

Original Research Article

Does Source Sanitation affect Water Quality?

ABSTRACT

Aim: To correlate sanitation around water source with the quality of water from the source

Study design: This study was a cross-sectional study on 15 boreholes across 5 political wards using quantitative method of data collection.

Place and Duration of Study: The Field survey was carried out in Selected wards of Sabongari Local Government Area (LGA) of Kaduna State, Nigeria, while the laboratory analysis was carried out at the Department of Water Resources and Environmental Engineering between February and March, 2017.

Methodology: We included all functional boreholes in each of the five selected wards within Sabon gari LGA that serve as communal source of water supply. A total of 15 boreholes (3 from each ward) were studied for water quality and surrounding sanitation. The physicochemical and microbiological analysis of water samples collected from the respective boreholes were carried out using standard methods and the results were compared to the Nigerian Standard for Drinking Water Quality and the WHO standards for conformity or otherwise while a checklist was used to assess the surrounding sanitation. The total score of both the water quality and sanitation were categorized respectively as poor, fair and good. A t-test was carried out using STATA/SE 13.1 Statistical Software to correlate the surrounding sanitation with the water quality.

Results: A total of 15 boreholes were investigated. Both the confidence interval for the mean difference between water quality and sanitation (0.2384 – 1.3616) and the *P*-value (*P* = .0086) suggest that there is a relationship between the sanitation and the quality of water.

Conclusion: As efforts are being made to increase access to clean water especially in developing economies like Nigeria, serious attention need to be given to the sanitation of the surroundings of the water source to prevent compromise of the water quality.

Keywords: Borehole, Physicochemical characteristics, Sanitation, Water quality, Zaria

1. INTRODUCTION

Clearly spelt out in the post-2015 Sustainable Development Goals (SDGs) is the call for universal access to clean water and sanitation by 2030 [1] yet the attainment of this goal still remains a major challenge for sub-Saharan Africa [2,3]. This is largely due to financial limitations on the part of the Governments within the regions to provide this amenity declared as a basic human right by a consensus of world governing bodies [4].

While efforts are being made by governments at various levels to meet the water needs of the people even with the limited resources, a majority of the populace still have to cater for their water needs at their respective household level. These personal efforts for household supply include wells and boreholes while others depend on direct consumption of surface water where available. While much effort is currently being made to increase the access to clean water both by governments and individuals, the efforts in the direction of sanitation seem not be commensurate. This is reflected among other indices by the poor sanitation around the water source. For instance, a careful observation at the surrounding of some

boreholes especially around the northern part of Nigeria, are refuse dumps and other kinds of activities that have tendencies of introducing impurities to the water.

Previous researches have assessed the physicochemical and microbiological characteristics of water from various sources, the influence of drinking water quality on health and other aspects of human concerns as well as the public perception about drinking water from boreholes but studies on the assessment of the sanitation condition of the water source surrounding on the quality of water from that source seem to be non-existent [4–12]. It therefore becomes imperative for researches such as this to be carried out to establish whether the sanitation of the surrounding of the water source have any effect on the quality of water from that source.

2. MATERIAL AND METHODS

2.1 Study Area

The study was conducted in Sabon gari local government area of Kaduna state of Nigeria. The LGA lies between Latitude $11^{\circ} 5' N$ and $11^{\circ} 16' N$, and Longitude $7^{\circ} 34' E$ and $7^{\circ} 47' E$. The LGA consists also of 11 political wards. The wards are Samaru, Jama'a, Bassawa, Hanwa, Dogarawa, Chikagi, Muchia, Zabbi, Jushi, Angwa gabas and Bomo. The map of study area is shown in Fig. 1.

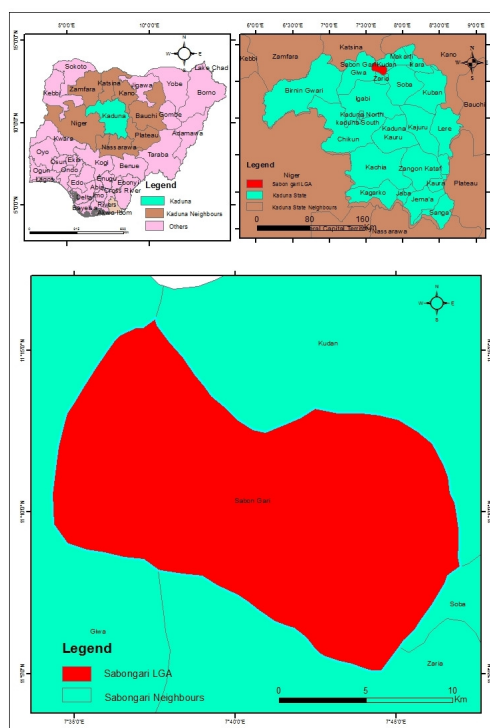


Fig. 1: Map of Study Area

2.2 Study Design

This study was a cross-sectional study on 15 boreholes across 5 political wards using quantitative method of data collection.

52 2.3 Inclusion and Exclusion Criteria

53 The study population included all functional boreholes in each of the five selected wards
54 within Sabon gari LGA that serve as communal source of water supply. Boreholes that were
55 not functioning at the time of the research as well as boreholes and wells that served only
56 individual households were excluded.

57 2.4 Sampling Technique

58 A multi-level sampling technique was used in this study. The first level involved the
59 purposive selection of five (5) wards (Bassawa, Chikaji, Dogarawa, Jama'a and Samaru)
60 based on accessibility and security concerns. The second level involved the selection of the
61 boreholes based on the inclusion and exclusion criteria earlier stated. Based on this three (3)
62 boreholes in each of the wards making a total of 15 were selected for the study.

63 2.5 Preparation for Data Collection

64 Reconnaissance visits were made to the District Heads of the respective communities to
65 intimate them on the research and solicit for their support. The assessment of the water
66 sources for inclusion or exclusion was done during these visits. Sterile sample collection
67 bottles were prepared for collection of samples for analysis in the laboratory. Three
68 undergraduate students were trained as research assistants for field enumeration. The
69 checklist for assessment of water source sanitation was pretested in the course of the visits.
70 All the required reagents and media for the physicochemical and microbiological analysis
71 were prepared before the commencement of the sample/data collection.

72 2.6 Data Collection Instruments and Data Collection

73 A pre-designed checklist was used to assess the sanitation condition of the selected
74 boreholes. The checklist contained five parameters for assessing the sanitation. The
75 parameters were all positive with a "yes" having a score of "1" and a "No" having a score of
76 "0". The total score for each borehole was used to classify the sanitation as 1=Poor (40%),
77 2=Fair (60%) and 3=Good (80%). Standard laboratory result sheets were used to record the
78 results of the physicochemical and microbiological analysis. The samples for the analysis
79 were collected in sterile bottles and labeled appropriately before transferring them to the
80 laboratory below a temperature of 4 °C for analysis. The results of the parameters were
81 compared with the Nigeria Standard for Drinking Water Quality (NSDWQ). The results of the
82 parameters that conform to the limits were labeled "yes" with a score of "1" while those that
83 fail to meet the standards were labeled "No" with a score of "0". The water quality was
84 classified based on the total score as follows: Poor ($\leq 60\%$) ranked 1, Fair ($>60\%$ but $\leq 70\%$)
85 ranked 2 and Good ($>70\%$) ranked 3.

86 2.7 Data Analysis

87 STATA/SE version 13.1 statistical software was to carry out the analysis of data. Paired t-
88 test was carried assess the relationship between the sanitation of the water source and the
89 quality of water. A 95% confidence level was used and $P \leq 0.05$ was considered statistically
90 significant.
91

3. RESULTS AND DISCUSSION

A total of 15 functional boreholes were identified across the five political wards of Bassawa, Chikaji, Dogarawa, Jama'a and Samaru. The results of the physicochemical and microbiological analysis are presented in Table 1 and 2. The results show that the BOD of all the samples tested did not conform to the acceptable limits. Although BOD limits were not specified in both NSDWQ and WHO standards, BOD of zero is generally accepted in drinking water. BOD is undesirable in drinking water as it is indicative of the presence of organic contaminants in water. Although the BOD values for all the samples were not so high, it still makes the water objectionable. All the samples analysed had a colour of 5 NSA which is far less than the 15 NSA limit specified by both NSDWQ and WHO. Only 33.33% of the samples conformed to the hardness limit of 150 mg/l specified with Dogarawa1 having the least value of 10.1 mg/l. the conformity of the remaining 67.67 % could be attributable to the geological characteristics of the area which is not within the scope of this study. All the samples conformed to the limits of 5 NTU for turbidity while 86.67 % conformed to the limit for Total Dissolved solids. Meanwhile, 66.67 % of all the samples fell within the specified 6.5 – 8.5 range, all samples passed the nitrate test. This implies that no faecal contamination has taken place. The Temperature of 80% of the samples was above the ambient temperature of 25 °C at the time of the study. The percentage of samples that conformed to the limits for electrical conductivity and total coliforms were 86.67 % and 46.67% respectively. The below average conformity of the Total coliforms should be taken with seriousness as it is indicative of probable faecal contamination which probably was introduced in the course of the activities around the borehole. This seems to contradict the nitrate results but could only be a reflection of the variations in the degree of contamination. 13.33 % of the samples had good qualities while 60 % and 26.67 % had fair and poor qualities respectively.

Table 1: Physicochemical and Microbiological Characteristics of the Water Samples

Sample	Bod (mg/L)	Colour (NSA)	Hardness (mg/l)	Turbidity (NTU)	Total Dissolved Solids (mg/l)	Chloride (mg/l)	pH	Nitrate (mg/l)	Temp (°C)	Electrical conductivity (µS/cm)	Total coliforms (Cfu/100ml)	Quality
Chikaji1	0.2	5	262.6	0.863	80.8	12.5	8.68	0	34	165.1	0x10 ³	Good
Chikaji2	0.7	5	1080.7	0.965	336	13.5	7.66	1.2	33	694	0x10 ³	Fair
Chikaji3	0.9	5	2111	0.372	362	17.5	7.56	0	33	727	1x10 ³	Poor
Samaru1	1.3	5	302.02	1.68	600.3	118	7.4	0	24	1225	2x10 ³	Poor
Samaru2	2.2	5	132.3	0.454	455	115.6	7.3	2.1	25	949	1x10 ³	Fair
Samaru3	0.5	5	301.2	0.412	315.6	50.8	7.5	3.2	24	630	2 x10 ³	Poor
Dogarawa1	0.3	5	10.1	0.278	92.8	21.99	9.06	2.4	29	188.4	2 x10 ³	Fair
Dogarawa2	0.2	5	80.8	0.724	110.4	27.49	8.82	5.3	28	223.8	1x10 ³	Good
Dogarawa3	2.3	5	262.62	2	68.6	14.99	8.83	1.6	29	136	1x10 ³	Fair
Bassawa1	1.8	5	151.5	0.863	118.8	22.99	8.31	0	29	244	2 x10 ³	Fair
Bassawa2	1.5	5	80.8	0.868	151	42.48	8.22	1.3	28	304	2 x10 ³	Fair
Bassawa3	1.8	5	383.83	0.454	693	61.48	8.1	3.6	28	1357	2x10 ³	Poor
Jama'a1	0.9	5	151.51	0.169	123.1	17.9	8.56	1.3	28	244	1 x10 ³	Fair
Jama'a2	0.7	5	212.11	0.789	303	29.49	8.44	4.3	28	151	2 x10 ³	Fair
Jama'a3	0.2	5	141.41	0.734	80.1	11.49	8.47	0	29	165.1	2 x10 ³	Fair
NSDWQ	0	15	150	5	500	250	6.5-8.5	50	25	1000	1 x10 ³	
WHO	0	15	150	5	500	250	6.5-8.5	50	25	2500	1 x10 ³	

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122 **Table 2: Physicochemical and Microbiological Characteristics of the Water samples**

Characteristics	Frequency	Percentage
BOD		
Yes	0	0
No	15	100
Colour		
Yes	15	100
No	0	0
Hardness		
Yes	5	33.33
No	10	66.67
Turbidity		
Yes	13	86.67
No	12	13.33
Chloride		
Yes	15	100
No	0	0
pH		
Yes	10	66.67
No	5	33.33
Nitrate		
Yes	15	100
No	0	0
Temperature		
Yes	3	20
No	12	80
Electrical Conductivity		
Yes	13	86.67
No	2	13.33
Total Coliforms		
Yes	7	46.67
No	8	53.33

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124 Similarly, the results of the assessment of the sanitation condition around the boreholes are
125 presented in Table 3 and 4. All the water samples were clean in their appearance.
126 Meanwhile, refuse dumpsites were found around 26.67 % of the boreholes. More so,
127 washing activities were found around about 33 % of the boreholes. None of the boreholes
128 had drainage around it while only about 13 % had clean surrounding. Based on the weighths
129 allocated for these observations, about 7 % had good sanitation while 40 % and 53 % had
130 fair and poor sanitations respectively.

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135 **Table 3: Results of the Assessment of Sanitation around Water Source**

Samples	Drinking water is clean	No dump site around water source	No washing around water source	The source is properly drained	The source surrounding is clean
Chikaji1	Yes	Yes	Yes	No	Yes
Chikaji2	Yes	Yes	No	No	No
Chikaji3	Yes	No	Yes	No	No
Samaru1	Yes	Yes	No	No	No
Samaru2	Yes	Yes	No	No	No
Samaru3	Yes	No	Yes	No	Yes
Dogarawa1	Yes	Yes	Yes	No	No
Dogarawa2	Yes	Yes	Yes	No	No
Dogarawa3	Yes	Yes	No	No	No
Bassawa1	Yes	No	Yes	No	No
Bassawa2	Yes	No	Yes	No	No
Bassawa3	Yes	Yes	Yes	No	No
Jama'a1	Yes	Yes	No	No	No
Jama'a2	Yes	Yes	Yes	No	No
Jama'a3	Yes	Yes	Yes	No	No

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137 **Table 4: Sanitation Characteristics of the Water Sources**

Characteristics	Frequency	Percentage
Drinking water is clean		
Yes	0	0
No	15	100
No refuse dumpsite around Source		
Yes	11	73.33
No	4	26.67
No washing at the source		
Yes	10	66.67
No	5	33.33
Drainage at the source		
Yes	0	0
No	15	100

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139 Furthermore, the results of the t-test to examine whether or not the quality of water has a
140 relationship with the sanitation are presented in Table 5.

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142 **Table 5: Relationship between the water source sanitation and water quality**

Variable	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]
Water quality	15	2.33	0.1869	0.7237	1.9325 – 2.7341
Sanitation	15	1.53	0.1652	0.6399	1.1790 – 1.8877
Difference	15	0.80	0.2619	1.0142	0.2384 – 1.3616

t = 3.0551

P = .0086

143 The confidence interval for the mean difference between water quality and sanitation does
144 not include zero which suggests a relationship between them. This is further buttressed by

145 the small P -value ($p = .0086$). This implies that there is actually a relationship between the
146 water quality and the source sanitation.

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148 **4. CONCLUSION**

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150 The results obtained in this study have shown evidence of a relationship between the quality
151 of water from the boreholes studied and the conditions of sanitation around the boreholes. It
152 is therefore very important for policy makers to pay attention to maintaining good sanitation
153 around water sources as they have the capability of compromising the water quality. As
154 efforts are being made to increase access to clean water especially in developing economies
155 like Nigeria, serious attention need to be given to the sanitation of the surroundings of the
156 water source to prevent compromise of the water quality.

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COMPETING INTERESTS

None

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