M EDTA until the

solution turns from wine red to sky blue with no hint of red. The titration was repeated to obtain two concordant results. The total concentration of $\text{Ca}^{2+}(\text{aq})$ and $\text{Mg}^{2+}(\text{aq})$ ions in the mineral water sample was then calculated in mol dm^{-3} .

2.3.3 Chloride Content (Mohr's argentometric method)

25 ml water sample were taken into a conical flask and pH of the sample were also measured. 1.0ml indicator solution was also added and standard silver nitrate solution were titrated to pinkish yellow, the volume of the titrant was noted down. Chloride ion concentration was calculated.

$$\text{Chloride Ion Concentration (mg/L)} = (A \times N \times 35.45) \times 1000 / V_{\text{sample}}$$

3.0 RESULTS AND DISCUSSION

The results of physical and chemical parameters of well water are presented in Table 1 and 2, and represented in Figure 1-8.

3.1 Physical Parameters

3.1.1 Temperature

The mean values and standard deviations of well water temperatures for T/Wada, S/Gari, Mayana, Madawaki, Galadima wards are $23.8^{\circ}\text{C} \pm 0.32^{\circ}\text{C}$, $27.0^{\circ}\text{C} \pm 0.20^{\circ}\text{C}$ and $21.8^{\circ}\text{C} \pm 0.18^{\circ}\text{C}$, $18.8^{\circ}\text{C} \pm 1.44^{\circ}\text{C}$, and $29.8^{\circ}\text{C} \pm 0.48^{\circ}\text{C}$ respectively. The values reported in this work are within the range recommended by WHO (30°C) and National Guideline and standards for water quality (20°C --- 33°C) in Nigeria for aquatic life, industrial and agricultural uses (FME, 1992). Although, there is seasonal fluctuation in well water temperature values, this may be due to function of the climatic conditions at a particular geographical location and period.

3.1.2 Turbidity

The mean turbidity values for T/Wada, S/Gari, Mayana, and Madawaki (2.3 ± 1.0 , 1.0 ± 3.50 , 4.50 ± 0.08 , 3.0 ± 0.08 NTU respectively) are lower than the WHO recommended value (5.00 NTU). While that of Galadima ward (15.7 ± 0.077) is higher

Where: A = volume of titrant used, N is normality of silver nitrate (here we used N/71 or 0.0141 N), and V_{sample} is volume of sample used (mL).

2.2.4 Conductivity Determination (AOAC, 1998)

The conductivity of the samples was determined using digital conductivity meter (model HACH CEL/890). The power key and the conductivity key of the conductivity meter were switched on and allowed to warm for about fifteen minutes. The temperature of the meter was adjusted and then standardized with 0.001M KCl to give a conductivity value of $14.7 \mu\text{S/cm}$ at 25°C . The electrode was thoroughly rinsed with distilled water and then immersed directly into water sample and each measurement was taken. The probe was thoroughly rinsed with distilled water after each measurement.

than WHO recommended value. This may be due to the presence of clay, silt, finely divided organic matter, plankton and other microscopic organisms (Durance, 1986).

3.1.3 Total Dissolved Solids

The mean and standard deviations of total dissolved solids for T/Wada ($102 \pm 0.25 \text{mg/L}$), S/Gari ($94 \pm 0.31 \text{mg/L}$) and Mayana ($86 \pm 0.33 \text{mg/L}$) Galadima ($97 \pm 0.01 \text{mg/L}$) are lower than the recommended value of 500mg/L by the National guideline and standards for water quality in Nigeria and the WHO specification limits (1000mg/L) for drinking water (Edimeh *et al.*, 2011).

3.1.4 Total Suspended Solids

Total Suspended solids (TSS) value of all the well are within the permissible limits of 1000mg/L respectively. In the rainy season, TSS value was high due to floating materials like fine silt carried by rainwater (Raji *et al.*, 2015).

3.1.5 Colour, Odour and Taste

The water samples of all the wards are colourless, odourless and has unobjectionable taste which makes the water aesthetically acceptable (Egbohet *et al.*, 2007).

Table 1: Results of the Physical Parameters of Well Water in Gusau Metropolis

PARAMETERS	W.H.O	T/WADA	S/GARI	MAYANA	MADAWAKI	GALADIMA
Temperature ($^{\circ}\text{C}$)	30	23.8 ± 0.32	27.0 ± 0.20	21.8 ± 0.18	18.8 ± 1.44	29.8 ± 0.48
Turbidity (NTU)	5	2.3 ± 1.00	1.0 ± 3.50	4.50 ± 0.08	3.0 ± 0.08	15.7 ± 0.077

Total Dissolved Solids (mg/l)	1000	102 ± 0.25	94±0.31	86 ± 0.33	97±0.01	116±0.00
Total Suspended Solids (mg/l)	1000	230 ± 0.30	300±0.03	280±0.00	240±0.50	310±0.33
Colour	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
Taste	Unobj	Unobj	Unobj	Unobj	Unobj	Unobj

Key: TSS=Total suspended solids, TDS=Total dissolved solids, Unobj=Unobjectionable
 Values for TURB, TDS, TSS are presented in mean±SD

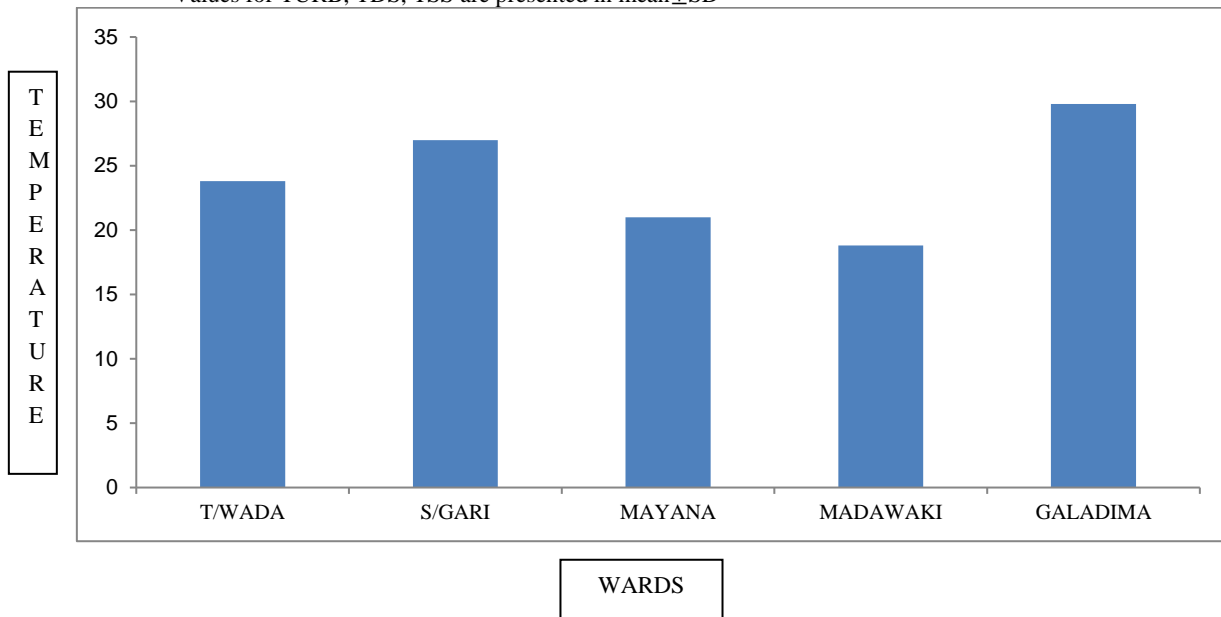


Figure 1: Comparison of the Temperature Values of the well Water Samples of 5 wards in Gusau Metropolis and the Maximum Permissible Limits Set by (W.H.O. Ambient)

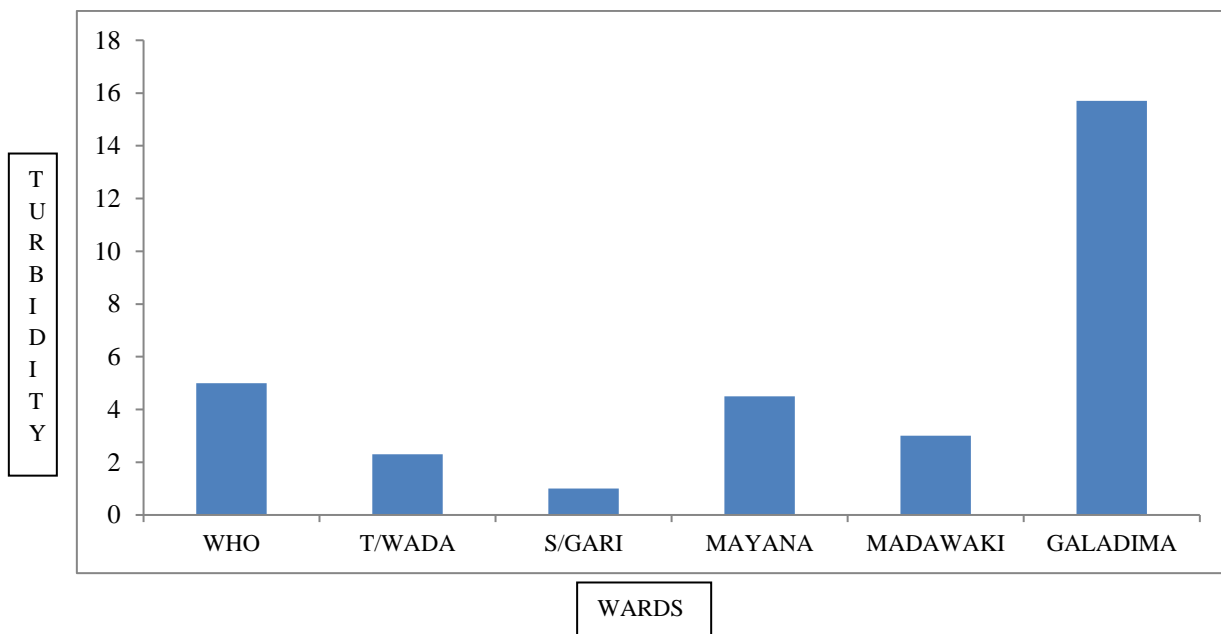


Figure 2: Comparison of the TURBIDITY Values of the well Water Samples of 5 wards in Gusau Metropolis and the Maximum Permissible Limits Set by (W.H.O. 5.0 NTU).

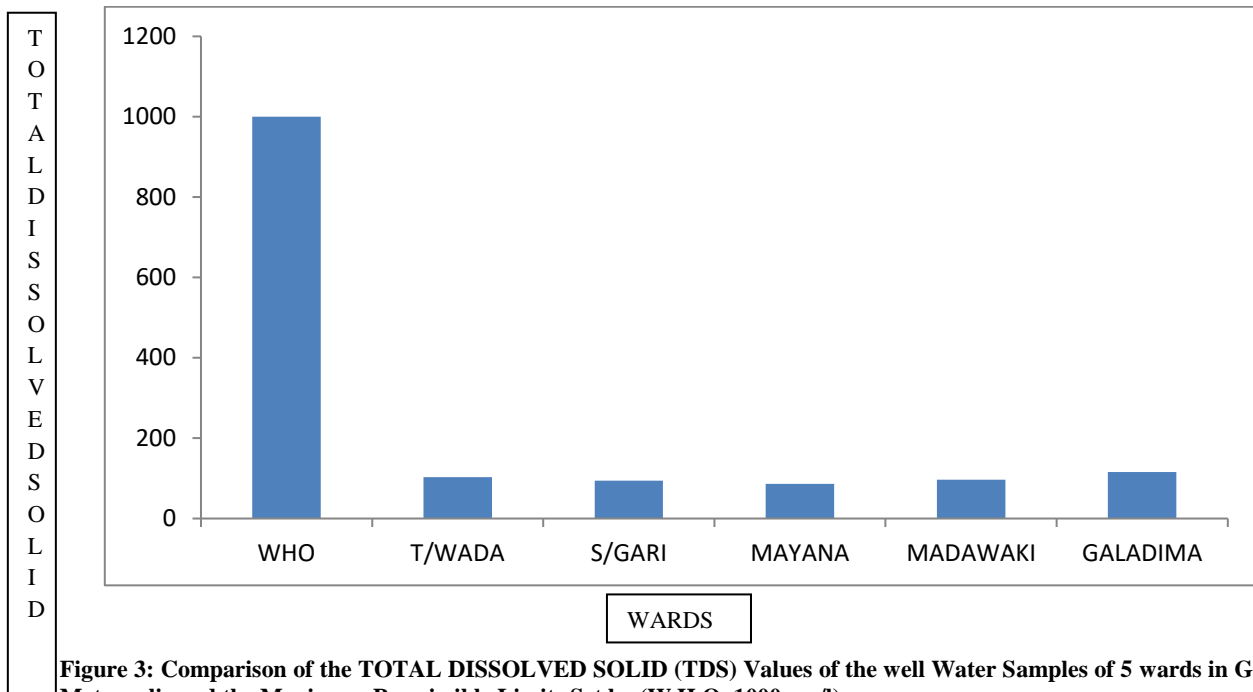


Figure 3: Comparison of the TOTAL DISSOLVED SOLID (TDS) Values of the well Water Samples of 5 wards in Gusau Metropolis and the Maximum Permissible Limits Set by (W.H.O. 1000 mg/l)

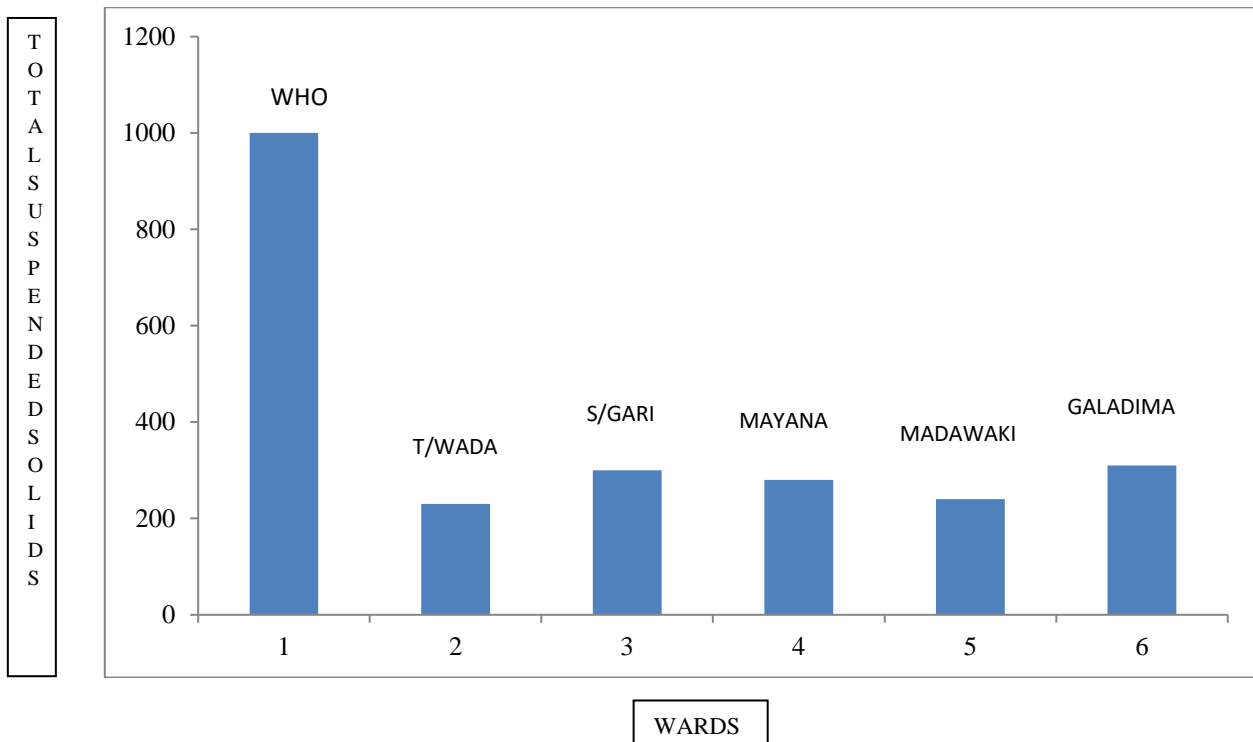


Figure 4: Comparison of the TOTAL SUSPENDED SOLIDS (TSS) Values of the well Water Samples of 5 wards in Gusau Metropolis and the Maximum Permissible Limits Set by (W.H.O 1000 mg/L)

3.2 Chemical Parameters

3.2.1 pH

The mean pH values obtained for the five (5) wells are within the range of 6.5-8.9, recommended by WHO (1996) for drinking water. Although the

values indicate that the well water samples are slightly acidic, it is in agreement with what was reported by other researchers in similar study (Hammeul *et al.*, 2014).

3.2.2 Total Hardness

The mean and standard deviation values of total hardness of all the wards are within the WHO specification limits for drinking water, but they are high enough to cause hardness of water. Therefore, this explains further the presence of carbonates/bicarbonates which may cause poor lather formation and scales on boilers (Durrance, 1986).

3.2.3 Chloride Content

All the Chloride content values obtained for the well analyzed were below the WHO 2006, maximum permissible of 250mg/l except for the sample from Madawaki ward which recorded mean value of 317±1.7mg/l. The high chlorides in these well of Madawaki ward could probably be as a result of

rock containing chlorides which may be underlying the area and when in contact with the water in the aquifer dissolves into the groundwater or probably the location of the wells are close to a dumping site where refuse can influence the groundwater with chloride. Masona (2009), reported high chloride above WHO permissible limit and attributed it to the nature of the rocks underlying the study area which interacts with the underground water.

3.2.4 Conductivity

Electrical conductivity gives an account of all the dissolved ions in solution. All the values obtained were below the WHO 2006, maximum permissible limit of 1000µS/cm for drinking water and therefore, the electrical conductivity values recorded from the samples do not have any potential health risk to the consumers. Electrical conductivity is considered to be a good and rapid measure of determining total dissolve solids as reported by Quaitto, (1996).

Table 2: Results of the Chemical Parameters of Well Water in Gusau Metropolis

PARAMETERS	W.H.O	T/WADA	S/GARI	MAYANA	MADAWAKI	GALADIMA
pH	6.5-8.9	6.26 ± 0.60	6.60±0.08	7.50±0.05	6.90±0.05	6.80±0.010
Total hardness(mg/l)	500	260 ± 0.77	270±1.2	180±0.2	220±1.4	300±0.88
Chloride(mg/l)	250	66 ± 0.73	82±0.90	224 ± 1.42	317±1.7	46±1.53
Conductivity(µs/cm)	8 – 10000	7.0 x 10 ²	4.0 x 10 ²	5.0x 10 ²	8.0 x 10 ²	3.0 x 10 ²

Key: Values for pH, total hardness and chloride are presented in mean±SD

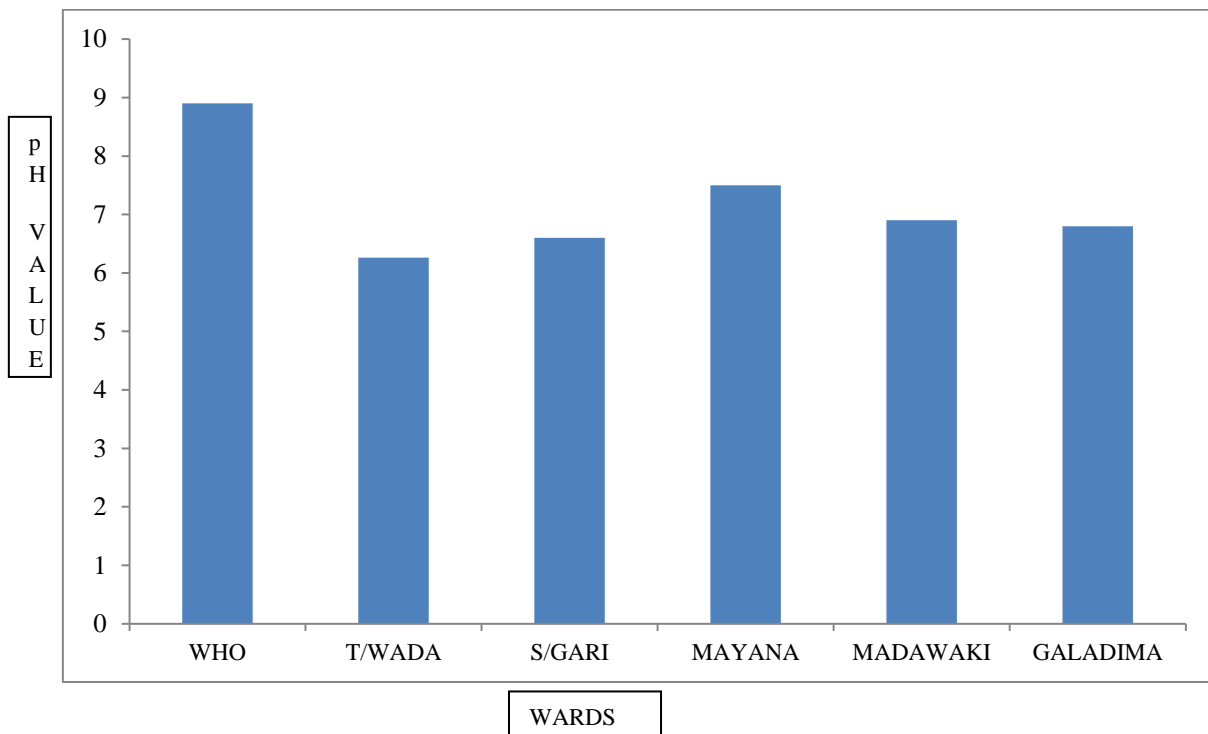


Figure 5: Comparison of the pH Values of the well Water Samples of 5 wards in Gusau Metropolis and the Maximum Permissible Limits Set by (W.H.O 6.5-8.5)

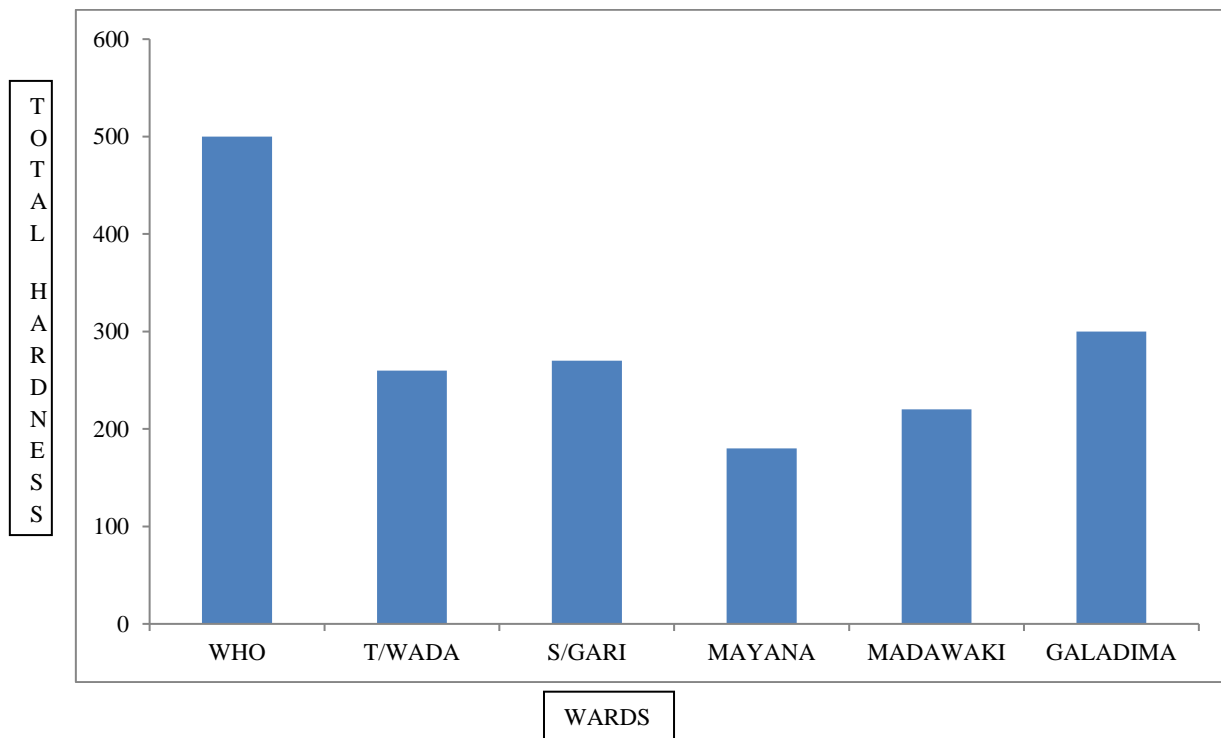


Figure 6: Comparison of the TOTAL HARDNESS VALUES of the well Water Samples of 5 wards in Gusau Metropolis and the Maximum Permissible Limits Set by (W.H.O 500 mg/l).

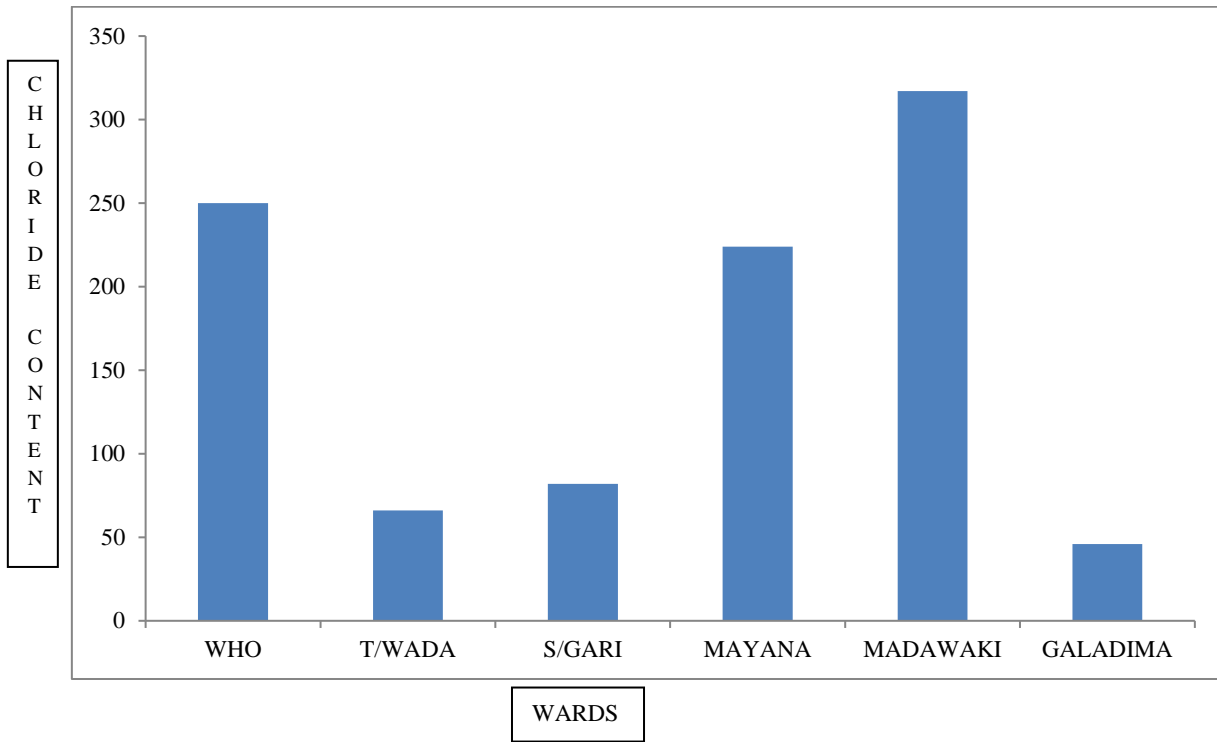


Figure 7: Comparison of the CHLORIDE content of the well Water Samples of 5 wards in Gusau Metropolis and the Maximum Permissible Limits Set by (W.H.O 250mg/L)

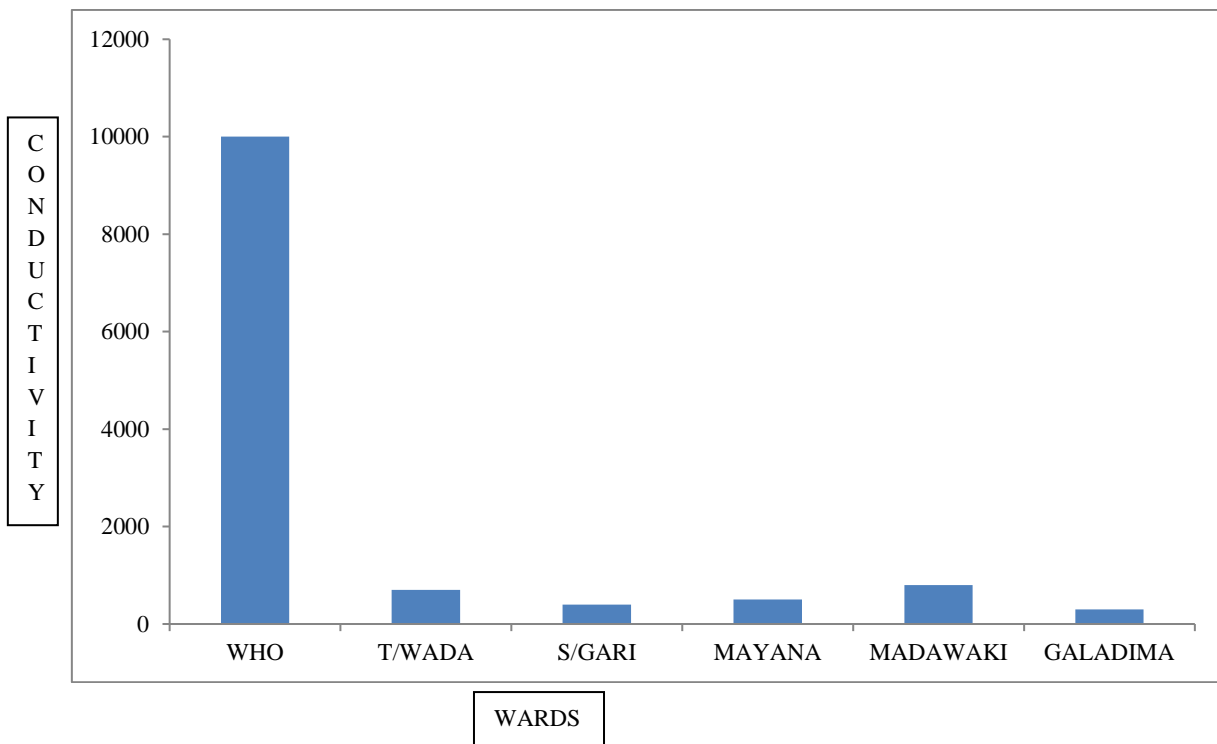


Figure 8: Comparison of the CONDUCTIVITY value of the well water Samples of 5 wards in Gusau Metropolis and the Maximum Permissible Limits Set by (W.H.O 1000µs/l)

4.0 CONCLUSION

Based on the findings, it is evident that not all the wells investigated had parameters that were in conformity with the WHO 2006, recommended permissible limits for drinking water. Therefore, possible adverse effect due to consumption of the water containing high levels of these parameters may occur among the inhabitants of this study area.

REFERENCE

- Adejo, Y., Bagudo, B.U., Tsafe, A.I. and Itodo A.U. (2013). Physico-chemical quality assessment of ground water within Gusau metropolis. *International journal of modern analytical separation science*. 2(1):1-19.
- Ademoroti, C.M.A. (1996). Standard Method for Water and Effluent Analysis. Foludex press Ltd, Ibadan, pp. 28-29, 40-43.
- Adeyeye, E.I. (2000). "Bio-concentration of macro and trace mineral in prawns living in Lagos lagoon". *Pak. J. Sci. Ind. Res.* 43:367-373.
- APHA (2005). *Standard Methods for the Examination of Water and Waste water*. Washington D.C. :American Public Health Association.
- Aremu, M. O. Olaofe, O. Ikokoh, P. P & Yakubu, M. M. (2011) physicochemical characteristics of stream, well and borehole water sources in Eggon, Nasarawa State, Nigeria. *Journal Chemical Society Nigeria*, 36 (1), 131-136.
- Asaolu, S.S. (2002). " Determination of some heavy metals in *Oreochromis niloticus*, *Clarias geniepinus* and *Synontis spp* from the coastal water of Ondo state ,Nigeria". *Pak. J. Sci. Ind. Res.* 45:17-19.
- Durance, J. L. (1986). United State Geological Survey (USGS) water Science for School. Retrieved 4, April, 2009 Pp 1-8.
- Edimeh, P. O., Eneji, I. S., Oketunde, O. F. & Sha'ato, R. (2011). Physico-chemical parameters and some Heavy metals content of Rivers Inachalo and Niger in Idah, Kogi State. *Journal Chemical Society Nigeria* 36 (1): 95-101.
- Egboh, E. H. O. and Emeshilli, E. M. (2007). "Physico-chemical characteristics of River Ethiope source in Umuaja, Delta State, Nigeria," *J. Chem. Soc. Nigeria*, vol. 32, pp. 72-78.
- Enger, E. D. and Smith, B. F. (2004), *Environmental chemistry*. Return Press Ltd, 2004.
- Federal Ministry of Environment (1992). National Guideline and Standard for water quality in Nigeria. Technical Advisory Committee on water quality criteria, Nigeria Pp 14-16.
- Fundamentals of Environmental Measurements FEM, (2016). Foundriest environmental inc. Retrieved from <https://www.foundries.com/environmentalmeasurements/parameters/waterquality/turbidity-total-suspended-solids-waterclarity>.
- Ike, E. E. & Ugodulunwa. F.X.O. (1999). History and philosophy of Science, University of Jos Consultancy Limited, Jos. Pp 134-136
- Kangpe, N.S., Egga, E.S. and Mafuyai, G.M. (2014). Physico-Chemical and Microbial Assessment of Some Well Water from Mista-Ali Town, Bassa LGA, Plateau State- Nigeria. *Asian Review of Environmental and Earth Sciences* ISSN: 2313-8173 Vol. 1, No. 2, 39-42.
- Masona V.L. (2009). "Evaluation of Groundwater Quality in the selected boreholes located in Kwanwoma District of Ghana" *African Journal of Biotechnology* 7(11) pp 1200 - 1209.
- Nigerian Industrial Standards NIS (2007). Nigerian Standard for Water quality , approved by Standard Organization of Nigeria. © SON 2007. Retrieved from <https://www.lenntech.com>applications>.
- Quaitto, W.A (1996). *Ultimate Chemistry*. Pixelimage Accra, pp. 105-110
- Raji, M.I.O., Ibrahim, Y.K.E., Tytler, B.A. and Ehinmidu I.O. (2015). Physicochemical characteristics of water samples collected from River Sokoto, Northwestern Nigeria. *Atmospheric and Climatic Science*, 5, 194-199.
- Shewaye, M. (1999). Public Water Supply Demand, WHO Resource Management 25th WEDEC Conference, Ethiopia.
- Uriyo, A.D. and Singh, B.R. (1997). *Practical soil chemistry*. Morogoro: University of Dar-es-salam press.
- WHO (1991). *International standard for drinking water*. Third edition. Geneva: Switzerland.
- WHO (1996), *Guideline for Drinking-water quality, recommendation, 1*. Pp 16-17.
- WHO (2006). *Guideline for Drinking Water quality (electronic Resource)*. Incorporating first Addendum 1, Recommendations-3rd retrieved June 4, 2008.