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Assessment of Water Quality from Hand Dug Wells in Kurmin Siddi, Kaduna State

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Abstract *After considering the necessity for portable water and hand dug wells as the common source of water, physicochemical and biological analysis was carried out on water samples collected from four hand-dug wells located within Kurmin Siddi settlement in Kaduna State, Nigeria. Mean values of the measured parameters were Turbidity (2.50±0.01 to 4.90±0.20 NTU) Hardness (61.99±0.02 to 83.70±0.01 mg/L), conductivity (0.06±0.83 to 1.66±0.32 µS/cm6), pH (6.30±2.27 to 8.21±0.24) and total coliform count (9 to 26). The analysed parameters were compared with WHO (2002) requirements for drinking/portable water. Although all the measured parameters were within WHO standards, the total coliforms count is above the standard which indicate that the water is not suitable for drinking except it is treated*

Key Words: Portable water assessment, hand-dug well, physicochemical and bacteriological assessment.

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1.0 Introduction

Water is the most abundant and essential commodity in life. 75% of the earth surface is covered by water. (WHO, 2006). Despite being the essential commodity, most settlement in Nigeria lack access to portable water because of excessive cost involved in design and management of water treatment plant (Eboh *et al*., 2017). Consequently, since the demand for water is always high, several individuals and communities have resort to affordable source such as bore holes, shallow wells (hand dug and machine dug), collection and storage of rain water, stream water, etc. Shallow wells manually dug are the major source of water in most settlements within the Northern part of the country because stream or river are not common, in addition to the nearness of the first layer of the underground [illegible]08). Water pollution can be caused by improper management of human waste, fertilizer, radioactive waste, petroleum product, herbicide, and insecticide and community market waste. (Nasiri *et al.,* 2018; Jagaba *et al.,* 2020). The presence of bacteria and pathogenic (disease causing organism) has been reported to constitute significant contribution to water pollution (Agunwamba, 2001; Chappelle, 1993; Wahab, 2008). Organo leptic properties of water can be influenced by organic impurities (Chilton *et al.,* 1992; Kolo *et al.,*2009). Toxic heavy metals are also significant cause of water pollution (Chiroma, 2008; Odoemelam and Eddy, 2009). Shallow wells have been widely reported to be a strong source of contamination and in most cases, water from shallow wells hardly meet WHO recommended limits (UNESCO, 2013). For example, Samuel *et al*. (2016) stated that most of the drinking water in rural areas are contaminated with faecal coliform and other microorganisms. Rutkoviene *et al*. (2005) found that more than 50 % of swallow well water in Luthuania are polluted with nitrate and they concluded that the strongest impact on nitrate pollution of the wells is related to the distances of the well to the outhouse, cowshed, manure pile and vegetable garden, as well as the surroundings of the well and local human activities. According to Egbinola and Amanambu, (2014), ground water is the main source of water for domestic use in Nigeria; however, out of a total of one hundred well water studied, 98 and 100 of the samples were contaminated with arsenic and fluoride. Ijebor *et al* (2019) assessed hand dug well in Bauchi metropolis and the results show high level of total coliform and faecal coliform. Other studies by Yakubu (2013), Gin *et al.,* 2018, Boateng *et al.,* 2015, Mohammed et al., 2018 and Taiwo *et al.,* 2011 revealed that the waters are unfit for consumption and may pose a serious health issue. Etim (2017) also reported pollution of some shallow well water by arsenic in Ibadan and observed that 74.3 and 100 % of the water samples were contaminated by arsenic during wet and dry seasons respectively. Wongsasluk *et al.* (2013) observed high level of contamination of swallow ground water well in agricultural area in Ubon Ratchathani province in Thailand. In Pakistan, contamination of ground water from shallow wells has been reported by Shahid *et al.* (2018) with respect to arsenic. According to Orebiyi *et al*. (2010), shallow well water may constitute serious health risk if not treated. Almost all reported studies on shallow well have revealed that the water may not be portable for drinking. Besides, different locations could have different source of contamination and different levels. Therefore, the present study is aimed at investigating the quality of hand dug wells water in Kurmi Siddi settlement of Kachia Local Government Area, Kaduna State

2.0 Materials and Methods

2.1 Materials

Analytical grade reagents were used. These included, MacConkey broth, HCl, phenolphthalein and disodiumethylene diamminetetraacetate (Na_2EDTA). They were obtained from Steve Moore chemical store Zaria, Kaduna State. 17.50 g of MacConkey broth was measured and dissolved in 500 mL flask using 500 mL distilled water and this was dispensed into culture tubes containing an inverted Durham tubes, and the culture tubes were capped with foil paper. Culture tubes was sterilized in an autoclave at 115 ℃ for 15 minutes (WHO, 2006).

2.2 Study area

Kurmin Siddi is located in Kachia Local Government Area in the southern part of Kaduna state. It is bounded in the north by Chikun and Kajuru LGAs, in the east by Zango Kataf LGA and the south by Kagarko and Jaba LGAs. Kachia LGA is located between latitude 7 °32' and 10 °10′N and longitudes 7°00′E and 8°05′E.The local government area is divided into three main relief features: the western zone comprised mainly of plains and lowland areas with 602 m above the sea level as the highest peak, while the central part comprised of upland areas with elevation ranging between 602 m and 676 m above the sea level. The eastern margins of the LGA are more strongly dissected with elevation ranging from 671 m to 926 m. There are three major rivers in Kachia LGA. The largest of these rivers is the River Bishimi which is located in the southern extreme of the LGA. At the middle of the LGA is River Amful, which drains the central as well as the western parts of the LGA. River Sarkin Pawa forms a natural boundary between Kachia LGA and Chikun and Kajuru LGA in the north.

2.3 Water sample

Four (4) wells were randomly selected to represent the study area. The distant of the wells from possible contamination sources were identified as shown in Table 1. Water samples were collected by using hard plastic and screw capped bottles that have been sterilized to avoid contamination. The well water samples were aseptically transferred into the sterile containers. Samples for bacteriological analysis were kept in screw capped bottles that have been sterilized in an autoclave for 15 minutes at 121 ℃ before transferring them to the laboratory for microbial analysis.

Table 1: Well description and distance from toilet and gutter

Well description	Distance from toilet	Distance from gutter
Well one (W1)	7.50	15.00
Well two (W2)	10.50	12.00
Well three (W3)	9.00	16.00
Well four (W4)	6.00	14.00

2.4 Water sample analysis

Analysis of water samples was carried out at the Department of microbiological laboratory faculty of science, Kaduna state University and Central Laboratory Barnawa water Board Kaduna State.

pH of the water samples was determined in situ by inserting the probe of a pre-calibrated pH meter into the water. Also the conductivity of the water was determined in situ using model 4510 conductivity meter

The hardness of the water was determined using titrimetric method. 50 mL of the sample was transferred into a conical flask, 0.5 mL of buffer solution was added followed by approximately 0.2 g of total hardness indicator with stirring. The solution was then titrated with the standard disodium ethylene diamminetetraacetate (Na_2EDTA) with stirring until the color changed from red to blue. The titre value was taken (WHO, 2006).

Turbidity meter was used for measuring the turbidity of the water. The power button was switched on and the standard was inserted into sample cell and covered. Using the zero buttons, the reading on the screen was adjusted to “0.00”. The 0.00 NTU standard was removed and 10.00 NTU standard was inserted into the sample and covered. Using the standardize button, the reading on the screen was adjusted to 10.00. An empty sample bottle was filled with the sample to be measured and covered. The sample bottle was cleaned and inserted into the sample cell and covered, the displayed reading was taken (WHO, 2006).

2.4.1 Total Coliforms count

Five rows of tubes were arranged in three test-tube racks. The tubes in the first row hold 10 mL of double-strength presumptive medium while the tubes in the second and third rows contained 10 mL of single –strength presumptive medium. With syringe, 10 mL of sample was added to each of the five tubes in first row using a calibrated syringe. With sterile syringe, 1 mL of sample was added to each of the five tubes in the second row. With another sterile syringe 0.1 mL of sample was added to each of the five tubes in third row. After gently shaking the tubes to mix the contents, the 15 tubes were incubated at 35℃ or 24 hours. Each of the tube was observed for the presence of gas and the number of positive tubes enters the table. The presumptive results were confirmed after 24 to 28 hours by transferring a loopful of broth to a confirmatory broth and incubated at 44 ℃ for 24 hours and the presence of coliforms was confirmed by the released of gas (WHO, 2006).

3.0 Results and discussion

Measured values of pH of the well water are presented in Table 2. The pH of the well water varied from 6.30±2.27 (at W1) to 8.21±0.24 (at W3). Mean pH at W2 and W4 were 8.10±0.22 and 7.10±0.32 respectively.

Table 2. Results of pH parameter for well waters

Well	pH	WHO standard
W1	6.30±2.27	
W2	8.10±0.22	7.0-8.5
W3	8.21±0.24	
W4	7.10±0.32	

The pH is mildly acidic at W1, mildly alkaline at W4 and alkaline at W2 and W3. There is no strong correlation between the measured pH and distance of the well from pit toilets (laterine). Mohamed and Kitwana (2018) reported pH values of some well water in some hand-dug wells from Micheweni District of Pemba Island, Zanzibar to range from 6.9 to 8.30, which is within the range obtained in this study. Accepted range for pH of portable water is 7.0 to 8.5 (WHO). Therefore, the analysed well water is not polluted with respect to pH except at W1.

Table 3: Results of preliminary screening of water samples for the presence of total coliform

Sample number	W1	W2	W3	W4
Number of test tubes	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Double strength (10 mL)	+ + + + +	+ + + + +	+ + + + -	+ + + + +
Single strength (1 mL)	+ - - + +	+ + + - +	+ + - - -	+ + - - +
Single strength (0.1 mL)	+ + + + -	+ + - - -	+ - - - +	+ + - + +

Table 4: Confirmatory results for total coliform count in well water

Sample number	W1	W2	W3	W4
Number of test tubes	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Double strength(10mL)	+ + - - +	+ - - + -	+ + + - +	+ + + + -
Single strength (1 mL)	+ + - - -	+ - - + -	+ + + -	+ - +
Single strength (0.1 mL)	+ - - -	+ - -	+ + +	+ - - - -

Table 5: Concentration of total coliform count in the water

Well	Total coliform count (/100ml)	WHO Limit
W1	11.00	
W2	9.00	0.00
W3	11.00	
W4	26.00	

The results for the presumptive and confirmatory test for total coliforms count shown in Table 3 and 4 indicated the presence of coliform count. This motivated the need for confirmatory tests which also indicated their presence in some of the water samples. The WHO acceptable value for total coliforms count (TCC) in drinking water is 0.00 per 100 mL. Yakubu et al., (2017) and Gin *et al*., (2018) reported the total coliform of hand dug well water to be 94.50 and 105.2 per 100 mL respectively. In comparison, these values are higher than the values gotten from hand dug wells water in Kurmin Siddi, Kaduna state. Consequently, the water samples are contaminated by coliform indicating that it may constitute serious health risk refer with respect to water borne diseases (WHO, 2006). The presence of coliforms means presence of microbial faecal contamination (Akerejola, 2008). The presence of total coliform in hand dug well water and those from other shallow wells have been reported by several investigators (Isa et al., 2015; Mohammed and Kitwana, 2018; Orebiyi, *et al*.,2010).

Electrical conductivity of water is a measure of the concentration of electrolyte in water. Table 6 presents values of electrical conductivities of water from the hand dug wells. Mean conductivity values were 0.06±0.83, 0.14±0.01, 0.01±0.20 and 1.66±0. µS/cm6 at W1, W2, W3 and W4 respectively. These values are low and significantly less than the WHO limit of 1000 µS/cm6. This indicate that the well water does not have significant presence of electrolytes, some of which could be useful to the body. However, the water from the studied wells are not contaminated with respect to conductivity.

Table 6: Mean conductivities of water from the studied wells

Well	Conductivity ($\mu S/cm^2$)	WHO limit
W1	0.06±0.83	
W2	0.14±0.01	1000
W3	0.01±0.20	
W4	1.66±0.32	

Mean turbidly of the well water samples ranged from 2.50 to 4.90 NTU. Measured standard deviation were low indicating low variability of closeness of values. At W1, W2, W3 and W4, mean turbidity was 2.50±0.01, 4.90±0.20, 4.46±0.04 and 3.66±0.18 NTU respectively. These values are below WHO limit of 10 NTU for portable water. Okro *et al.,* (2014) reported the values of total hardness of hand dug wells water in in Akwa, range from 20 to 0.5 respectively. Therefore, turbidity does not constitute a serious problem to the well water.

Table 7: Mean turbidity of water from hand dug wells in Kurmin Siddi

Well	Turbidity (NTU)	WHO limit
W1	2.50±0.01	
W2	4.90±0.20	10.00
W3	4.46±0.04	
W4	4.46±0.04	

Total hardness of W1 (83.70mg/L), W2 (83.20 mg/L), W3 (61.99 mg/L) and W4 (81.46mg/L) were within the WHO acceptable value for drinking water (Table 8). All the four wells water in Kurmin Siddi are moderately hard water category of 75-120 mg/L which can be treated by simple boiling the water. Yakubu *et al*., (2017) reported the values of total hardness of hand dug wells water in Sabon Gari Zaria, range from 166.3 to 190 mg/L respectively. This shows that the values of this study are lower than the reported values. Health studies in several countries in recent years indicate the mortality rates from heart diseases are lower in areas with moderately hard water (Chiroma, 2008).

Table 8: Hardness of water from hand dug well in Kurmin Siddi

Well number	Total hardness (mg/L)	WHO limit
W1	83.70±0.01	
W2	83.20±1.13	150
W3	61.99±0.02	
W4	81.46±0.11	

4. 0 Conclusion

The present study indicates that most well water in the studied area are heavily contaminated with coliform organism but there is no significant contamination with respect to hardness, turbidity and conductivity. Therefore, the water is not suitable for drinking except it is treated.

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