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EFFECT OF PROXIMITY OF PIT LATRINE AND SOAK-AWAY ON THE MICROBIOLOGICAL AND PHYSICOCHEMICAL QUALITY OF WELL WATER IN FOUR LOCAL GOVERNMENT AREAS OF KANO METROPOLIS

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ABSTRACT
This study determines the microbiological and physicochemical quality of well water samples in relation to their proximity to pit latrine in four Local Government Areas of Kano Metropolis. A total of 32 water samples were collected and analyzed for aerobic mesophilic bacterial count, fungal, coliform and faecal coliform count. The physicochemical parameters analyzed included Chromium, Cadmium, Lead, Zinc, Copper, Iron, Phosphate, Nitrate, Electrical conductivity, Total dissolved solid, Biological oxygen demand, Dissolved oxygen, Temperature and pH. The mean aerobic mesophilic bacterial, fungal, coliform and faecal coliform count in the well water samples close to pit latrines in Dala Local government were 2.7×10^5cfu/ml, 7.86×10^4cfu/ml, 6.75/ml and 3.5/ ml respectively. These were higher than the count of the Well water samples from same Local government that are located away from pit latrine with the mean values of 1.7×10^5cfu/ml, 2.83×10^4cfu/ml, coliform counts 1.0/100ml and 3.5/100ml faecal coliform count respectively. However, a total of seven genera of bacteria were isolated including E.coli, Enterobacter spp, Shigella spp, Salmonella spp, Proteus spp, Klebsiella spp, Pseudomonas spp. Similarly, three fungal genera were isolated including Aspergillus spp, Penicillum pp, and Cladosporium spp. The average mean value of Electrical conductivity ranged from 14.3-1118.3µs/cm, pH 5.8-7.0, Temperature 25-28^{o}C, Cadmium 0.09-55mg/ Lead 0.05-0.53mg/L, Zinc 0.05-0.66mg/L, Cupper 0.06-0.27mg/L, Nitrate 0.12-18.83mg/L, Chromium 0.09-0.44mg/L, Phosphate 0.11-16.2mg/L, Iron 0.06-0.46mg/L. Some of the water samples analysed were not within the acceptable limit of World Health Organization and National Standards for Drinking Water Quality standard for drinking water quality. Wells should be located at least 30m away from pit latrine and soak aways as proposed by World Health Organization and National Standard for Drinking Water Quality.
Keywords: Well water, Chromium, World Health Organization, Enterobacter spp.

INTRODUCTION

Water is no doubt one of the most important resources on earth and remains man's prime need in his environment. It is also a fact that potable water supply is lacking in many communities despite being one of the most important resources on earth (Tye, 2012). According to World Health Organization (2006) about 2 billion people lack access to potable drinking water supply, in most cities, towns and villages in Nigeria. Valuable man's hours are spent on seeking and fetching water, often of doubt quality from distant sources (Efe, 2005). The high population density, poor sanitation habit and lack of enforcement of environmental law have contributed immensely to the pollution of water sources (Kolo, 2013).

Pollution in groundwater can be from various sources mainly municipal (i.e., leakages of solid wastes and liquid wastes from landfills), industrial (i.e., liquid waste tanks and pipe line leakages, oil field and brine) and agricultural sources (Kolo, 2013) These problems of acute water supply have resulted in the rapid increase of hand dug wells; however, most of the dug wells are located within the proximity of soak away and pit latrines (Chilton, 1996).

However, WHO (2003) recommended that well should be located at least 30m away from latrine and 17m from septic tanks in order to avoid seepage of fecal matters into the well water.

Contrary to which may likely introduce pathogenic microorganism into the water source. Presences of water borne pathogens are usually established by the presence of faecal coliforms or *Escherichia coli* serving as an indicator organism for faecal contamination or pollution (Okafor, 2010) Bacteriological examination of water is a powerful tool in order to foreclose the presence of microorganisms that might constitute health hazard (Singh and Neelam, 2011). However World Health Organization (WHO) recommended that no fecal coliform should be present in 100ml of drinking water. Good quality water should be colorless, odorless, tasteles and free from faecal contamination in excess of WHO tolerable level (Okafor, 2010). However, most of the communities within the study areas depend largely on hand dug wells as their major sources of drinking water. These wells were constructed without giving consideration to the recommended distance between well, to latrine, septic tanks and soak away. This means water obtained from these sources (wells) is vulnerable to contamination. This study was carried out to determine the Microbiological quality of hand dug well water that is located in close proximity to pit latrine.

MATERIALS AND METHODS

Study Area and field survey

This study was conducted in four Local Government Areas of Kano State (Dala, Gwale, Kumbotso and Kano municipal). Recurrent visits were made to the study area during which collection of primary data was done through group and individual interviews to the respondents. The data was collected from functional wells which were conceptualized as those in frequently use.

Collection of Water Samples

A total of 32 water samples were collected. From each Local Government Area 8 samples were collected i.e. 4 from well located close to pit latrine and 4 from well located far away. The wells were randomly selected, and the distance between the well and sanitary structure (Pit Latrine) were measured using measuring tape. Water samples were collected in 25ml non transparent crew capped brown bottles from each of the well using properly clean and sterile container tied with 40 feets rope, the sampling bottles were rinsed with the water to be sampled. Parameter such as temperature, pH were measured right in the field, while the samples were collected in the bottles two for physicochemical analysis and one for microbiological analysis. The samples that were not analyzed immediately were stored in a refrigerator at 4^0C (Cheesbrough, 2000).

Bacteriological Analyses of the Water Samples

Enumuration of Aerobic Mesophilic Bacterial and Fungal Count

Aerobic mesophilic bacteria and fungi in the water sample were analyzed using pour plate method (Dhwala and Lamaster 2003). D ifferent dilutions were inoculated into Nutrients Agar (for bacteria) and Dextrose Agar (for fungi) and incubated at 37^0C for 24 hours. Dilution containing 30-300 discrete colonies was counted and the estimation of viable number of bacterial and fungal in each sample was made and result expressed in colony forming unit per milliliter of the water sample.

Enumeration of Coliforms and feacal coliform counts

Coliforms and feacal coliforms were enumurated using multiple tube fermentation method for the most probable number (MPN) as described by Chesbrough (2005). All the tubes were incubated at 37^0C for 24 hours. After 24 hour the tubes with gas production were scored positive. Brilliant green lactose bile (BGLB) broth and Eosine methylene blue (EMB) were used to further confirm feacal coliforms and members of *Enterobacteriaceae* (Cheesbrough, 2005).

RESULTS

Tables 4.1 and 4.2 show the results of aerobic mesophilic bacterial count, Coliform, faecal Coliform as well as Fungal count. Aerobic mesophilic bacterial count of all the samples, ranged from$1.18\text{x}10^5$to 8.9×10^4 cfu/ml. While well water sample located away from pit latrine from Kumbotso having the lowest count of $1.18\text{x}10^5$cfu/ml, highest count was recorded in well water close to soak away from Gwale with average mean value of $8.9\text{x}10^4$cfu/ml

Coliform count has the highest count with mean value of 119MPN/ml for well water samples close to pit latrine from Kano municipal, while lowest count was recorded in well water sample close to pit latrine from Gwale with average mean value of 0.75MPN/ml.

Table 1: Mean of aerobic Mesophilic Bacteria, Fungal, Coliform and Faecal Coliform Counts of Well Water Samples from the Study Areas

Location (site)	*Distance to pit- latrine	Aerobic Mesophilic Count (cfu/ml)	Fungal Count (cfu/ml)	Coliform Count (MPN/ml)	Faecal Coliform Count (MPN/ml)
NS	Away	$2.79x10^5$	0.0	5.8	3.3
	Close	$2.24x10^5$	$3.23x10^4$	119	2.8
KT	Away	$1.18x10^5$	0.0	3.25	5.5
	Close	$1.82x10^5$	$1.27x10^5$	9.0	3.5
DL	Away	$1.70x10^5$	$2.83x10^4$	1.0	0.8
	Close	$2.70x10^5$	$7.86x10^4$	6.75	3.5
GW	Away	$3.32x10^5$	$2.36x10^5$	0.75	6.0
	Close	$8.92x10^4$	$5.5x10^4$	38.3	0.0
WHO		0.0	0.0	0.0	0.0
NSDWQ		0.0	0.0	10	0.0

WHO (2010, 2006); NSDWQ (2007)

KEYS: KM = Kano Municipal, KT = Kumbotso, DL = Dala, GW = Gwale, *Close (Located less than 30 meters), Away (Located within 30 meters), NS = No statistical difference between water sources location at p > 0.05

Table 2: Frequency of Occurrence of Bacterial Isolates Obtained from Well and Bore Hole Water Samples from the Study Areas.

S/N	Bacterial isolate	Frequency	Percentage (%)
1	*E.coli*	12	50.0
2	*Salmonella* spp	4	16.7
3	*Shigella* spp	2	8.3
4	*Proteus* spp	2	8.3
5	*Enterobacter* spp	1	4.2
6	*Klebsiella* spp	2	8.3
7	*Pseudomonas* spp	1	4.2
	Total	24	100.0

Table 3: Frequency of Occurrence of Fungal Isolates in well and borehole water samples

S/N	Fungal isolate	Frequency	Percentage (%)
1	*Aspergillus*spp	7	50.0
2	*Penicillium*spp	4	28.6
3	*Cladosporium*spp	3	21.4
	Total	14	100.0

Tables 4 and 5 show the physical and chemical parameters of well water samples, respectively. The chromium contents of the well samples ranged from 0.19 to 0.44mg/L, with highest value recorded in well water sample away from pit latrine from Kumbotso Local Government and well water close to pit latrine from Kano municipal Local Government both having same value of 0.44 ± 0.21mg/L. While the lowest, value was recorded in samples from Dala and Kano Municipal Local Governmentof well water close to pit latrine, also having the average mean value of 0.19 ± 0.14mg/L. However, lead content of the well samples ranged from 0.11± 0.02 to 0.32 ±0.33mg/L. Zinc content of the samples ranged between 0.05± 0.02 to 0.20 ±0.08mg/L,with highest value recorded in well water samples away from pit latrine from Gwale Local Government, while well water close to pit latrine from Gwale Local Government have the lowest value as shown on the table . phosphate content of all the samples analyzed have average mean value ranging between 4.83 ± 4.56 to 16.2 ± 1.59mg/L, the lowest value was recorded in well water located away from pit latrine from Dala Local Government having average mean value of 4.83 ± 4.56, the highest value was recorded in well water away from pit latrine from Kumbotso Local Government mean value of 16.2± 1.59mg/L.However, Iron content of the samples ranged between 0.05±0.02 to 0.35 ± 0.10mg/L, while Copper content of the samples ranged between 0.068 ± 0.04 to 0.29 ± 0.30mg/L.

Temperature of the samples ranged between 25.82 ± 12.833 to 27.9 ± 0.216mg/L, lowest temperature value was recorded in well water located away from pit latrine from Dala Local Government. The pH of the samples ranged between 5.8 ± 0.282 to 7.2 ± 0.245mg/L, lower value was recorded in well water located away from pit latrine from Gwale Local Government, while the highest value was recorded in sample from Kano municipal Local Government of well close to pit latrine. The EC of the samples ranged between 107.5 ± 537.1to 143.5 ± 5.94mg/L.

Table 4: Chemical Parameters (mg/L) of Well Water Samples from the Study Area.

	Lead		Zinc		Copper		Iron		Chromium		Phosphate		Nitrate		TDS		CARDMIUM		DO		BOD	
KT AWAY	0.11	±0.02	0.09	±0.03	0.18	±0.10	0.14	±0.14	0.44	±0.21	16.2	±1.57	11.33	±5.16	355.5	±28.9	0.40	±0.07	12.3	±1.04	3.6	±1.49
KT CLOSE	0.0975	±0.042	0.12	±0.041	0.20	±0.07	0.22	±0.16	0.22	±0.18	15.48	±0.991	7.53	±4.71	395.25	±104.3	0.48	±0.08	14.9	±4.29	4.15	±1.16
KM AWAY	0.14	±0.083	0.09	±0.036	0.293	±0.30	0.35	±0.101	0.127	±0.282	13.53	±1.31	0.20	±0.07	261.88	±222.8	0.40	±0.21	3.79	±0.50	2.83	±0.55
KM CLOSE	0.215	±0.068	0.12	±0.040	0.068	±0.05	0.068	±0.170	0.44	±0.140	13.5	±0.30	0.175	±0.043	743.5	±202.5	0.425	±0.08	4.09	±0.80	3.21	±0.39
DL CLOSE	0.292	±0.398	0.133	±0.041	0.175	±0.06	0.235	±0.099	0.197	±0.053	13.63	±0.944	1.925	±0.661	324.47	±6.686	0.375	±0.04	13.6	±3.59	6.4	±2.02
DL AWAY	0.3225	±0.333	0.17	±0.134	0.203	±0.04	0.135	±0.078	0.32	±0.141	4.825	±4.561	2.225	±0.369	363.75	±153.8	0.35	±0.09	13.8	±5.79	7.38	±6.42
GW AWAY	0.0525	±0.021	0.205	±0.075	0.157	±0.07	0.24	±0.078	0.252	±0.088	13.4	±1.565	1.575	±0.580	494.5	±147.4	0.35	±0.05	14.7	±12.7	9.1	±12.6
GW CLOSE	0.05	±0.017	0.05	±0.022	0.203	±0.08	0.05	±0.02	0.193	±0.108	13.75	±0.606	1.575	±0.303	383.7	±182.2	0.375	±0.18	7.0	±3.18	2.0	±1.07
WHO	0.01		3.0		1.0		0.3		0.05		5.0		50		500		0.003					
NSDWQ	0.01		3.0		1.0		0.3		0.05		5.0		50		500		0.003					

WHO (2010, 2006); NSDWQ (2007)

Table 5: Physical Parameters of Well Water Samples from the Study Area.

Sample	Temperature $^{\circ}C$		Hardness (mg/l)		EC (μs/cm)		pH	
	MN	SD	MN	SD	MN	SD	MN	SD
KT away	26.95	0.46	176.7	73.3	143.5	5.94	6.675	0.08
KT close	26.73	0.433	236.4	47.74	1075	537.13	7	0.25
KM away	27.3	0.125	29.75	12.404	526.4	292.97	24.1	28.811
KM close	27.13	0.0434	18.325	12.761	514.75	254.81	7.2	0.245
DL close	26.0	1.225	691.25	75.084	517.25	109.746	6.75	0.456
DL away	25.82	12.633	286	74.923	507	296.978	6.85	0.21794
GW away	27.95	0.1118	371.95	210.91	308.25	88.972	5.8	0.282
GW close	27.97	0.216	423.65	179.684	380.25	97.506	5.875	0.129

WHO (2010, 2006); NSDWQ (2007)

<u>Key</u>

MN = Mean

SD = Standard Deviation

EC = Electrolytic Conductivity

*Close (Located less than 30 meters), Away (Located within 30 meters)

DISCUSSION

Water analysis was carried out in four different Local Government Areas of Kano Metropolis in order to assess microbiological qualities of well water in close proximity to pit latrines. The study area was observed to be densely populated in which the most common source of domestic water supply across the Metropolitan Local Government Areas studied was found to be well. This is the trend in all the communities. However, many wells were shelter uncovered and often dug too close to refuse dumps, pit latrines, gutters, and soak-away. Additionally, there was no care for sanitary standard at the vicinity of the wells in accordance with World Health Organization Standard for construction of wells. Disregarding these could be partly responsible for dissemination of microbial pathogen into the ground water sources.

The result of water analysis carried out on wells from four Local Government Areas of Kano Metropolitans was compared with the World Health Organization (WHO) and National Standard for Drinking Water Quality (NSDWQ) as a baseline to compare the quality of the Samples from different sources.

Bacteriological analysis of well water analyzed had varying level of aerobic plate count, coliform, feacal coliform as well as fungal count. All counts are not within standard value recommend by Regulatory agencies of 0.00cfu/ml of drinking water.

Moreover considering the distance between pits latrine with well, it was observed that well close to pit latrines were more contaminated with higher number of microbial load than those that are located far away from sanitary structures (pit latrine). This finding corroborates that of Abdulkadir *et al.*, (2015) and that of Sudgen (2006) who stated that the greater the distance between latrine and the water point, the lower the risk of contamination and vice versa.

It was generally observed that in all the samples analyzed a total of seven bacterial isolates were obtained. This isolates belongs to the genera of pathogenic bacteria, namely *Eschirichia coli*, *Enterobacter aerogenes*, *Klebsiella* spp, *Pseudominas* spp, *Salmonella* spp, *Shigella* spp,as well as *Proteus* spp. These organisms are known to course many types of diseases ranging from urinary tract infection nosocomial infection, paratyphoid fever (Olajubun and Ogunnika, 2014). From the result obtained as shown in Table 4.3 which indicate the distribution of bacterial isolates. Out of the total number of 38 isolated bacteria, *E. coli* have a higher frequency of occurrence, the presence of these organisms is an indication that well water in the study area had probably come into contact with human or animal faeces. Some of these bacteria are used as an indicator of possible water contamination or pollution. This finding also conformed to the finding of Abdulkadir *et al*,(2015) who stated that E.coli served as the most predictive and most frequently isolated species in water quality assessment.

Based on cultural and microscopic appearance, the fungal species isolated in this study are *Aspergillus* spp *Penicillium* spp and *Cladosporium* spp. The most frequently isolated fungi was genus *Aspergillus*, having the highest frequency and percentage of occurrence , followed by genus *Penicullium* , then *Cladosporium* spp with 3 (21.4%). This work corroborates the work of Auwal and Taura(2013), who reported that A*spergillus* spp was the most common isolated genus in their work. *Aspergillus* are known to produceaflatoxins (B_1 B_2 and G_1, G_2), the most toxic and potent hepatocacinogenic natural compounds ever characterized. These cause a wide variety of fungal diseases in human ranging from hypersensitivity reaction to invasive inflation associated with angio-invasion.

However, *Penicillium* spp was especially abundantly distributed and clearly has the ability to survive water treatment and contaminate water reaching various network installations. Only heating of water seems to inhibit the recovery of viable spores or hypae (Auwal and Taura, 2013). The implication of *Penecillium* spp. in allergy asthma or other respiratory problems has been a subject of several studies worldwide (Schwab and Strans, 2004).

The results for hardness (mg/L) showed that all the samples have met the standard set by WHO and NSDWQ of 150mg/L except the samples from Kano Metropolis. This showed that all water samples collected from Kano Metropolis were relatively of soft category of hardness, this is because their values were below the recommended standard of 150mg/L set by regulatory agencies. , acidity increase the capacity of water to attack geological material and leach toxic into the water potentially harmful to human consumption (Kafia *et al.*, 2008). Though, pH does not have direct effect int human life (NSDWQ, 2007). Electrical conductivity of all the samples analyzed were within the standard limit proposed by WHO and NSDWQ for 1000µs/cm, except the sample from Kumbotso from well water close to pit latrine that exceeded the recommended limit, although there is no disease or disorder associated with Temperature of the drinking water does not affect water quality. The recommended temperature set by regulatory agencies is 27 – 28°C. However, the temperature of all the samples analyzed fell between 25°C to 27°C, this indicates that the temperature of the samples were slightly below the recommended standard for safe drinking water quality.

Nitrate content of all the samples analyzed fell within the permitted level of 50mg/L. The elevated nitrogen concentrations are often caused by runoff from barnyards (WHO, 2009), as a result of excessive use of fertilizer or seepage of feacal matter into the ground water sources. The result of phosphate analysis showed that the phosphate level of well water located away from pit latrine in Dala Local Government fell within the acceptable limit of 50mg/L set by WHO and NSDWQ, while the rest of the samples did not meet the standard guideline.

Chromium and lead contents for all the samples were slightly above the recommended limit of 0.05mg/L for chromium, and 0.01mg/L for lead which is proposed by regulatory agencies. In some epidemiological studies associations have been found between exposure to Chromium and lung cancer (Pakistan Environmental Protection Agency, 2008). Presence of Lead above the recommended limit courses cancer, interfere with vitamin D metabolism, and affect mental development in infant and toxic to central nervous system (NSDWQ, 2007). Likewise, Copper and zinc contents of all the water samples used in this study fell within the standard limit of 1mg/L for cupper and 3mg/L for zinc. Although cupper above the standard limit may result to gastrointestinal distress with a shorter term exposure, while in a long term exposure may experience liver or kidney damage (EPA, 2012).

Iron also, has its own standard value set up by WHO and NSDWQ, which is 0.3, the iron level for all sample analyzed falls within the acceptable limit. Iron's role in human nutrition is necessary for our health. The most well-known role that iron plays in human nutrition is formation protein hemoglobin, which transports oxygen to all cells of the body. Iron is also used in similar metabolism and is found in many of the body enzymes. Low iron stored in the body can lead to iron deficiency, anemia and fatigue and can make human body more susceptible to infection. (Pakistan Environmental Protection Agency, 2008)

Total dissolved solid of all the samples were within the acceptable limit of 500mg/l. the total dissolved solid is the term used to describe conductivity of drinking water (NSDWQ 2007). inorganic salt and small amount of organic matter present in the water. The principal constituent are usually magnesium, sodium and potassium cation, carbonate, hydrogen carbonate, chlorides, sulphades and nitrate ion (WHO 2006). The presence of total dissolved solid in water may affect its test. Drinking water with extremely low concentration of total dissolved solid is unacceptable because of its flat insipid test (WHO 1995; Bruvold and Ongenth, 1969; Mustapha 1999).

Cadmium level of all the well water analysed exceeded the recommended limit of 0.003mg/l. Presence of this chemical in drinking water above the WHO recommended level show that people that use this water sources are prone to kidney disease or toxication (NSDWQ, 2007). The dissolved oxygen concentration of water is defined as the number of milliliter of oxygen gas per liter of water. Higher dissolved oxygen in a drinking water supply is good because it makes drinking water test better. The DO and BOD level of most of the samples did not conformed to recommended limit of 5 – 7mg/L and 3-6mg/L respectively proposed by WHO and NSDWQ as showed in Table 4.

Statistical analysis was carried out regarding four bacteriological parameters, that are Aerobic mesophilic bacterial, fungal, coliform and faecal coliform count, which shows no significant different at *p*-value =0.05% between well water close to pit latrine and Well water located away from pit latrine.

CONCLUSION

The result of Aerobic mesophilic bacterial, Fungal, Coliform and Faecal coliforms count revealed that the water samples had higher level of microbial load. Seven genera of bacteria were Isolated belonging to the pathogeric genera of bacteria that included *E. coli*, *Salmonella* spp, *Shigella* spp, *Klebsiella* spp, *Pseudomonas* spp and *Protues* spp and *Enterobacter* spp. The Fungal genera Isolated include *Aspergillus* spp, *Cladosporium* spp. and *Penicillum* Spp. However, the result of physicochemical analysis showed that heavy metals such as chromium, cadmium, lead and phosphate were above the recommended limit. Other parameters such as temperature, pH, Zinc, Copper, Nitrate are within the recommended standard set by WHO and NSDWQ.

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