Research Article
Volume 8:8, 2022

Hydrology: Current Research

ISSN: 2157-7587

Open Access

Physico-Chemical Assessment of Hand Pump Borehole Water Samples: A Case Study of some Schools in Gashua Town, Bade LGA, Yobe State

Ahmad Alin Baffa*

Department of Chemistry, Federal University Gashua, Yobe, Nigeri

Abstract

Background: The research was aimed at ascertaining the quality of Boreholes water in some selected institutions in Gashua Town namely; Federal University Gashua, Umar Suleiman College of Education, Gashua and Ramat UBE School, Gashua. The results highlighted vital information on the potability of water samples sampled in Hand Pump water borehole sources. Some physico-chemical parameters were assessed using water quality tests instruments and Spectroscopic equipment's. The parameters analysed are: pH, Electric Conductivity, Turbidity, TDS, Sulphate, Total Chlorine, Nitrate, Nitrite, Magnesium, Manganese, Molybdenum, Chromium, Iron, Copper, Lead, Nickel and Cadmium. The findings of the research indicated the potability of the water, its usability domestically, agriculturally and industrially.

Keywords: Physicochemical parameters • Spectroscopy • Electric Conductivity

Introduction

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth. As of now only earth is the planet having about 70% of water. But due to increased human population, industrialization, use of fertilizers in the agriculture and man-made activity it is highly polluted with different harmful contaminants. Therefore, it is necessary that the quality of drinking water should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases. It is difficult to understand the biological phenomenon fully because the chemistry of water reveals much about the metabolism of the ecosystem and explain the general hydro-biological relationship [1].

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Natural water containing different types of impurities are introduced in to aquatic system by different ways such as weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and the use of metal based materials [2]. The increased use of metal-based fertilizer in agricultural revolution of the government could result in continued rise in concentration of metal pollutions in fresh water reservoir due to the water run-off. Also faucal pollution of drinking water causes water born disease which has led to the death of millions of people [3]. People on the globe are under tremendous threat due to undesired changes in the physical, chemical and biological characteristics of air, water and soil. These are related to animal and plants and finally affecting on them [4]. Industrial development (Either new or existing industry expansion) results in the generation of industrial effluents, and if untreated results in water, sediment and soil pollution [5]. High levels of pollutants mainly organic matter in river water cause an increase in biological oxygen demand [6], chemical oxygen demand, total dissolved solids, total suspended solids and fecal coli form. They make water unsuitable for drinking, irrigation or any other use [7]. There are trends in developing countries to use sewage effluent as fertilizer has gained much importance as it is considered a source of organic matter and plant nutrients and serves as good fertilizer [8]. Farmers are mainly interested in general benefits, like increased agriculture production, low cost water source, effective way of effluent disposal, source of nutrients, organic matter etc, but are not well aware of its harmful effects like heavy metal contamination of soils, crops and quality problems related to health.

Research has proven that long term use of this sewage effluent for irrigation contaminates soil and crops to such an extent that it becomes toxic to plants and causes deterioration of soil [9]. This contains considerable amount of potentially harmful substances including soluble salts and heavy metals like Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+}, Ni^{2+}, Pb^{2+}. Additions of these heavy metals are undesirable. Plants can accumulate heavy metals in their tissues in concentrations above the permitted levels which is considered to represent a threat to the life of humans, and animals feeding on these crops and may lead to contamination of food chain, as observed that soil and plants contained many toxic metals, that received irrigation water mixed with industrial effluent [10]. The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface and ground water. In many parts of the country available water is rendered non-potable because of the presence of heavy metal in excess. The situation gets worsened during the summer season due to water scarcity and rain water discharge. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms is one of the serious major health problems. The recent research in Haryana (India) concluded that it is the high rate of exploration then its recharging, inappropriate dumping of solid and liquid wastes, lack of strict enforcement of law and loose governance are the cause of deterioration of ground water quality [11].

Most of the rivers in the urban areas of the developing countries are the ends of effluents discharged from the industries. African countries and Asian countries experiencing rapid industrial growth and this is making environmental conservation a difficult task [12].

Statement of research problem and justification

Agricultural activities (fertilizers and soil amendments), septic systems,

***Address for Correspondence:** Ahmad Alin Baffa, Department of Chemistry, Federal University Gashua, Yobe, Nigeria, Tel: +2348036383448, E-mail: ahmadalinbaffa@yahoo.com, ahmadalinbaffa@fugashua.edu.ng*

Date of Submission: 02 August, 2022, Manuscript No. hycr-22-75912; **Editor Assigned:** 05 August, 2022, Pre QC No. P-75912; **Reviewed:** 15 August, 2022, QC No.Q-75912; **Revised:** 22 August, 2022, Manuscript No.R-75912; **Published:** 30 August, 2022, DOI: 10.37421.2157-7587.2022.13.427

solid waste and geology are the potential sources of groundwater pollution. When fertilizers are applied to agricultural land, a portion usually infiltrate and percolate through soil to the water table. Phosphate and nitrate fertilizers are absorbed on soil particles and constitute a pollution problem. In Gashua, groundwater is extensively used as a source of water supply. There is a huge need for the continuation of publishing researched information on the microbiological, chemical and physical quality of groundwater in Gashua. Therefore, it is important that studies should be carried out. This research analysed some physico-chemical parameters of borehole water samples used in schools in Gashua as listed in the Table 1.

Aims and objective

To determine the level of these physico-chemical parameters in the borehole samples:

pH, Electric Conductivity, Turbidity, TDS, Sulphate, Total Chlorine, Nitrate, Nitrite, Magnesium, Manganese, Molybdenum, Chromium, Iron, Copper, Lead, Nickel and Cadmium and compared the level of the parameters to WHO standard.

Materials and Methods

Sample collection

Samples were collected according to Fitfield and Haines [13], the following steps were followed when sampling the water for the analysis:

Polyethylene vessels were used, and before use, the containers were washed and stored in 10% nitric acid for two days and rinsed with double distilled water. The water was left to run for 3 to 4 min to avoid collecting water with high accumulation of metals stemming from pipes, soldering and welds. Three samples were collected in each point.

Water samples were collected from three (3) different schools in Gashua as shown in Table 1. The water sources selected are those that were used for drinking and other domestic purposes such as cooking and cleaning.

Equipment's

Atomic Absorption Spectroscopy was used in analysing the metals while the physical parameters were analysed using Lamotte Water testing kit PRO 250 Series, Cyberscan 500 conductivity meter, AQ2010 LABOTEC turbidity meter and H1 8014 HANNA instrument pH meter. Respective test strips were used in analyzing Nitrates and Nitrites.

Methods

Assessment of physical quality: Physical parameters such as conductivity, turbidity, pH and temperature were measured in the field using Lamotte Water testing kit, Cyberscan 500 conductivity meter, AQ2010 LABOTEC turbidity meter and H1 8014 HANNA instrument pH meter. pH meter was calibrated in a buffer solution of pH of 7 and 10 before measurement.

Assessment of chemical quality: Chemical quality was assessed by checking the concentrations of the respective metals. Atomic absorption spectroscopy (AAS) was used to measure the concentrations of Magnesium, Manganese, Molybdenum, Chromium, Iron, Copper, Lead, Nickel and Cadmium.

Results and Discussion

Table 2 showed the results obtained from the analysis conducted on nine (9) different water samples obtained from different schools around Gashua town. Four (4) physical parameters namely: pH, electrical conductivity, Turbidity and TDS were analysed.

Key:

FHM1: Fuga hostel male 1

FHM2: Fuga hostel male 2

FAF: Fuga agric farm (hand pump)

FHF: Fuga hostel female

FHMO: Fuga hostel male old

COESQ: College of education staff quarters

COEHA: College of education hostel A

COEHC: College of education hostel C

RUBES: Famat ube school

The pH value ranged between 6.76 ± 0.01 – 8.69 ± 0.03 and this meant that most of the samples are within the recommended level of 6.5 to 8.5 as suggested by The World Health Organisation (WHO, 1998) and The European Union's drinking water standards as captured in the council directive 98/83/EC on the quality of water intended for human consumption, adopted by the council [14].

Electrical conductivity EC was found to be between 36.17 ± 0.29 and 122.00 ± 0.80 uS/cm. These values are far below the EPA's highest recommended value of 2500 uS/cm.

Turbidity measured in NTU was found to be between 0.74 ± 0.03 and 142.09 ± 0.25.

Total Dissolved solids (TDS) was found to be within the range 22.11 ± 0.01 – 420.50 ± 0.87 mg/Liter. These values fall within safe limit below the maximum concentration of 500 mg/L set by EUDWS.

Thirteen (13) chemical parameters were analysed and the results are as follows:

- Sulphate was not detected in five (5) out of nine (9) of the analysed samples, while 2.00 ± 0.01 to 25.00 ± 0.50 mg/L was found in the remaining four samples as shown in Table 2. This is also far below the maximum allowable limit of 500 mg/Liter set up by World Health Organisation in Geneva [15].
- Total Chloride (Cl) values were found within the range 0.02 ± 0.00 – 0.07 ± 0.00. It wasn't detected in COEHC sample. These values are safe for consumption according to WHO, 1998 as the allowable limit was set to be 250 mg/L.

Table 1. Sampling areas, names and abbreviations.

S.No	Institution	Location of Borehole	Abbreviation
1.	Federal University Gashua	Fuga hostel male 1	FHM1
2.	Federal University Gashua	Fuga hostel male 2	FHM2
3.	Federal University Gashua	Fuga agric farm (hand pump)	FAF
4.	Federal University Gashua	Fuga hostel female	FHF
5.	Federal University Gashua	Fuga hostel male old	FHMO
6.	Umar Suleiman College of Education, Gashua	College of education staff quarters	COESQ
7.	Umar Suleiman College of Education, Gashua	College of education hostel A	COEHA
8.	Umar Suleiman College of Education, Gashua	College of education hostel C	COEHC
9.	Ramat Primary and UBE School, Gashua	Ramat ube school, Gashua	Rubes

Table 2. The analysis conducted on nine (9) different water samples obtained from different schools around Gashua town.

S.No	Number of Samples	1	2	3	4	5	6	7	8	9
		FHM 1	FHM 2	FAF	FHF	FHMO	COESQ	COEHA	COEHC	RUBES
	Parameters	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
1	pH	8.35 ± 0.03	8.00 ± 0.01	6.76 ± 0.01	8.69 ± 0.03	7.12 ± 0.01	7.99 ± 0.01	7.66 ± 0.01	7.76 ± 0.01	7.25 ± 0.01
2	Elect Conductivity (uS/cm)	82.33 ± 1.04	94.50 ± 3.50	122.00 ± 0.80	116.43 ± 0.59	88.30 ± 0.52	62.10 ± 0.17	68.33 ± 0.58	81.33 ± 0.58	36.17 ± 0.29
3	Turbidity (NTU)	0.74 ± 0.03	4.94 ± 0.02	18.79 ± 0.21	21.30 ± 0.01	48.64 ± 0.02	0.00 ± 0.00	34.40 ± 0.17	142.09 ± 0.25	2.47 ± 0.01
4	TDS (mg/Litre)	222. 7± 0.70	231.9 ± 1.55	420.50 ± 0.87	334.13 ± 1.69	22.11 ± 0.01	25.17 ± 0.16	232.67 ± 2.31	22.14 ± 0.13	55.40 ± 0.35
5	Sulphate (mg/Litre)	25.00 ± 0.50	0.00 ± 0.00	0.00 ± 0.00	3.70 ± 1.13	0.00 ± 0.00	2.00 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	2.00 ± 0.01
6	Total Chlorine (mg/Litre)	0.04 ± 0.00	0.04 ± 0.00	0.03 ± 0.00	0.07 ± 0.00	0.04 ± 0.00	0.02 ± 0.00	0.12 ± 0.01	0.00 ± 0.00	0.02 ± 0.00
7	Nitrate (mg/Litre)	1.65 ± 0.04	10.20 ± 0.18	1.21 ± 0.02	1.05 ± 0.01	1.08 ± 0.03	1.03 ± 0.02	12.25 ± 0.04	1.08 ± 0.03	0.51 ± 0.01
8	Nitrite (mg/Litre)	0.073 ± 0.004	0.052 ± 0.001	0.019 ± 0.00	0.091 ± 0.001	0.061 ± 0.001	0.091 ± 0.001	0.047 ± 0.001	0.10 ± 0.01	0.034 ± 0.001
9	Magnesium (mg/Litre)	0.008 ± 0.002	0.012 ± 0.001	0.005 ± 0.001	0.041 ± 0.001	0.004 ± 0.001	0.031 ± 0.001	0.000 ± 0.000	0.008 ± 0.001	0.002 ± 0.000
10	Manganese (mg/Litre)	1.600 ± 0.050	0.000 ± 0.000	0.300 ± 0.020	0.902 ± 0.003	0.497 ± 0.008	0.480 ± 0.044	2.191 ± 0.019	0.403 ± 0.005	0.301 ± 0.001
11	Molybdenum (mg/Litre)	0.315 ± 0.013	0.300 ± 0.010	0.200 ± 0.010	0.600 ± 0.012	0.411 ± 0.010	0.303 ± 0.002	0.501 ± 0.002	0.304 ± 0.005	0.307 ± 0.021
12	Chromium (mg/Litre)	0.020 ± 0.01	0.020 ± 0.001	0.020 ± 0.002	0.012 ± 0.002	0.010 ± 0.001	0.020 ± 0.001	0.020 ± 0.001	0.011 ± 0.001	0.011 ± 0.001
13	Iron (mg/Litre)	0.120 ± 0.005	0.910 ± 0.020	2.470 ± 0.005	0.190 ± 0.001	3.756 ± 0.049	0.062 ± 0.003	2.817 ± 0.006	5.927 ± 0.025	0.240 ± 0.001
14	Copper (mg/Litre)	0.040 ± 0.002	0.000 ± 0.00	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.010 ± 0.001	0.000 ± 0.000	0.000 ± 0.000
15	Lead (mg/Litre)	0.007 ± 0.001	0.004 ± 0.001	0.002 ± 0.001	0.004 ± 0.001	0.009 ± 0.001	0.002 ± 0.001	0.014 ± 0.001	0.009 ± 0.001	0.000 ± 0.000
16	Nickel (mg/Litre)	0.007 ± 0.006	0.007 ± 0.006	0.003 ± 0.006	0.022 ± 0.002	0.011 ± 0.003	0.013 ± 0.003	0.007 ± 0.001	0.006 ± 0.004	0.001 ± 0.001
17	Cadmium (mg/Litre)	0.001 ± 0.001	0.001 ± 0.001	0.000 ± 0.000	0.001 ± 0.001	0.001 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.001 ± 0.001	ND

- For Nitrate (NO_3^-) and Nitrite (NO_2^-), maximum values of 12.25 ± 0.04 and 0.10 ± 0.01 mg/L were determined respectively and all values were below the maximum permissible limit of 50 mg/L recommended for both anions by WHO. The values also fall far below the permissible limits set by [14]; 50 mg/L for NO_3 and 0.50 mg/L for NO_2 [14].
- Magnesium in trace quantity is considered an essential element and was detected in trace quantity with a highest value of 0.004 ± 0.001 mg/L which is also less than 30 mg/L recommended by WHO.
- Manganese showed a value up to 2.19 ± 0.019 mg/L and this value is higher than WHO and EUDWS recommended values of 0.5 mg/L and 0.05 mg/L respectively [14,15]. Eight (8) of nine (9) of the samples showed values higher that the recommended values except in FHM2 sample which was not detected at all.
- Molybdenum results falls within the range 0.200 ± 0.001- 0.600 ± 0.012 mg/L while WHO recommended 0.07 mg/L. This meant that all samples have high concentrations of Molybdenum higher that the safe limit of consumption.
- 0.010 ± 0.001 to 0.020 ± 0.001 mg/L of Chromium were found during the analysis. WHO and EUDWS recommended a maximum of 0.05 for chromium in drinking/potable water, thus the water analysed is safe for consumption.
- Iron (Fe) was found to be high due to a recorded value of 5.927 ± 0.025 mg/L found in COEHC. Most of the samples gave a high value of Fe compared with the recommended value of 0.2 mg/L by [14].
- Copper (Cu) was not detected in all the samples except in FHM1 (0.014 ± 0.002) and COEHA (0.010 ± 0.001) mg/L respectively. Both WHO and EUDWS pinned the permissible limit of copper to 2.0 mg/L and as such, it could be concluded that Copper content is low in all the nine (9) samples analysed.
- Lead (Pb) was not detected in RUBES sample but available in other samples at low level of 0.002 ± 0.001 to a highest of 0.014 ± 0.001 mg/L in COEHA sample. The findings suggested that the samples analysed are safe and are within the recommended permissible limit of 0.01 mg/L recommended by both EUDWS and WHO.
- Nickel (Ni), showed values that fall in the range of 0.001 ± 0.001 – 0.022 ± 0.002 mg/L while EUDWS and WHO recommended a value of 0.02 mg/L as safe limit. As such, only FHF sample showed a value around the permissible limit. It could be averagely said that the samples have low level of Nickel and are thus fit for consumption.
- Cadmium (Cd) showed almost nil values (0.001 mg/L) across all the analysed samples and could therefore conclusively agreed that it was not detected. EUDWS and WHO suggested that Cadmium should not be more than 0.003 mg/L and 0.005 mg/L respectively for drinking water.

Conclusion

From the results discussed above, it is clear to see that Water samples taken from hand pump bore holes across all the three (3) institutions of learning are relatively safe for consumption except for few parameters like Iron (Fe), Manganese (Mn) and Molybdenum (Mo). These may be due to the ages of the hand pump boreholes which may all be experiencing corrosion in the metal pipes buried deep beneath the earth. It may also be due to the nature of the environment which was known for high temperature.

The pH values suggested that the water samples are neutral to slightly basic in nature as non was found to be acidic. The low values for electrical Conductivity (EC) also meant the water has low concentrations of Cations and Anions.

It could be concluded that the water samples are fit for consumption as well as good for agricultural and/or industrial applications.

Recommendations

I recommend that other parameters not analyzed should be analyzed and results compared with the relevant regulatory bodies.

Acknowledgement

This work was sponsored by Tertiary Education Trust Fund (TETFUND) under the Institutional Based Research grants scheme (IBR)

References

1. Basavaraja S.M., Hiremath, K.N.S Murthy and E.T.Puttiah. “Analysis of water quality

using physico-chemical parameters Hosahalli Tank in Shimoga District, Karnataka, India." *GJSFR* (2011):31-34.

2. Adeyeye E.I "Determination of heavy metals in Ilesha Africana, associated Water, Soil Sediments from some fish ponds." *Int J Environ Sci* 45 (1994):231-240.
3. Adefemi S.O and E.E Awokunmi. "Determination of physico-chemical parameters and heavy metals in water samples from Itaogbolu area of Ondo-State, Nigeria." *Afr J Environ Sci Technol* 4 (2010):145-148.
4. Misra S.G and Dinesh D. "Soil Pollution, Ashing Publishing House", New Delhi, India. (1991)
5. Fakayode S.O., "Impact assessment of industrial effluent on water quality of the receiving Alaro river in Ibadan." *Nigeria-African J Enviro Assoc* 10 (2005):1-13.
6. Kulkarni G.J., "Water Supply and Sanitary engineering." (10th edn) Farooq Kitab Ghar, Karachi (1997):497.
7. Hari O.S., Nepal, M.S Aryo and N. Singh. "Combined effect of waste of distillery and sugar mill on seed germination, seeding growth and biomass of okra." *J Environ Biol* 3 (1994):171-175.
8. Riordan O, E.G Dodd and V.A. Tunney. "The Chemical Composition of Sewage sludges." *J Agric Res* 25 (1983): 2392-49.
9. Quinn B.F., and Syers J.K., "Surface irrigationof pasture with treated sewage effluent, heavy metal content of sewage effluent, sludge, soil and pasture." *New Zealand J Agric Res* 21 (1978):435-442.
10. Adnan Amin, Taufeeq Ahmad, Malik Ehsanullah and Muhammad Ayaz-Khan. et al. "Evaluation of industrial and city effluent quality using physicochemical and biological parameters." *Elec J Env Agricult Food Chem* 9(2010): 931-939.
11. Gupta D.P., and Sunita J.P., "Physiochemical analysis of ground water of selected area of Kaithal City (Haryana) India." *Researcher* 1(2009):1-5.
12. Agarwal Animesh and Manish Saxena. "Assessment of pollution by Physicochemical Water Parameters Using Regression Analysis: A Case Study of Gagan River at Moradabad- India." *Adv Appl Sci Res* 2 (2011):185 -189.
13. Fitfield F.W. and Haines P.J. "Analytical Chemistry: A modern approach to Analytical Science." (2000)
14. EUDWS. "European Union's Drinking Water Standard. Council Directive 98/83/EC on the quality of water intended for human consumption adopted by the council on 3rd November." (1998).
15. WHO. Guideline for drinking water quality.. (2nd edn) WHO (1998):30-113.

How to cite this article: Baffa, Ahmad Alin. "Physico-Chemical Assessment of Hand Pump Borehole Water Samples: A Case Study of some Schools in Gashua Town, Bade LGA, Yobe State." *Hydrol Current Res* 8 (2022): 427.