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Assessment of Some Physicochemical Parameters and Heavy Metals in Ground Water From Sandy Areas of Argungu Emirate, Kebbi State, Nigeria

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Abstract

Some physicochemical parameters and heavy metals contents of some water were obtained from four Local Government Headquarters of Argungu Emirate of Kebbi State Nigeria. Spectrometry, colorimetry, complexometry, gravimetry and titrimetry were the main methods applied. Results of the parameters obtained ranged as: temperature (29.83-32.53^{0}C), conductivity (17.07-515 μScm^{-1}), total suspended soil, (TSS) (0.00-2500 mg/l), total dissolved solids (TDS) (80.33-670 mg/l), turbidity (0.00-1.90 NTU), chloride (Cl^-) (0.002-0.07 mg/l), nitrate (NO_3^-) (0.04-6.41 mg/l), nitrite (NO_2^-) (0.01-0.08 mg/l), total hardness ($CaCO_3$) (21.69-54.86 mg/l), sulphate (SO_4^{2-}) (27.44-40.47 mg/l), phosphate (PO_4^{3-}) (0.26-0.45 mg/l), biological oxygen demand (BOD) (14.13-37.80 mg/l) and chemical oxygen demand (COD) (1.60-9.87 mg/l).The levels of heavy metals in mg/l were detected using an Atomic Absorption Spectroscopy (AAS) and showed ranges as: Cu (0.000-0.032), Co (1.270-1.502), Cr (0.037-0.110), Mn (0.004-0.143), Ni (0.003-0.419) and Pb (0.017-0.122). The results of the physicochemical parameters of the water samples indicated that temperature, conductivity, turbidity, chloride, nitrate, total hardness, sulphate, phosphate and COD were all within permissible limits set by World Health Organization (WHO) and Nigerian Industrial Standard (NIS) in all the water samples. TSS, TDS and BOD were within the limits in most of the samples and nitrite was above the limit in most of the samples. The results of the heavy metals indicated that only Cu was within the permissible limit in all the samples. Mn was within the limit in most of the samples, Cr and Ni were above the limits in most of the samples, while Co and Pb were above the limits in the entire samples. The study thus revealed that most of the water samples were slightly polluted with the heavy metals and few physicochemical parameters.

Keywords: *Argungu, Kebbi, Physicochemical Parameters, Heavy Metals and Boreholes Water.*

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Introduction

Water is the most essential resource to every living organism. It is the most common solvents in nature referred to as the universal solvent for many substances. It is the most essential chemical compound that sustains all forms of life. Most living beings can only survive for a short period of time without water (Kegley and Andrews, 1998). Water plays a key role in prevention of diseases; drinking eight cups of water daily can decrease the risk of colon cancer by forty-five percent(45%) and bladder cancer by fifty percent (50%) as well as reducing the risk of other cancers (APEC, 1999). Water is one of the major abundant compounds in nature that approximately covers three-fourth (3/4) of the earth surface (FGN, 2000).

The quality of drinking water analysis, including trace metal contents is very essential for public health studies. It is a major aspect of pollution studies in environments (Dogan and Soylak, 2002). Water quality analysis is a chemical study that discloses quality of water that is fit for drinking, domestic, agricultural or industrial use as a result of atmospheric, soil or rock-water interaction. The suitability of water for any use is defined by water quality parameters as approved by water quality standard panels that regulate the levels of contamination (Sharma, 2003).

Heavy metals are toxic metallic elements whose density exceed five gram per cubic centimeter (5 gcm^{-3}). They are called trace metals due to their presence in water at much lower concentrations compared to major ions like sulphate, chloride, nitrate, etc., (Adepoju-Bello *et al.,* 2009). A large number of elements fall within this category, but those of relevance in environmental context are ascetic, lead, cadmium, chromium, copper, nickel, zinc, manganese, cobalt, iron, mercury, etc. They exist in water as colloidal particles and dissolved phases. They are components of earth's crust that can enter water and food cycles through a variety of chemical and geological processes (Uffia *et al.,* 2013). Some heavy metals are essential for life sustenance and must be present for normal body function like calcium, magnesium, potassium and sodium, etc. Also cobalt, copper, iron, molybdenum, manganese and zinc are needed at low levels as catalysts for enzyme activities (Adepoju-Bello *et al.*, 2009). However, excessive exposure to heavy metals can cause toxicity and serious health effects with varied symptoms depending on the nature and quantity of metals injected. (Babel and Kurniawan, 2003).

The aim of this study is to determine some physicochemical parameters and heavy metals in ground water samples from sandy areas of Argungu Emirate Councils of Kebbi State, Nigeria.

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They are toxic, even in parts per billion (ppb) ranges (Miroslav and Vladimir, 1999). Heavy metals are dangerous since they gradually accumulate in living things. Their toxicity can result in damaged or reduced mental and central nervous function lowers energy levels and damages blood composition, lungs, kidney, liver and other vital organs. Long term exposure may result in slow progressing, physical muscular and neurological degrading processes that extend to muscular dystrophy, multiple sclerosis, allergy and cancer, etc. (NINH, 2006).

Materials and Methods

Description of Study Area

Argungu Emirate comprises four Local Governments Areas, namely, Argungu, Augie, Arewa and Dandi Local Governments. The research was focused within the four local government headquarters (Argungu, Augie, Kangiwa and Kamba Towns). Figure 1.0 shows the map of Kebbi State and the four Local Government headquarters (sample sites).

Argungu is a city in a Kebbi State, Nigeria. It is situated on the Sokoto River. As at 2007, Argungu had an estimated population of 47, 064. The city is the seat of the Argungu Emirate, a traditional state. The city is a major agricultural center for the area, with key crops including tobacco, peanuts, rice, millet and sorghum. The city also hosts an international fishing festival (World Gazetteer, 2007).

Augie is a Local Government Area in Kebbi State, Nigeria. It's headquarter is in Augie town. It shares boundaries with Argungu and Arewa Local Governments at the eastern and western regions respectively. The area is primarily agricultural producing sugarcane, mango, banana, etc. the major language groups are Hausa, Fulani and Zabarmanwa. The population is predominantly Muslims. It has an area of 1,185 Km^2 and a population of 117,287 at the 2006 national census. The postal code of the area is 861 (NIPOST, 2009).

Kangiwa Town hosts the headquarters of Arewa Local Government of Kebbi State, Nigeria. Arewa Local Government shares a boundary with Niger Republic at the Western Region. It has an area of 3, 901 km^2 and a population of 184,030 at the 2006 census. The postal code of the area is 861 (NIPOST, 2009).

Kamba Town is the Headquarter of Dandi Local Government Area in Kebbi State, Nigeria. Dandi Local Government is sharing boundaries with Republic of Niger at the

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Western region and a southern region with Bunza Local Government. Area. It has an area of 2, 003 km^2 and a population of 144, 273 at the 2006 census. The major language groups are Hausa, Fulani and Zabarmanwa. It is predominated by Muslim population (NIPOST, 2009).

Sampling and Sample Collection

Water samples for the physicochemical parameters and heavy metals analyses were collected from twelve (12) borehole locations in four local government headquarters of Argungu Emirates, Kebbi State. The water samples were collected using sterile and pre-washed plastic containers. Each plastic container was rinsed three times with the water samples before collection (Ndamitso, 1997).Before samples collection, the water was allowed to run out of the borehole pipes for about two minutes to clear the outlets. The sample containers were slowly filled up to avoid air bubbles. The temperature of the water samples was instantly measured and recorded at the collection sites. The sample containers were tightly fitted with their covers, subsequently refrigerated and warmed to room temperature before running the tests (Ndamitso, 1997).

Sample Treatment and Digestion

Calcium carbonate ($CaCO_3$) was used as an absorbent for metal ions in the water sample analyses.(Bhattachariyya and Gupta, 2008b).10g of calcium carbonate ($CaCO_3$) was mixed with each of 100 cm^3 of the water samples in a beaker, thoroughly mixed and the slurry was evaporated to dryness in an oven and kept for analysis. 0.5 g of the dried slurry was dissolved in a 250 cm^3 beaker containing some distilled water. Then 10 cm^3 of concentrated HNO_3 (88% and 1.14 s. g.) was added. The solution was transferred into 100 cm^3 volumetric flask and diluted to the volume with distilled water, and used in the analysis.

Determination of Physicochemical Parameters

Temperature was measured using thermometer, conductivity was measured using DD-S307 Rex conductivity meter; Filter papers were employed in TSS measurement and Aqualytic 9V block TDS Meter was used to measure TDS. Chloride, nitrite and turbidity were measured using HATCH DR/2010 Portable Data Logging Spectrophotometer. Total hardness in the form of calcium carbonates ($CaCO_3$) was determined using complexometric titration. Colorimetry was used in the determination of both nitrate and phosphate. 5-day BOD incubation and titrimetric methods were respectively used for determination of BOD and COD.

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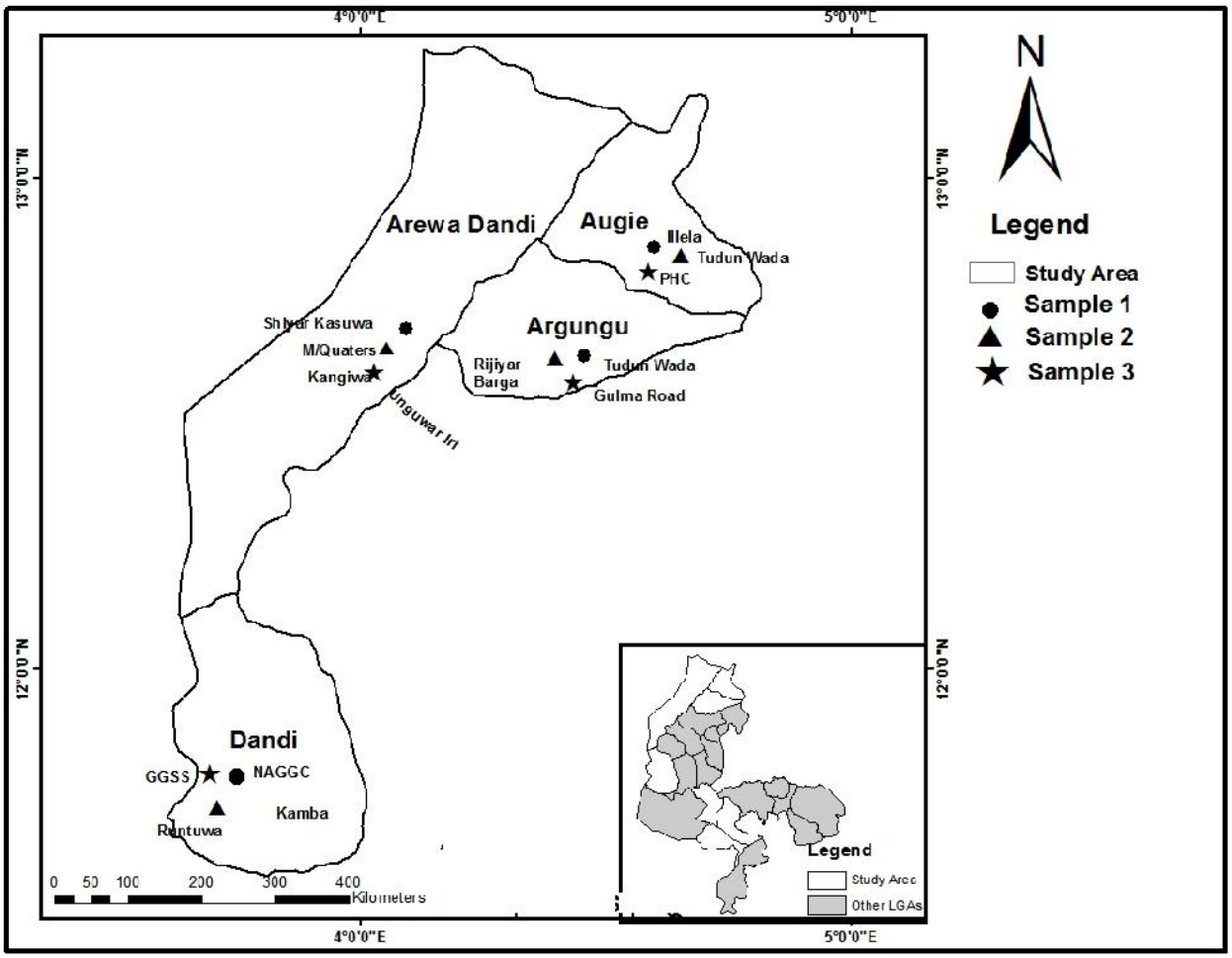

Figure 1.0: Showing Map of Kebbi State and Sample Sites

Determination of Heavy Metals

The six heavy metals were determined using a Perkin-Elmer Atomic Absorption Spectrophotometer (Buck Scientific Model 200/210A) with double beam and background corrector. Air-acetylene flame and Graphite furnace (Perkin-Elmer HGA 500) and a hollow cathode lamp were used.

Results and Discussion

The assessment of quality status of the ground water in Argungu Emirate is based on determination of thirteen (13) main physicochemical parameters (temperature, conductivity, total suspended solids, total dissolved solids, turbidity, chloride, nitrate,

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nitrite, total hardness, sulphate, phosphate, biological oxygen demand and chemical oxygen demand); in addition to six heavy metals (Cu, Co, Cr, Mn, Ni and Pb).

Table 1: Mean concentrations of the physicochemical parameters in three areas of Argungu metropolis.

Parameter	Sample Sites			WHO/NIS
	Tudun Wada	Gulma Road	RijiyarBarga	
Temperature ((°C))	31.46±0.06	31.50	31.67±0.28	Ambient
Conductivity (µS/cm)	515.00±1.0	108.90±0.10	170.67±1.16	1000
TSS (mg/l)	500.00	0.00	500.00±5.00	500
TDS (mg/l)	244.67±0.58	670.00±1.55	369.67±0.58	500
Turbidity (NTU)	0.01	0.00	0.20	5
Chloride (mg/l)	0.02±0.01	0.02±0.01	0.07±0.01	250
Nitrate (mg/l)	6.41±0.02	1.44±0.02	2.80±0.01	50
Nitrite (mg/l)	0.04±0.01	0.05±0.01	0.01	0.02
Hardness (mg/l)	56.64±2.95	27.50±2.50	36.70±2.90	150
Sulphate mg/l)	38.42±6.29	30.18±2.38	40.47±3.15	100
Phosphate (mg/l)	0.35±0.01	0.45	0.44±0.03	5
BOD (mg/l)	32.40	23.00±0.10	31.32±0.03	<30
COD (mg/l)	6.93±0.23	7.47±0.23	9.87±0.23	<250

TSS = Total Suspended Solids, TDS = Total Dissolved Solids, BOD = Biological Oxygen Demand, COD = Chemical Oxygen Demand (COD)

Tables 1-4 show mean values for concentrations of the physicochemical parameters from the four local government headquarters of the Argungu Emirates; while Tables 5-8 show mean values for concentration levels of the heavy metals determined using AAS. It could be noticed in Tables 1-8 that the mean values obtained for the concentrations of both the physicochemical parameters and heavy metals varied with the sample sites. The levels of temperature, conductivity, turbidity, chloride, nitrate, total hardness, sulphate, phosphate and chemical oxygen demand were all within permissible limits of World Health Organization (WHO) and Nigerian Industrial Standard (NIS) in all the water samples. The study thus revealed that the parameters may impose no health hazard to the boreholes water.

The mean values for total suspended solids (TSS) as in Tables 1-4 range as 0.00 – 2500 mg/l. Water sample from Kamba2 (GDSS) reflects highest concentration of 2500.00±5.00, while that of Argungu2 (Gulma Road) shows lowest concentration of 0.00 mg/l. The desirable limit of TSS in water is 500mg/l (WHO, 2006). Four samples from

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Argungu3 (RijiyarBarga), Kamba1 (NAGGC), Kamba2 (M/Quarters) and Kamba3 (Runtuwa), with respective values of 1166.67±2.89, 1500±5, 2500±5 and 1500, show concentrations higher than the allowable limit. The study shows that the ground water from these areas are turbid probably due to their nature of soils being sandy (Ademoroti, 1995; Sharma and Sharma, 2000). All the remaining water samples were within the limit.

Table 2: Mean concentrations of the physicochemical parameters in three areas of Augie Metropolis.

Parameter	Sample Sites			WHO/NIS
	Illela	Tudun Wada	PHC	
Temperature ((°C))	31.77±0.05	32.23±0.26	32.00	Ambient
Conductivity (µS/cm)	170.67±1.16	47.17±1.26	63.53±0.06	1000
TSS (mg/l)	1.66.67±2.89	1166.67±2.89	1.67±1.19	500
TDS (mg/l)	320.67±0.58	350.67±1.16	250.67±1.21	500
Turbidity (NTU)	0.93±0.06	0.70	1.90±0.10	5
Chloride (mg/l)	0.02	0.02±0.01	0.02	250
Nitrate (mg/l)	0.04	2.00	0.09	50
Nitrite (mg/l)	0.03	0.06±0.01	0.06	0.02
Hardness (mg/l)	28.36±2.89	54.86±5.02	35.03	150
Sulphate mg/l)	27.44±1.19	34.85±2.65	32.66±0.63	100
Phosphate (mg/l)	0.45±0.01	0.38	0.26	5
BOD (mg/l)	37.80	31.65±0.13	14.13±0.06	<30
COD (mg/l)	7.40±0.20	7.87±0.23	7.80±0.20	<250

PHC = Primary health Care.

The range of values for total dissolved solids (TDS) as shown in Tables 1-4 is 80.33 – 670 mg/l. Argungu2 (Gulma Road) recorded highest concentration of 670±1.55 mg/l and Kamba1 (NAGGC) has the least value of 80.33±0.58 mg/l. This indicates that Argungu2 water sample contains highest dissolved minerals matter in their soils; hence the water is more conductive than the rest of water samples. The maximum permissible limit of TDS is 500 mg/l (NIS, 2004). From the results, only samples from Argungu2 and Kamba3 have TDS concentrations above the permissible limit. This may impart taste quality character in their water which may be attributed to nature and geological structure of the areas (Sharma and Sharma, 2000). This agrees with a study on physicochemical parameters and heavy metals of water samples from different sources in Ife North Local Government area of Osun State (Adekunle *et al.,* 2010).

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Table 3: Mean concentrations of the physicochemical parameters in three areas of Kangiwa Metropolis.

Parameter	Sample Sites			WHO/NIS
	ShiyarKasuwa	M/Quarters	Unguwar Ire	
Temperature ((°C))	30.50±0.10	30.10±0.10	29.83±0.29	Ambient
Conductivity (µS/cm)	20.33±0.58	20.27±0.12	17.07±0.12	1000
TSS (mg/l)	1.67±1.19	500.00±5.00	500.00±5.00	500
TDS (mg/l)	380.33±1.53	365.33±0.58	335.00±1.16	500
Turbidity (NTU)	0.00	0.20	0.20	5
Chloride (mg/l)	0.002	0.013±0.01	0.02	250
Nitrate (mg/l)	0.04	0.09	0.04	50
Nitrite (mg/l)	0.05	0.04	0.04	0.02
Hardness (mg/l)	36.70±2.89	21.69±1.44	31.70±2.89	150
Sulphate mg/l)	33.75±0.41	39.79±2.34	38.15±0.96	100
Phosphate (mg/l)	0.27	0.31±0.01	0.29±0.01	5
BOD (mg/l)	24.00±0.17	20.87±0.06	24.30±0.01	<30
COD (mg/l)	9.33±0.23	6.67±0.31	7.60±0.80	<250

M/Quarters = Millennium Quarters.

Table 4: Mean concentrations of the physicochemical parameters in three areas of Kamba Metropolis.

Parameter	Sample Sites			WHO/NIS
	NAGGC	GDSS	Runtuwa	
Temperature (°C)	31.00	32.53±0.31	32.43±0.38	Ambient
Conductivity (µS/cm)	51.07±0.12	23.67±0.12	29.23±0.15	1000
TSS (mg/l)	1500±5.00	2500±5.00	1500.00	500
TDS (mg/l)	80.33±0.58	445±1.00	510	500
Turbidity (NTU)	0.40	1.00	0.30	5
Chloride (mg/l)	0.04	0.03	0.02	250
Nitrate (mg/l)	1.42±0.03	0.06	1.63±0.02	50
Nitrite (mg/l)	0.08	0.05	0.04	0.02
Hardness (mg/l)	37.53±2.51	51.67±2.83	30.03±5.01	150
Sulphate mg/l)	34.43±0.24	32.24±0.86	39.37±0.42	100
Phosphate (mg/l)	0.30±0.01	0.28	0.27	5
BOD (mg/l)	26.30	25.37±0.12	32.87±0.58	<30
COD (mg/l)	1.60±0.40	3.87±0.23	4.00	<250

NAGGC = Nana Asma'u Government Girls College, GDSS = Government Day Secondary School.

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Table 5: Mean concentrations of the heavy metals (mg/l) in three areas of Argungu Metropolis.

Metal	Sample Sites			WHO/NIS
	Tudun Wada	Gulma Road	RijiyarBarga	
Cu	0.000	0.005±0.001	0.003±0.001	1
Co	1.481±0.047	1.349±0.032	1.502±0.013	0.01
Cr	0.110±0.007	0.095±0.013	0.045±0.004	0.05
Mn	0.127±0.010	0.031±0.021	0.037±0.005	0.05
Ni	0.025±0.019	0.044±0.022	0.044±0.022	0.02
Pb	0.017±0.010	0.067±0.022	0.114±0.063	0.01

Table 6: Mean concentrations of the heavy metals (mg/l) in three areas of Augie Metropolis

Metal	Sample Sites			WHO/NIS
	Illela	Tudun Wada	PHC	
Cu	0.002±0.001	0.032±0.001	0.007±0.001	1
Co	1.319±0.025	1.322±0.026	1.329±0.072	0.01
Cr	0.042±0.006	0.109±0.019	0.092±0.002	0.05
Mn	0.067±0.001	0.049±0.004	0.039±0.010	0.05
Ni	0.069±0.047	0.027±0.019	0.046±0.020	0.02
Pb	0.122±0.018	0.072±0.029	0.033±0.007	0.01

Table 7: Mean concentrations of the heavy metals (mg/l) in three areas of Kangiwa Metropolis

Metal	Sample Sites			WHO/NIS
	ShiyarKasuwa	M/Quarters	Unguwar Ire	
Cu	0.004	0.006±0.001	0.003±0.001	1
Co	1.351±0.050	1.389±0.043	1.322±0.021	0.01
Cr	0.037±0.020	0.083±0.005	0.091±0.015	0.05
Mn	0.037±0.001	0.042±0.003	0.088±0.013	0.05
Ni	0.050±0.008	0.013±0.002	0.047±0.020	0.02
Pb	0.103±0.043	0.123±0.004	0.121±0.031	0.01

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Table 8: Mean concentrations of the heavy metals (mg/l) in three areas of Kamba Metropolis

Metal	Sample sites			WHO/NIS
	NAGGC	GDSS	Runtuwa	
Cu	0.008±0.001	0.010±0.001	0.005±0.001	1
Co	1.355±0.065	1.299±0.055	1.270±0.052	0.01
Cr	0.082±0.007	0.083±0.009	0.086±0.003	0.05
Mn	0.004±0.001	0.015±0.009	0.143±0.003	0.05
Ni	0.003±0.002	0.419±0.029	0.025±0.012	0.02
Pb	0.071±0.029	0.026±0.002	0.073±0.025	0.01

The concentrations of nitrate as shown in Tables 1-4 range as 0.01 – 0.08 mg/l. Kamba1 (NAGGC) recorded highest nitrite concentration of 0.08 mg/l, while Argungu3 (RijiyarBarga) recorded least concentration of 0.01 mg/l. With the exception of Argungu3, all the samples exceeded the nitrite allowable limit of 0.02 mg/l (NIS, 2004). This water may cause blue baby syndrome in which infants' blood is less able to carry out oxygen due to poisoning and nitrosamine digestive tract which is linked to cancer; as the two effects of nitrite and nitrate (Vermont, 2016).

Concentrations of biological oxygen demand (BOD) in the water samples as in Tables 1-4 range as 14.13 – 37.80 mg/l. Argungu3 (RijiyarBarga) has the least BOD level of 14.13±0.06 mg/l while Augie1 (Tudun Wada) has highest level of 37.80 mg/l. The BOD allowable limit in drinking water as for Indian water standard specification is less than 30 mg/l (BIS, 2012). Based on this specification, most of the water samples can be regarded as clean with an exception of five of them in which BOD was above the limit. Those above the limit are Argungu1 (32.40 mg/l), Argungu3 (31.32±0.03 mg/l), Augie1 (37.80 mg/l), Augie2 (31.65±0.15 mg/l) and Kamba3 (32.87±0.58 mg/l). Higher BOD levels in these water samples could be due to domestic sewage, petroleum residue, plant and animal wastes, etc., percolating through the water. This measures high contents of degradable organic materials in the samples which attract microbes. This agrees with a study on physicochemical parameters and heavy metals of water sample from different sources in Ife North Local Government area of Osun State (Adekunle *et al.*, 2010).

Concentrations of copper in the water samples as shown on Tables 5-8 have a range of 0.000 – 0.032 mg/l. Argungu1 (Tudun Wada) recorded least concentration of 0.000 mg/l, while Auie2 (Tudun Wada) recorded the highest concentration of 0.032±0.001 mg/l. The concentrations of all the water samples remain below the Cu limit of 1 mg/l

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(NIS, 2004; WHO, 2006). This might be due to less minerals matter and absence of copper related products in their water channels. This analysis agrees with a study report from drinking water in Nassarawa State, Nigeria, by Ibrahim and Gube Ibrahim (Adeyemi *et al.*, 2007).

Mean concentrations of cobalt in the water samples have a range of 1.270 -1.502 mg/l as shown in Tables 5-8.Kamba3 (Runtuwa) water samples has least concentration of 1.27±0.052 mg/l and Argungu3 (RijiyarBarga) has highest concentration of 1.502±0.013 mg/l. The concentrations of all the water samples were above the Co limit of 0.01 mg/l (WHO, 2006). This might be due to sewage effluents and agricultural runoff as some major anthropogenic contributors of cobalt to water. Oral exposure to cobalt results in adverse effects on respiratory, cardiovascular, gastrointestinal, hematological, hepatic, renal, endocrine, etc (ATSDR, 2004).

The chromium contents in the samples as shown in Tables 5-8 have concentrations range of l0.037 – 0.110 mg/l. Kangiwa1 (ShiyarKasuwa) has the least concentration of 0.037±0.02 mg/l, while Argungu1 (Tudun Wada) has the highest level of 0.110±0.007 mg/l. Only three water samples were within Cr limit of 0.05 mg/l. The remaining samples have higher concentrations above the limit which may cause human carcinogen. The most abundant damage is induced by Cr-DNA adducts which cause mutation and chromosomal breaks. Cr (VI) has an environmental mobility and can originate from both anthropogenic and natural sources (IARC, 1990).

Manganese concentrations lie within a range of 0.004 – 0.143 mg/l as shown in Tables 5-8. Kamba1 (ShiyarKasuwa) recorded lowest concentration of 0.004±0.001 mg/l, while Kamba3 (Runtuwa) recorded highest Mn concentration of 0.143±0.003 mg/l. Four water samples (Argungu1, Augie1, Kangiwa3 and Kamba3) were above Mn permissible limit of 0.05 mg/l (NIS, 2004). The remaining eight samples were within the limit. The high concentrations of Mn in those samples could be a natural factor since Mn occurs naturally in rocks, soils, underground pollution , etc., (Bundesgesundhitsamt, 1991). Elevated Mn level in water can disrupt nervous system, develop psychological difficulties and regeneration of hemoglobin among others (Ibrahim and El-Naggar, 2006).

Nickel concentrations in the water samples range as 0.003 – 0.419 mg/l. Kamba1 (NAGGC) water recorded lowest concentration of 0.003±0.003, while Kamba2 (GDSS) water recorded highest concentration of 0.419±0.020 mg/l. Only two out of twelve water samples were within the nickel permissible limit of 0.02 mg/l (NIS, 2004). These

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samples are Kangiwa2 (M/Quarters) and Kamba1 (NAGGC). All the remaining were above the limit. The higher concentrations of nickel might be due to leaching of nickel soluble compounds e.g. nickel silicate or arsenide, etc. through the soils or rocks (Perveen *et al.,* 2006). High levels of nickel can cause dermatitis, nasal irritation and lungs cancer (Ibrahim and El-naggar, 2006).

Levels of lead in the water samples were within a range of 0.017 – 0.122 mg/l. Argungu1 (Tudun Wada) has least concentration 0.017±0.010 mg/l while Augie1 (Illela) has highest concentration of 0.122±0.018 mg/l. The concentrations of all the water samples exceeded the lead allowable limit of 0.01 mg/l (WHO, 2006). The elevated lead levels might be due to leaching from dissolution of lead pipes in the water channels or geological composition of the area, etc., (Zuane, 1996). High level of lead is well known for its lead poisoning e.g. inhibition of hemoglobin synthesis, malfunction in kidneys, joints and reproductive system, cardiovascular system and acute chronic damage to central, etc., (Raphael *et al.,* 2009). Similar work on high lead levels in ground water at Zaria was reported by (Musa *et al.,* 2004).

Conclusion

The results of the study revealed that most of the physicochemical parameters (temperature, conductivity, turbidity, chloride, nitrate, total hardness, sulphate, phosphate and chemical oxygen demand, COD were within permissible levels of World Health Organization (WHO) and Nigerian Industrial Standards (NIS) in all the water samples. Total suspended solids (TSS), total dissolved solids (TDS) and biological oxygen demand (BOD) were within permissible limits in most of the water samples. TSS was above the limit in four samples (Argungu3, Kamba1, Kamba2 and Kamba3. TDS exceeded the limit in a single sample (Argungu2) and BOD was above the limit in five samples (Argungu1, Argungu3, Augie1, Augie2 and Kamba3). Nitrite alone was above the limit in all the samples with the exception of Argungu3 water sample. In the case of heavy metals, the results showed that only copper were within allowable limits in all the water samples. Mn was within the limit in most samples except in four places (Argungu1, Augie1 Kangiwa3 and Kamba3). Cr and Ni were above the limits in most samples with the exception of Argungu3, Augie1, Kangiwa1, Kangiwa1 andKangiwa2. Cobalt and lead were found to be above the limits in all the samples. Thus the water samples in which the parameters and heavy metals exceeded the permissible guideline levels may impart some ill health effects.

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