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Full Length Research Paper

Evaluation of groundwater quality in hand-dug wells (HDW) from Kofar Marusa area, in Katsina state Nigeria

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ABSTRACT: The study analyzed the water quality of hand-dug wells (HDW) from Kofar Marusa area in Katsina metropolis, Nigeria for the Physical, Chemical, and Bacteriological parameters. The study used standard laboratory techniques for the water quality analysis and the results were evaluated based on the benchmark standards of the World Health Organization (WHO) and Nigerian Standard of Drinking Water Quality (NSDWQ). A random sampling method was used to select 10 HDW for the water quality analysis. Excel 2007 software was used for data analysis and the results were presented in Table. The results of water quality from HDWs were found to fall within or below or in excess of the safety limits of drinkable water based on the benchmark standard set by the WHO and the NSDWQ. The study concluded that the quality of water from HDWs in Kofar Marusa area was not suitable for drinking. The study recommended regular monitoring of groundwater quality and further research to determine the sources of groundwater pollution in the study area.

Keywords: water quality analysis, parameters, drinking water, hand dug wells, Katsina, Nigeria

INTRODUCTION

Inadequate drinking water supply, quality and poor sanitation are among the world's major causes of preventable morbidity and mortality (WHO, 2003). WHO estimated that basic hygiene-related diseases have a significant impact on human health. Diarrhoeal disease alone causes 2.2 million of the 3.4 million water-related deaths per year. Many of the deaths involve children less than five years of age and the poorest households and communities. The problem is not limited to developing countries. In member countries of the Organization for Economic Co-operation and Development (OECD), waterborne outbreaks occur all too frequently. Moreover, many outbreaks remain undetected, and it is likely that beyond the reported outbreaks, there is an unrecognized background burden of disease (Bhavtosh et al., 2017).

Water with good quality is essential not only to survive the humans but for the proper development of ecosystem. Deterioration of drinking water quality has become a serious issue due to some anthropogenic behavior including increase in population, mismanaged agricultural and industrial activities. Besides this, some climatic factors also affect the hydrological cycle. Consequently, human interventions and natural processes affect the quality of ground water as well as surface water also. Domestic manners, mining, power generations, forestry practices etc. are also responsible to create the changes in physical, chemical and biological properties of water (Sharma et al., 2017).

Water is a universal solvent which dissolves many organic and inorganic substances. Absolutely pure water

almost never exists in nature. Pure water contains only two molecules of hydrogen and a molecule of oxygen. However, rain water might be considered as pure water. Conversely, as rain falls, some atmospheric gases dissolve in them and cause the water to be contaminated. Water acquires more impurities as it dissolves minerals and salts by flowing over or through their deposits after falling on the ground. Similarly, it has been reported that the type and extent of chemical contaminants in groundwater depends on the geochemistry of the soil through which the water passes to the aquifers (Ibn Abubakar et al., 2018).

Water is most abundant occupying about 75% of the earth's surface, but access to potable water that is safe for drinking and sanitation is a global issue. The quality of water used for drinking or any domestic purpose is an important factor in public health. Poor quality water can cause a disease outbreak and according to world health organization about 40% of the diseases in the world are due to consumption of polluted groundwater, and in developing countries about 75% of diseases are induced by polluted water (Muhammad et al., 2015). Contaminated water affects drinking water demand across the various sectors ofthe society. Good water quality could increase the rate of demand while on the other hand poor water quality could result in decrease in water demand rate (Shannon et al., 2008). People nearby contaminated sites and consumers of untreated drinking water are mainly affected with water borne diseases. Water with degraded quality may also impact the crop productivity and food security. According to United Nations, approximately 700 million people suffer today from water scarcity problem in 43 countries. It is estimated that 1.8 billion people will be affected with absolute water shortage by the year 2025 (Sharma et al., 2017).

Human health is directly related with safe drinking water consumption. Ingestion of contaminated drinking water may create several health related problems. Sometimes, it may cause serious issues even death also. In this regard, the students and community people as the main part of society may play a key role in the better understanding of water quality issues. There are many parameters including physico-chemical and bacteriological parameters to judge the quality of drinking water for which certain guidelines has been issued by various authorities like WHO (Sharma et al., 2017).

In Katsina metropolis adequate supply of portable water is lacking. Thus, residents in the low income residential areas such as Kofar Marusa a Area resorted to sourcing water from hand dug wells due to affordable cost. In Kofar Marusa area hand dug wells are the most common sources of domestic water supply for drinking and other domestic uses and in most houses a pit latrine is used for sewage disposal. In addition, the area lacks adequate infrastructure for surface water drainage sand solid waste disposal. Furthermore, some of the HDWs are poorly constructed while some others are located close to pollution sources such as the pit latrines. Therefore, the water from HDWs in Kofar Marusa should be assessed to ascertain their quality for consumption.

MATERIALS AND METHODS

Description of study area

According to Wikipedia, Katsina has a hot semi arid climate and is one of the thirty six states that constitute the federation of Nigeria covering an approximate land mass of about 24,192 km^2. It is approximately located between latitude 11°00'N to 13º25'N and longitude 6°45'E to 9°05'E and is estimated to cover about 13% of Nigeria's landmass. The state is bounded by the Niger republic to the north, Jigawa and Kano states to the east, Kaduna state to the south and Zamfara state to the west, the state has 34 local government areas with an estimated population of over 7.4 million.

Sample collection

The water samples were collected from 10 Hand dug wells located at various locations in Kofar Marusa area in Katsina State. The water samples were collected directly from each well by means of a sterile plastic container fitted with a weight at the base; taking care to avoid contamination by surface scum. The samples were named HDW1 to HDW10 for easy identification, with respective depth of 7.3m, 4.89m, 6.44m, 5.43m, 7.03m, 6.25m, 7.00m, 4.50m, 5.02m, and 7.45m. The samples were collected on 16-08-2019 and were taken to the Ajiwa Water Treatment Plant for examination and analysis.

Methods of analysis

The standard laboratory analysis was used in collaboration with the benchmark standard of WHO and the NSDWQ to assess water quality from HDW in Kofar Marusa a area based on physical, chemical and bacteriological parameters. The variables examined under the three parameters include: The physical parameters of Turbidity, pH, Total dissolved solids and; the Chemical parameters were Total Hardness and calcium hardness, bacteriological parameters includes faecal coliform and total coliform.

Physico-chemical analysis

The water samples collected were analyzed for pH, turbidity, total dissolved solids, total hardness, calcium hardness as presented in (Table 1).

Table 1: Physico-chemical and Bacteriological parameters of hand dug wells water samples.

Parameters	Turbidity (NTU)	PH (mg/l)	TDS (mg/l)	Total Hardness (mg/l)	Calcium Hardness (Mg/l)	Faecal Coliform	Total Coliform
HDW1	1.610	7.04	338	142	23.20	3	8
HDW2	0.829	6.87	359	160	22.00	1	2
HDW3	0.767	6.87	521	121	25.10	2	5
HDW4	0.998	6.88	437	101	32.00	1	2
HDW5	1.040	6.88	355	118	31.08	3	8
HDW6	0.410	7.18	905	150	30.00	0	2
HDW7	0.729	7.00	1294	131	25	1	2
HDW8	7.790	6.82	654	140	15	4	13
HDW9	1.310	6.58	851	102	35	2	5
HDW10	0.747	6.57	879	150	25	1	2
WHO	5 – 25	6 – 8.5	1500	200	25 – 100	0	0
NSDWQ	5	6 – 8.5	500	150	50	0	10

WHO=World Health Organization, NSDWQ= Nigerian standard of drinking water quality

pH

The pH value of any water body significantly depends on the temperature of the water body and varies according to the temperature variation of the aquatic body. pH is actually the presence of hydrogen ions (H^+) in the sample. The value of pH varies from 0 to 14. Water samples with a pH lower than 7.0 are considered as acids whereas the samples with a pH more than 7.0 up to 14.0 are considered as alkaline in nature. pH 7.0 has been considered as neutral value of pH. The alkaline nature of water may be due to the presence of carbonates and bicarbonates of lime-stones from nearby rocks where as the acidic nature of water body may be due to the presence of humic acid produced by the decay of forest vegetation (Joshua et al., 2014). The pH of the water samples was determined using the Wagtech pH meter. 10 ml of each of the samples was poured into a sterile beaker and the anode of the pH meter was dipped into it and readings were obtained when it was stable. In all the water samples the pH values ranged from 6.57 - 7.18 which are within the standards of WHO and NSDWQ in Nigeria.

Turbidity

Turbidity measurements indicate the level of materials that are suspended in the water. It therefore expresses the light scattering and absorbing properties of water caused by the presence of particles such as clay, silt, colloids and microorganisms (Miner et al., 2016). Turbidity in water occurs due to suspended material, colloidal matter, and finely divided inorganic or organic matter. Particulate matters including the attached microorganisms like bacteria, viruses and protozoa which are threat to human health, increase the problem of turbidity in surface water whereas clay or chalk particles or the precipitation of non-soluble reduced iron and other oxides creates the turbidity problem in ground water (Sharma et al., 2017). The turbidity analysis of all the samples from the HDWs showed values ranging from 0.41-7.79 NTU. The 7.79 NTU is the highest value above the maximum safety limits of 5 NTU as recommended by both NSDWQ and WHO. Therefore, water from the HDWs in Kofar Marusa area is fit for drinking in terms of turbidity values, accept for HDW 8 with the turbidity value of 7.79 NTU that requires treatment.

Total dissolved solids

The WHO standard recommended a value of 1500mg/l as safe water for drinking, but the NSDWQ recommended maximum value of 500mh/l of water as safe drinking in Nigeria. Therefore the only water samples with TDS values below 500mg/l were considered safe for drinking. From the result of the analysis the TDS values were between 338 and 1294. This means that the TDS values in some samples were below the maximum limits while some others were above the maximum limit of 500mg/l recommended by NSDWQ. Only results of water samples from 4 HDW: 1, 2, 4, and 5 recorded values 338mg/l, 359mg/l, 437mg/l, and 355mg/l respectively, and were considered safe for drinking in Nigeria, based on the TDS as recommended by the NSDWQ. The high TDS values in the study area might be a result of dissolution of weathered materials from the rock formation in the study area or from pollution through leaching from pit latrines in to the hand dug wells due to the un-protective nature of the hand dug wells in Kofar Marusa area.

Total hardness

The hardness of water was explained as the capacity of water to precipitate the soap. Dissolved polyvalent metallic ions, mainly calcium and magnesium cat ions from sedimentary rocks, seepage and runoff from soils

are responsible for water hardness. The values of total hardness recorded in the water samples ranges from 101-160mg/l. the HDW 2 is the only one with the high value of 160mg/l above the 150mg/l recommended by NSDWQ which makes it not safe for drinking.

Calcium hardness

The values of calcium hardness in the water samples were between 15-35 mg/l which shows that all the samples are suitable for consumption in terms of calcium hardness as the values are not above 50mg/l permitted safety limit for drinking water in Nigeria by the NSDWQ.

Faecal coliform

The faecal coliform values obtained were high, ranges from 1-4 except a HDW 6 in which nothing was detected, based on the permitted safety limit for drinking water in Nigeria by NSDWQ only water in HDW 6 are suitable for consumption.

Total coliform

The total coliform values ranges from 2-13 cfu/ml in which HDW 8 is the only one with the highest value of 13 beyond the 10 cfu/ml permitted safety limit for drinking water in Nigeria by the NSDWQ.

Conclusions and recommendation

The results of the analysis showed a variation in water quality parameters. In some parameters, the water samples from hand dug wells in Kofar Marusa areas are within safety limits while in many parameters the water quality either falls below or in excess of the standards set by the NSDWQ and WHO. Therefore, the study concluded that water from hand dug wells in Kofar Marusa areas are not safe for drinking and the water should be treated before drinking. The study recommended regular assessment of ground water quality and a further research to determine the sources of ground water pollution in Kofar Marusa areas in order to design measures for improving water quality in HDWs in the study area.

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