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Microbiological Qualities of Some Borehole and Well Water in Industrial and Sewage Disposal Sites of Kano Metropolis

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Abstract- The paper investigated some borehole and Well waters located within industrial and sewage disposal sites of Bompai, Sharada (Sabuwar gandu), Challawa (Tsamawa) and Gyadigyadi, (court road), Wailari, with a view to determine their microbiological qualities. A total of fifty (50) samples. Ten (10) wells and Ten (10) boreholes (two from each location) were sampled and analyzed for their bacterial counts, coli form, faecal coliform counts, *staphylococcal* count and *salmonella-shigella* count using standard microbiological techniques. Cultural, morphological characharistics of the isolates revealed the presence of the following bacteria; *Escherichia coli, proteus spp. Pseudomonas spp. Klebsella spp. Enteobacter sp., Staphylococcus spp. Shigella spp. and Salmonella spp*. The mean bacterial load of boreholes ($x10^4$cfu/ml) were 1.83, 1.85, 0.17, and 0.13 for total viable count while in well water samples ($x10^4$cfu/ml) was 1.254, 0.437, 0.823, 1.234, and 1.982, In-vitro sensitivity test against 16 common antibacterial agents demonstrated high multiple-resistance incidence to, Ampicillin, Amoxicillin, Cabenicillin, Chloramphenicol, Cotrimoxazol, Cephalexin, Cefotaxime and Cloxacin, and lower resistance frequencies (0-33%) to Erythromycin, Floxacin, Nitrofuranton, Gentamicin, Metronidazole, Penicillin, Streptomycin, and Tetracyclin were however observed. Results also indicated the presence of potentially drug-resistant strains of some bacteria in all the sources except some borehole water samples. The result shows that some of the borehole and well samples are not within the recommended limit of WHO (2006) and NSDWQ (2007) standard for drinking water. The borehole and well water should therefore be protected and treated before consumption.

Keywords: Microbiological, Qualities, Industrial, Sewage, Disposing

I. INTRODUCTION

Water is the most important of all natural resources [1-4] and it is vital for all living organism and the quality of drinking. It is a powerful environmental determinant of health [5]. Accessibility and availability of fresh clean water is key to sustainable development which is an essential element in health, food production and poverty reduction [6-8]. The presence of a safe and reliable source of drinking water is important pre-requisite for the establishment of a stable community [9-12]. The supply of water of wholesome quality helps reduce the incidence of water related diseases. Water supply to community may be public (network of pipe borne water) or private (wells and boreholes) and all private supplies can pose a threat to health unless they are properly treated and protected [13]. The microbiological nature of the discharged pathogenic bacteria, viruses and parasitic protozoans with the efficiency of the available water treatment barriers justify a policy of mandatory disinfection of waste and water effluent [14]. The concept of microbial barriers in water supply and waste water treatment involves a variety of processes other than disinfection. Many of these treatment processes have evolved from the enhancement of some factors associated with natural self-purification, nutrients limitation, water pH, sedimentation and aeration. Utilizing the concept in treatment of waste water before discharge to receiving waters and the further treatment possible are beneficial in optimizing the quality of raw water resources prior to further processing in drinking water supplies [14]. Study of microbial population in bottom sediments has revealed approximately 100 to 1000-fold of more viable faecal coliform bacteria in the sediment water interface than in overlying waters. Salmonellae were also isolated with far greater frequency from these bottom sediments than directly from overlying water. Groundwater is one of the major sources of drinking water all over the world [15]. Freshwater quality and availability remain one of the most critical environmental and sustainability issues of the twenty-first century of all sources of fresh water on the earth, groundwater constitutes over 90% of the world's readily available freshwater resources with remaining 10% in lakes, reservoirs, rivers and wetlands. Groundwater is also widely used as a source, for drinking water supply and irrigation in food production [13]. However, groundwater is not only a valuable resource for water supply, but also a vital component of the global water cycle and the environment. As such, groundwater provides water to rivers, lakes, ponds and wetlands helping to maintain water levels and sustain the ecosystems [13].

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Boreholes and wells are feed from ground water both of which are a major source of drinking water all over the world. Most communities in Nigeria make use of water dug from boreholes and wells as an alternative source; this is to complement the spatial supply of pipe borne water. However, with increasing population demand, water supply from these boreholes and wells becomes insufficient, especially in dry season when groundwater levels drops. It stabilizes during rainy season when groundwater levels become replenished by rain [13].

There have been reports of boreholes and well water contamination through many domestic waste water and livestock manure especially if there is a puncture in a layer of soil [16]. These waste and sewage when deposited near the boreholes or wells may travel with percolating rain water directly into the boreholes or may travel along the well- wall or surrounding material of the drill-holes [16]. Although industrialization is inevitable, various devastating ecological and human disasters which have continuously occurred over the years implicate industries as major contributor to environmental degradation and pollution processes of various magnitudes [17]. In heavily industrialized areas, the quality of groundwater is compromised mostly as a result of industries dumping their wastes on land as well as in surface water which ultimately leaches to groundwater. This may lead to contamination due to accumulation of toxic substances which are not completely degraded [18]. Consequently, this study therefore is aimed to determine the microbiological qualities of some Boreholes and Wells located at Industrial and Sewage disposing sites of Kano Metropolis and compare with the standards for Drinking Water of WHO and NSDWQ respectively.

II. MATERIAL AND METHODS

II.I STUDY AREA

The metropolitan area of Kano lies between latitude 11^0 55, 23.93N to 12^o 3, 53.10N and longitude of 8^o 27, 42.26, E to8^o 36, 41. 62, E [19]. It covers a land mass of 499km^2 and comprises of eight (8) local government areas; Dala, Fagge, Gwale, Municipal, Nassarawa, Tarauni, Kumbotso, and Ungoggo local governments. It has a population of 2,828,861 as 2006 Nigerian census, with a growth rate projected to 3.3%. Kano metropolis is characterized with a daily temperature ranging from 26^{o}C to 33^{o}C with mean daily maximum temperature of 40^{o}C between March and May before the onset of rains in mid-May to September. A mean annual rainfall ranging from 800mm to 100mm and the natural vegetation consisting of Sudan and the Guinea savannah. Kano metropolis is highly industrialized with the industries in three industrial estates, namely Bompai, Challawa, and Sharada [20]. Major industries in Challawa and Sharada industrial estates are textiles, tanneries, chemicals and allied, iron and steel. The activities of these industries have led to the discharge of untreated waste water on land and in rivers and streams. Slightly dense human settlements can be found in and around these industrial areas whose major source of domestic water ranges from pipe bone water, well water to borehole water.

II.II SAMPLE COLLECTION

10 samples each of boreholes and well water were collected from Sabuwargandu in Sharada, Panshekara and Tsamawa in Chalawa and some areas in Bompai, Gyadigyadi and Wailari using sterile glass containers with stoppers. The samples were transported to laboratory in ice packs and processed between 2-3 hours after collection.

II.III BACTERIOLOGICAL ANALYSIS OF WATER SAMPLES

II.III.I DETERMINATION OF BACTERIAL POPULATION (BIOLOAD)

A ten-fold serial dilution of water samples from Boreholes and wells (industrial and sewage dumping) site were used for enumeration of bacterial species using the spread plate technique, Nutrient agar (N.A) was used to determine total viable count (TVC), Eosin methylene blue (EMB) agar was used to determine total fecal coliform count (TFC), MackConkey agar was used for total coliform (TCC) and salmonella-shigella gar (SSA) was used to determine the *salmonella* and *shigella* species respectively. All plate was incubated at 37^{O}C for 24h except that of EMB plates meant for the isolation of fecal coliform were incubated at 44^{O}C for24h, the colonies were counted and expressed as colony forming unit per millimeters (cfu/ml) [21].

II.III.II IDENTIFICATION OF BACTERIAL ISOLATES

Colonies grew on the respective media was sub cultured on Nutrient agar to obtain discrete colonies. These isolates were further classified using morphological, microscopic and biochemical tests. Characterization was done in accordance with methods implied by [22].

II.III.III ANTIBIOTIC SUSCEPTIBILITY TEST

The antibiotic susceptibility of bacterial isolates was carried out as earlier described by [23]. Three (3) pure colonies were inoculated at 37^{0}C for 24hrs. The overnight culture was adjusted to the turbidity equivalent to 0.05 Mcfarland standards. The adjusted inoculum was sub cultured on the surface of Mueller Hilton agar (MHA) plate and incubated at 37^{o}C for 24hrs. The diameter zones of inhibition of bacterial isolate was recorded in percentage of resistance.

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III. RESULTS

This study determines the bacterial contaminants that colonize boreholes and well drinking water sources in industrial and sewage disposal areas of Kano metropolis using standard microbial culture and identification techniques**.** The result of bacteriological load as shown in table 1 (cfu/1000ml) of underground water from industrial and sewage disposal sites all parameters measured were found to be above the maximum acceptable label. Table 11 presented the characterization and identification of bacterial isolates from the underground waters sampled. *E. coli, salmonella, shigella, and proteus* species were the common isolates.

Table1: Total viable count, coliform count, fecal coliform, staphylococcal count and salmonella-shegella count of some borehole and well water sources within industrial and sewage disposing sites of Kano metropolis.

Location	Sample type	Sample No.	Bacterial loads (efu/ml) x 10^4				
			Total viable count	Total coliform count	Total fecal coliform count	Total staphylococcal count	Total salmonella shigella count
Bompai	Borehole	5	1.1	1.2	1.3	0.5	1.0
	Well	5	1.3	1.7	1.8	0.9	1.2
Chalawa	Borehole	5	1.98	0.24	1.2	0.4	0.25
	Well	5	2.60	1.34	1.22	0.9	1.40
Sharada	Borehole	5	1.98	0.21	0.23	0.08	0.12
	Well	5	2.06	1.34	1.82	0.40	1.40
Gyadi-Gyadi	Borehole	5	1.98	0.92	0.46	0.42	0.13
	Well	5	2.37	1.69	1.80	0.88	1.39
Wailari	Borehole	5	1.00	0.22	0.03	0.12	0.01
	Well	5	2.06	1.41	1.72	0.18	1.39
	Mean		1.83,1.85	1.06,1.03	1.01,0.10	0.62,0.45	1.03,0.91

Table 2: Characterization and possible identification of Isolates from some Boreholes and Wells water sample within industrial ad sewage disposing site of Kano Metropholis.

Isolate	Morphology	Gram Stain	MR	VP	Indole	Citrate	Urease	Oxidase	Catalase	Coagulase	Motility	TSI S	TSI B	TSI H_2S	TSI G	Probable identification
1	Rods	-	+	-	+	-	-	-	+	-	+	Y	Y	-	+	*Escherichia coli*
2	Rods	-	+	-	+	-	+	-	+	-	+	Y	Y	+	+	*Proteus*
3	Rods	-	-	-	-	-	-	+	+	-	+	R	R	-	-	*Pseudomonas*
4	Rods	-	-	+	-	+	+	-	+	-	-	Y	Y	-	+	*Klebsiella*
5	Rods	-	-	+	-	+	-	-	+	-	+	Y	Y	-	+	*Enterpnacter*
6	Rods	+	+	-	-	-	-	-	+	+	-	ND	ND	-	-	*Staphylococcus*
7	Rods	-	+	-	-	-	-	-	+	-	-	R	Y	-	-	*Shigella*
8	Rods	-	+	-	-	+	-	-	+	-	+	R	Y	-	-	*Salmonella*

Key: S:Slant, B: Butt, G: Gas, R: Red(alkaline reaction), Y: Yellow (acid reaction), +: positive, -: Negative, ND: No development.

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Table 3: Cultural and morphological characteristics of Bacterial isolates from borehole and well water within industrial and sewage disposing site of Kano metropolis.

S/N	Cultural Characteristics								Morphological Characteristics		
	Size	**Shape**	**Surface**	**Colour**	**Opacity**	**Consistency**	**Elevation**	**Edge**	**Pigmentation**	**Gram Stain**	**Morphology**
1	Tiny	Irregular	Smooth	Whitish on NA	Transparent	Non-mucoid	Raised	Convex	Nil	+	Cocci in pairs
2	Tiny	Irregular	Rough	Whitish on NA and golden yellow on MSA	Transparent	Non-mucoid	Raised	Convex	Golden Yellow	+	Cocci in cluster
3	Large	Irregular	Rough	Light blue-green on NA and MCA; purple on EMBA	Transparent	Non-mucoid	Flat	Convex	Blues-green	-	Rod shape
4	Large	Irregular	Dried rough	Whitish on NA, pinkish on MCA and purple on EMBA	Transparent	Non-mucoid	Flat	Convex	Nil	+	Rod shape in chains
5	Mode rate	Irregular	Smooth	Whitish on NA and greenish metallic sheen on EMBA	Transparent	Non-mucoid	Raised	Convex	Nil	-	Rod shape
6	Mode rate	Irregular	Smooth	Whitish on NA	Transparent	Non-mucoid	Raised	Convex	Nil	+	Coccobacilli
7	Large	Irregular	Smooth	Whitish on NA and pinkish on MCA and EMBA	Transparent	Mucoid	Flat	Convex	Nil	-	Rod shape
8	Tiny	Irregular	Rough	Whitish on NA and pinkish on MSA	Transparent	Non-mucoid	Raised	Convex	Nil	+	Cocci in cluster

Na=Nutrient Agar, MSA = Mannitol Salt Agar, EMBA= Eosine MEthylene Blue Agar; MCA =MacConkey Agar+=Positive;- = Negative

Table 4: Antibiotics Resistance of Bacterial Isolates from Boreholes and Well Water Sample.

Isolates	CIP	CN	AMP	CTX	AMC	LEV	CXM	OFX	C	IMP	SXT	S	CAZ
Escheriehia sp.	**10(71.4)**	**6(42.9)**	**13(92.9)**	**14(100)**	**14(100.0)**	**9(64.3)**	**14(100.0)**	**12(85.7)**	**11(78.6)**	**6(42.9)**	**12(85.7)**	**13 (92.7)**	**14(100.0)**
Bacillus sp.	**1(25.0)**	**0(0)**	**2(50.0)**	**3(75.0)**	**4(100.0)**	**0(0)**	**2(50.0**	**2(50.0)**	**0(0)**	**0(0)**	**1(25.0)**	**2(50.0)**	**3(75.0)**
Salmonella sp.	**6(75.0)**	**4(50.0)**	**8(100)**	**7(87.5)**	**8(100.0)**	**2(25.0)**	**8(100.0)**	**8(100.0)**	**5(62.5)**	**3(37.5)**	**7(87.5)**	**8(100.0)**	**8(100.0)**
Staphylococcus sp	**4(44.4)**	**3(33.3)**	**9(100)**	**9(100.0)**	**8(88.8)**	**4(44.4)**	**9(100.0)**	**6(66.6)**	**8(88.8)**	**2(22.2)**	**4(44.4)**	**9(100.0)**	**9(100.0)**
Pseudomones sp.	**3(42.9)**	**4(57.1)**	**5(71.4)**	**4(57.1)**	**5(71.4)**	**1(14.3)**	**7(100.0)**	**2(28.6)**	**2(28.6)**	**0(0)**	**5(71.4)**	**7(100.0)**	**5(71.4)**
Proteus sp.	**2(20.0)**	**1(10.0)**	**5(50.0)**	**5(50.0)**	**7(70.0)**	**2(20.0)**	**8(80.0)**	**4(40.0)**	**3(30.0)**	**0(0)**	**2(20.0)**	**3(30.0)**	**7(70.0)**
Enterococcus sp.	**3(60.0)**	**4(60.0)**	**3(60.0)**	**4(80.0)**	**3(60.0)**	**2(40.0)**	**5(100.0)**	**1(20.0)**	**1(20.0)**	**1(20.0)**	**2(40.0)**	**4(80.0)**	**4(80.0)**
Klebsiella sp.	**3(42.9)**	**2(28.6)**	**4(57.1)**	**5(71.4)**	**3(42.9)**	**2(28.8)**	**7(100.0)**	**4(57.1)**	**2(28.6)**	**1(14.3)**	**2(28.6)**	**3(42.9)**	**6(85.7)**

Key: CIP=Aprofloxacin, CN, Cephatexin, Amp = Amipicillin, CTX=cefotadime, MC = Amoxicillin, LEV= Levoftoxacm, CXM= Cefuroxime, OFX=Ofoxacin,C=Chloramphenicol,MPC,Impenem,SXT=Trimethoprim-sulpamethosazole,S=Straptosoc

IV. DISCUSSION

Cultural, morphological and biochemical characteristics of the isolates from some boreholes and well water in the industrial and sewage disposing areas revealed the presence of the following bacteria; *Escherichia Coli*, *Proteus* spp, *Pseudomonas* spp, *Klebsiella* spp, *Enterobacter* spp, *Staphylococcus* spp, *Shigella* spp, and *Salmonella* spp. [21] (Table 2). The mean bacterial load of boreholes ($x10^4$cfu/ml) were 0.33, 0.18, 0.17, and 0.13 for total viable count while in well water samples ($x10^4$cfu/ml) was 1.254, 0.437, 0.823, 1.234, and 1.982, In-vitro sensitivity test against 16 common antibacterial agents demonstrated high multiple-resistance incidence to especially, Ampicillin, Amoxicillin, Cabenicillin, Chloramphenicol, Cotrimoxazol, Cephalexin, Cefotaxime and Cloxacin, and lower resistance frequencies (0-33%) to Erythromycin, Floxacin, Nitrofuranton, Gentamicin, Metronidazole, Penicillin, Streptomycin, and Tetracyclin were however observed [24]. Results also indicated the presence of potentially drug-resistant strains of some bacteria in all the sources except some borehole water samples. The result shows that some of the borehole and well samples are not within the recommended limit of [25,26] standard for drinking water (Table 1&2).

V. CONCLUSION AND RECOMMENDATION

The result shows that borehole and well water sources in closed proximity to effluent from industries, urban and domestic sewage might experience some negative effects on the water quality overtime. Contaminants of boreholes and wells may arise from pollutants entering the water the water table some distance from the industries or sewage entering the water source itself through leakages, cracks or corroded cases. The increase level of bacteria in boreholes and wells was an indication of fecal pollution. At this juncture the result from this study showed that most of the boreholes and wells yield water of very poor quality microbiologically. All boreholes and wells fail to meet the 0.00cfu/100ml set by WHO and NSDWQ. A simple water purification method for purifying water from wells needs to be developed for this arrears of study as soon as possible.

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REFERENCE

[1] I., Bashir, A. S., Adam, H. S., Yahaya, D., Makeri, I., Ntulume, A. A., Aliero, R. O., Afolabi, "*Assessment of bacteriological quality of borehole water in Wamakko local government, Sokoto state, Nigeria*". Novel Research in Microbiology Journal, Vol. **2**, Issue **6**, **2018**.

[2] A. E., Onyango, M. W. Okoth, C. N., Kunyanga, B. O., Aliwa, "*Microbiological Quality and Contamination Level of Water Sources in Isiolo Country in Kenya*". Journal of environmental and public health, pp. **1-10, 2018**.

[3] C. E., Duru, U. S., Amadi, C. E., Enyoh, "*Storage and its Effect on Chemical Quality Indicators in Sachet Water Brands Sold in Owerri Municipal, Imo State, Nigeria*". World News of Natural Sciences. Vol. **12**, pp. **73-81, 2017**.

[4] S., Devangee, B., Kinjal, N. K., Jain, H. A., Modi, "*Physicochemical Analysis of Water from Various Sources and Their Comparative Studies"*. IOSR Journal of Environmental Science, Toxicology and Food Technology, Vol. **5**, Issue **3**, pp. **89-92, 2013**.

[5] WHO, "*World Health Assembly Reports on WHO drinking; Water and Sanitation. A way to Health 1211*". Geneva. 27 Switzerland Drinking Water Quality, **2015**.

[6] N., Banu, H., Menakuru, "*Enumeration of microbial contaminants in sachet water: a public health challenge"*. Health, Vol. 2, Issue **6**, pp. **582-588, 2010**.

[7] K. K., Addo, G. I., Mensah, M., Bekoe, C., Bonsu, M. L., Akyeh, "*Bacteriological Quality of Sachet Water Produced and Sold in Teshie-Nungua Suburbs of Accra, Ghana*". African Journal of Food Agriculture Nutrition and Debelopment. Vol. **9**, Issue **4**, pp. **1019-1030, 2009.**

[8] Third World Water Forum, Blockade, Myth, Illusions in development and cooperation, Vol. **30**, Issue **1**, **2003**.

[9] H. E., Jijingi, A. Y., Musa, "*Potential Use of Asa River Sand as Filter Media in Water Treatment Plants*". American Journal of Environmental Engineering and Science, Vol. **4**, Issue **5**, pp. **48-59, 2017**.

[10] O. O., Francis, N., Moses, "*Assessment of the Impact of Anthropogenic Activities on the Drinking Water Qualities of Boreholes/Shallows Well Water in Huruma Estate -Eldoret, Kenya*". Journal of Environment and Earth Science, Vol. **6**, Issue **3**, pp. **1-4, 2016**.

[11] C. H., Ikeme, I. J., Dioha, K. A., Olasusi, U. C., Promise, "*Physico-Chemical Analysis of Selected Borehole Water in Umuihi, Town Imo State, Nigeria*". International Journal of Scientific and Engineering Research, Vol. **5**, Issue **8**, pp. **680-689, 2014**.

[12] J. E., Umunnakwe, A. S., Ogamba, "*Assessment of the Impact of Industrial and Anthropogenic Activities on the Drinking Water Qualities of Borehole Water in Bundu – Ama Environs Port Harcourt, Nigeria*". *Journal of Environment and Earth Science*, Vol. **3**, Issue **10**, pp. **109-114, 2010**.

[13] J. E., Asuquo, E. E., Etim, "*Physicochemical and Bacteriological Studies of selected Borehole Water in Uyo Metropolis in Akwa Ibom State*". International Journal of Modern Chemistry, Vol. **2**, Issue **1**, pp. **7-14, 2012**.

[14] J. M., Symons, M. P., Koopmans, "Treatment techniques for controlling trihalomethane in drinking water, EPA-600: 18-156, *Municipal Environmental Research laboratory*, New York, **2014**.

[15] T., Tenzin, S. R., Madhuri, S., Prerna, "*Hydrogeochemical Assessment of Groundwater quality for Drinking purpose in parts of Rupnagar district, Punjab, India*". International Journal of Innovative Science, Engineering and Technology, Vol. **2** Issue **7**, pp. **634-648, 2015**.

[16] C. N., Obi, C. O., Okocha, "*Microbiological and Physicochemical of Selected Borehole Water in World bank Housing Estate Umuahia, Abia State, Nigeria*". Journal of Engineering and Applied Science, Vol. **2**, Issue **5**, pp. **920-929, 2007**.

[17] D., Salisu, H. B., Mustapha, "*Industrial Pollution and Implication on Source of Water Supply in Kano, Nigeria*", International Journal of Engineering and Technology, Vol. **10**, Issue **1**, pp. **76-81, 2010**.

[18] N. I., Nemerow, "*Industrial Water Pollution Origins Characteristics and Treatment Addison-Wesley*". Massachusetts Journal, Vol. **5**, pp. **738-740, 1978**.

[19] I. S., NaAbba, "*Transformation of the Kabuga Housing Estate*". Unpublished Phd Dissertation, Bayero University Kano, **2002.**

[20] M. H., Bichi, B. U., Anyata, "Industrial Waste Pollution in the Kano River Basin" Environmental Management and Health, Vol. **10**, Issue **2**, pp. **112-116**, **1999**.

[21] S. O., Obiekezie, G. E., Owuna, F. Nwagbara, H. Nhunnaro, "*Microbiological Qualities of Some Local Fermented Food (Ogiri, Ogi and Ugba) in Orlu, Imo State Nigeria*". International Journal of Biotechnology and Allied Science. Vol. **7**, Issue **2**, pp. **956-962, 2012**.

[22] M., Chesbrough, "*Medical Laboratory Manual for Tropical Countries*". The Thetford Press Limited. London, Vol. **2, 2006.**

[23] CLSI, "*Performance standards for antimicrobial susceptibility testing: 20th informational supplement, CLSI document M100-S20*" Clinical and Laboratory Standards Institute, Wayne, PA, **2010**.

[24] M. D., Mukhtar, "*Microbiological and Physicochemical studies on Salanta River*". Journal of Aquatic Sciences, Vol. **46**, pp. **89-94**, **1998**.

[25] WHO, "*Guidelines for drinking-water quality criteria*". 3rd edition incorporating 1st and 2nd addenda, Vol. **1**, pp. **13-33, 2006**.

[26] NSDWQ, "*Nigerian Standard for Drinking Water Quality*" NIS **554**, Son, Lagos, **30**, **2007**.