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Assessment of Physical and Chemical Water Quality for Drinking Purpose of Some Reservoirs and Ponds in Rimin Gado Local Government Area, Kano, State, Nigeria

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Abstract

The study assessed water quality for drinking purpose of some reservoirs and ponds in Rimingado Local Government area in Kano region. The scarcity of drinking water in the study area lead to the consumption of untreated surface water directly from reservoirs and ponds. The research aimed at analysing the physico-chemical characteristics in the reservoirs and ponds in the study. The study investigated some physiochemical characteristics of the surface water in the area to ascertain the quality condition of the water, standard laboratory techniques were employed in the water quality analysis. The result shows that the levels of physical and chemical parameters are above national and international standards for drinking water. In all the water bodies BOD, phosphate, nitrate, turbidity, and colour were found to be above standards while DO, alkalinity, pH, taste and odour fall within the standard guideline limits. Most of the parameters analysed are above standards of NAFDAC, WHO, SON and FEFA among others. For this reasons the water in the six water bodies is found to be polluted. It is therefore recommended among other things that the water from these sources should be treated properly before consumption besides sourcing water from underground.

Keywords: Ponds; Reservoirs; Physical; Chemical; Water quality.

1.0 INTRODUCTION

Water is an essential raw material for human life and presence of a reliable source of water is a vital factor in the establishment of a community. In the absence of drinking water in an area people must adopt a nomadic life style moving from one area to another looking for water to drink. Apart from being an important ingredient of life, water is also

capable of spreading ill health and death. Importance of an adequate supply of safe water was realized at the early time of man's development and cannot be over emphasized. The usual consequence of the establishment of a community in the vicinity of a water source is that unless effective sanitations measures are taken the water will become contaminated and

thus become potentially harmful because of hazards. It was reported that the evidence of such hazard was all too apparent in Europe and United States of America in 19th century and the appalling effects of ineffective sanitation and contaminated water supplies in many developing countries, this resulted in the establishment of the United Nations International drinking water supply and sanitation decade 1981-1990 (UNESCO, 1983). In developing countries there are many people without safe drinking water, which resulted in many water borne disease infections. It is predicted that by the year 2025 many African countries will experience water scarcity (WHO, 2002)

Most of the surface water bodies in Nigeria are contaminated with toxic chemicals either from industrial sources, agricultural land uses, and mining for example oil spillages in Niger Delta Region (Kudret and Iiker (2004). Nevertheless most of the water bodies in Kano State and those of Rimingado in particular have something in common, which is pollution (WECA 1977, 1978 and 1987). Thus, this study intends to assess the quality of surface water for drinking purpose.

Successful socio-economic developments in any country depend on available fresh water. The amount of such water both in quantity and quality for domestic, agricultural and industrial use could be determined only through appropriate monitoring and assessment of this valuable resource through quality assessment (WMO, 2002). Water quality is the physical, chemical and biological characteristics of the water (Kudret and Iiker, 2004) and (Robertson and David, 1993)

Water quality assessment is not a new issue because in the early 1950's the World Health Organization began to consider the need for some type of global quality standards. Its work resulted in the publication of International and European drinking water standards (WHO, 1971; WHO, 1993; WHO, 1996 and WHO 2011). The European Economic Community has also produced drinking water quality recommendation (EEC, 1975, EEC 1998). The most recent standard is that of WHO 1983 adopted from UNESCO 1983. Other standards include that of little (1975) combine standards of WHO, NAFDAC and SON adopted from NAFDAC report of 2002.

There is also Interim effluent limitation guidelines in Nigeria for all categories of

industries adopted from FEPA (2002). For a drinking water to be of good quality the level of physical and chemical parameters should not exceed the standards of national and international organizations such as those of WHO (1983), NAFDAC (2002) and FEPA (2002) among others.

On the basis of that many researches were conducted to access the quality of drinking water either surface or underground, among which there is that of Ross *et al.* (1991) who initiated a pilot programme of household water quality education in Warron county, Virginia, which included water sampling, testing and diagnosis. The parameters analyses by this research include iron, manganese, hardness, sulfate, chloride, fluoride, Total dissolved solids (T.D.S.), P^H, saturation index, copper, sodium and nitrate which were discovered to be above acceptable limit for a drinking water.

Another research on water quality is the one done by Kansas department of Health and Environment in the year 1998 and 2000, for example according to the report of K.D.H.E (2000) assessment of Kansas's surface water quality was conducted as required by 33 USC 466 et seq, the federal water pollution control Act., commonly referred to as the clean water Act. The water quality of Jameson and Grimes lakes was also analysed in September, 2004 and found the water parameters to be at toxic level (WSDE, 2004). In another research Ochir (2008) investigated the levels of P^H, dissolve oxygen, chemical oxygen, nitrate, nitrite, ammonia and biochemical oxygen demand in Tuul River, Netherlands and the result reported that they are all at toxic level.

The analysis of water quality for drinking purpose in Nigerian context is not a new task: Asma (1987) analysis surface water quality in metropolitan Kano. The parameters analyzed in her research work include hardness, TDS, Turbidity, cadmium, pH, colour, odor, taste and electrical conductivity the result shows that most of the physical and chemical parameters measured in the water bodies of Kano are present at high level.

Balarabe *et al.* (2002) conducted a research on surface water quality assessment of makwaya Farm Lake in Samaru Zaria in the year 2000. Also Essiet and Ajayi (2000) conducted a research on ground water quality in Hadejia valley project for agricultural use and reported that the water is of poor quality. In another development Moshood and Mustapha (2008)

conducted water quality assesment of Oyun reservoir in Offa Kwara state and find out that the levels of COD, hardness, phosphate and nitrate are above the permissible limits and no acidic pH was recorded. Bichi (2009) also assessed the physicochemical quality parameters of the Jakara basin in the Kano region where the finding indicated that the parameters are at toxic level. This will assist in

comparing parameters with standards for assessing the level of pollution in the surface water bodies for quality improvement. This provides the basis for the current study. Selected sources of water in Rimin Gado Local Government area of Kano state, Nigeria were assessed for their chemical and physical quality.

2.0 METHODOLOGY

2.1 The study Area

The study area (Rimingado L G.A) is located between Latitudes $12^{\circ} 00'N$, $12^{\circ}50' N$ and Longitudes $8^{\circ}; 10^{\circ}E$, $8^{\circ} 23'E$. It is about 28 kilometers west of Kano city from Kofar Kabuga traditional gate, with an approximate land area of 86.25 km^2 . Annual rainfall of Kano region is received between April and October, with storm and torrential pours in

July and August. The mean annual rainfall is given as 650mm. The temperature is characterized by warm and hot seasons with the occurrence of the harmattan between November and February. The study area (Figure 1) being underlain by basement complex rocks is characterized by abundant surface water (Olofin, 1987).

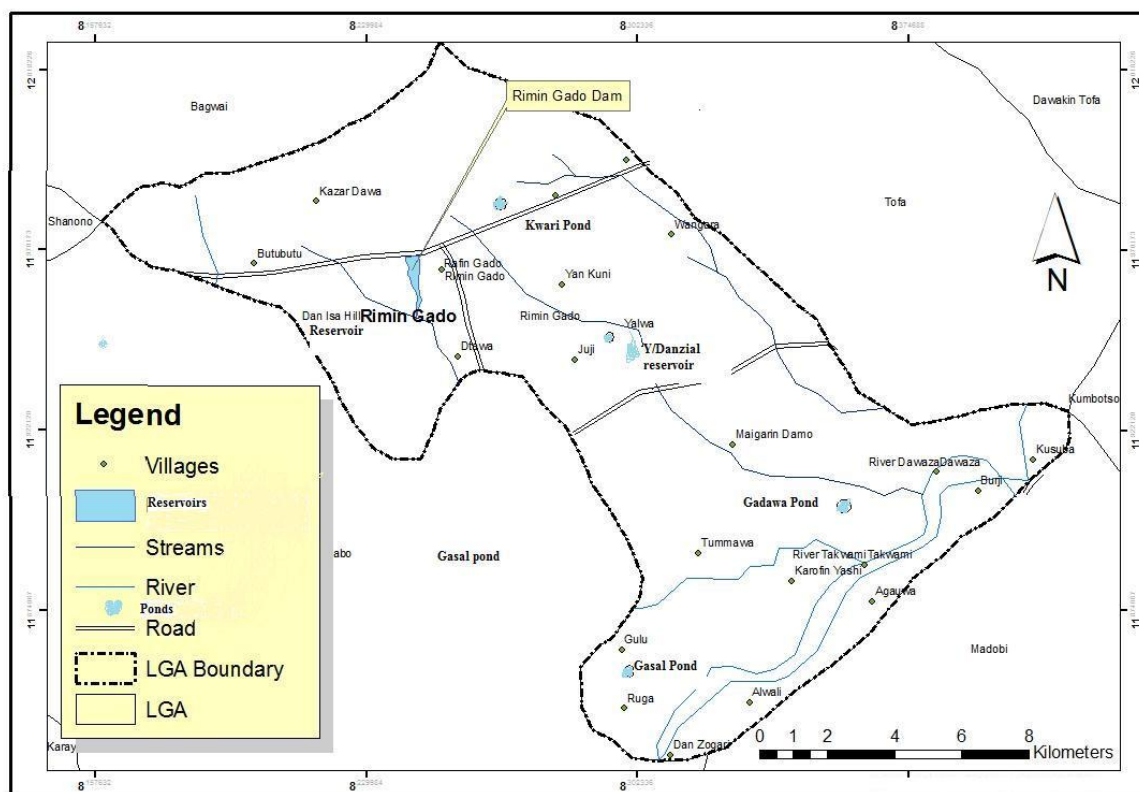


Figure 1: Map of the study Area.

2.2 Data Collection

2.2.1 Collection of water samples

A water samples were collected from the selected reservoirs and ponds using 250ml plastic bottles and rubber bottles as adopted from Ross *et al.* (1991). The samples were collected at three points from each water body i.e. at the middle and at two ends. But water samples for physical, chemical and biological tests were collected in separate containers because separate tests were carried out in the laboratory. These samples were collected during the month of November, 2006. From the sites preservatives were added to the water samples such as logos solution and formalin.

2.2.2 Laboratory Techniques

2.2.3 Techniques for Measuring Physical Parameters

The colour of the six water samples was measured using platinum cobalt method adopted from standard methods of water examination where a machine called colour NCASI253 (0- 500 units) was used to measure the Total colour units (TCU). Programme number for NCASI colour was entered, then wave length was rotated, samples were collected, 200ml of each in a 400-ml beaker, then ten more steps were followed before finally readings were displayed.

Taste was measured through tasting the water samples and find out whether it is objectionable or not to the consumers. In this case the five people met in ponds or reservoir were asked to taste the water and give their views. Odour was also measured through objectionable smell or not by the consumers. In this case too first five people were used as in taste.

2.2.4 Techniques for Measuring Chemical Parameters

Phosphate was measured using molybdonate method with spectrophotometer machine. Stored programme number was entered, the wave length was rotated, 25ml graduated cylinder was used to filled a sample cell with 25ml of deionized water (the blank) then another 25ml graduated cylinder was used to filled a second sample cell with 25ml of sample (the prepared sample), 1.0ml of molybdonate reagent was added to each sample, shift timer was pressed the result was displayed when the timer beeps.

Nitrate was measured in the laboratory using cadmium reduction method with spectrophotometer machine. At the beginning

stored number programme was entered, wave length was rotated until small display show 500nm then a sample cell was filled with 25ml of samples, nitrate reagent powder pillow was added to the sample cell, the cell was shake vigorously until the timer beeps in one minute. After a five minutes reaction period another cell was filled with 25ml of samples (the blank), when the timer beeps again the display show, zero was pressed, a stopper was removed and the Reed was pressed and the reading of Nitrate was displayed in mg/l. This was repeated in the remaining water samples.

Chloride was measured in the laboratory using Mercuric Thiocyanate method as adopted from (Zall *et al.*, 1956). At the first instance a stored number program for chloride was entered, 7.0 was pressed then enter and display was shown and nm was dialled to 455, the wave length was rotated until a small displayed show 455nm, a sample cell was filled with 25ml of deionized water (the blank) a pipet also filled with 2.0ml of mercuric thiocyanate solution into each cell swirl to mix, another pipet was filled with 1.0ml of Ferric iron solution into each cell again then shift timer was pressed and a two minute reaction period began until the timer beeps and the display show reading in mg/l. The same was repeated in the six water samples.

Turbidity was measured using Attenuated Radiation Method (direct reading) adopted from ISO method 7027. Stored number program was entered and 750 enter was pressed and then display showed and nm was dial to 860, wavelength dial was nitrated and small display was shown. 25ml of deionized water (the blank) was poured into the sample. The blank was placed into the cell holder alight shield was closed, zero was pressed. Another 25ml of the sample was poured into the cell and then READ was pressed until the reading appeared in N.T.U (Number of Turbidity Units).

The procedure used in measuring alkalinity is methyl orange method. First of all 25ml of the sample was measured from 25ml measuring cylinder and turned into 100ml conical flask, 2 drops of methyl orange was added and shake thereafter filtrated with 0.02N of H₂SO₄ till there is a colour change observed (greenish blue). Then alkalinity was calculated in mg/l using the formula:

Alkalinity = A x N x 50000 / MI sample

Where A= ML standard acid used.

N = Normality of standard acid

MI = MI litre sample.

The same procedure is repeated throughout the six water samples. Dissolved Oxygen (DO): - It was measured in the laboratory where the oxygen content was determined in the water. The maximum concentration of dissolved oxygen in water at 160 mg dm³ then it was estimated using the formulae.

$$x \cdot 100/10$$

Where x = amount of oxygen in water

10 is constant.

4.0 RESULTS AND DISCUSSION

4.1 Result of the Physical parameters

It was discovered from the field that four (4) out of the 5 people interviewed said it is unobjectionable at Rimingado reservoir, Yalwandanziyal reservoir and Banguna pond while four (4) out of the 5 said it is objectionable at the remaining 3 ponds (Table 1). It was discovered from the field that the whole 5 people asked said it does not smell at all for the six water bodies. The taste of water in Rimingado reservoir, Yalwan Danziyal reservoir and Banguna pond is unobjectionable as it contained in the WHO, NAFDAC, SON and FEPA standards. But in Gadawa pond, Gasal pond it was objectionable to 90% of the consumers in the six water bodies therefore no difference with the national and International standards. Therefore, the water in Gadawa pond and Gasal pond are rejected for drinking, while all the rest are accepted, as per taste is concern. Odour is unobjectionable to 90% of the consumers in the six water bodies therefore no difference with the national and international standards of drinking water. It means water in the six water bodies can be considered accepted as per odour is concern (Tables 1 and 2).

In terms of colour, it can be seen from the laboratory analysis that the Gasal pond recorded TCU of 19.0, Kwari pond with 18.0 and it is low in Rimingado and Yalwan Danziyal reservoirs. The colour of the waters' in Rimingado reservoir, Yalwan Danziyal reservoir, Banguna pond and Gadawa pond is within the limit of WHO, NAFDAC, SON and FEPA while that of Kwari pond and Gasal

BOD was determined in the laboratory by incubating a sample of the water for five days at 20°C then the amount of oxygen consumed is measured. This type of BOD is called 5 days BOD, it was measured in mg/L.

The same method used in measuring alkalinity was also used to measure P^H at 20°C for each samples using methyl orange method with spectrophotometer machine. Then the P^H is measured using a range of scale from 1- 14 from the pH meter.

3.1 Data analysis: The Data was analysed through laboratory techniques, simple statistics and comparing results of both physical and chemical parameters with standards.

pond is beyond the limit because they are above 3.0 and 15.0 TCU (Tables 1 and 2) It means the water is accepted for drinking in Yalwan Dan Ziyal reservoir, Rimmingado reservoir, Banguna pond, and Gadawa pond. While Kwari and Gasal pond are not accepted as per this parameter is concern. This finding is similar to that of Ochir (2008) in Netherland where it was at the toxic level.

4.2 Results of Chemical Parameters

Results showed that the surface water body with highest Dissolved Oxygen (DO) is Yalwan Dariziyal reservoir with Dissolved Oxygen of 21mg/l, Rimingado reservoir is having the lowest DO of 13.2mg/L out of the two reservoirs. While considering the ponds, Gadawa pond is having the highest Dissolve oxygen of 16.Smg/L and Banguna pond is having the lowest Do of 13.5mg/L. The level of dissolved oxygen in the six water bodies is not of significant importance because according to WHO, NAFDAC. SON, FEPA and Little (1975) there is no limit of dissolve oxygen in drinking water (Table 1 and 2). Therefore, the water can be considered accepted for drinking as far this parameter is concern. The result is similar to that of Ross *et al.* (1991).

Results of Biochemical Oxygen Demand (BOD) showed that Banguna pond has the highest mean of 696mg/L. Rimingado reservoir is having the lowest BOD of 186 mg/L, out of the two sampled reservoirs, BOD is higher in Yalwandanziyal reservoir with mean BOD of 620mg/L followed by Rimingado reservoir with mean of 186 mg/L (Table 1). It can be seen that the level of BOD

in the six water bodies was above the standards of WHO which is 50mg/l, SON 100mg/l, FEPA 50-500mg/l (Tables 1 and 2). BOD determines the level of pollution in drinking water because according to Wong *et al.* (2002) < 30mg/l of BOD in water it means that the water is clean with no pollution at 30 — 80mg/l the level of pollution is mild and > 80mg/l the level of pollution is severe. Due to the presence of DO at high level throughout the six water bodies and it is generally above standards it is therefore the water cannot be used for drinking because of pollution. The finding is in line with that of Bichi (2009), Asma (2002) and Ross *et al.* (1991).

Results of turbidity demonstrated that Banguna pond is more turbid than the rest of the water bodies with a mean turbidity of 434 NTU. The reservoir with the highest turbidity is Yalwandanziyal reservoir with 328 NTU while Rimingado reservoir is having a turbidity of 114 NTU. Among ponds Gadawa is the least turbid with a mean turbidity of 168 NTU. The result shows that there is high turbidity in the six water bodies. Turbidity of the six water bodies ranges between 434 NTU to 114 NTU. The standards of WHO, NAFDAC SON and FEPA is 5.0 NTU only (Table 1 and 2). Therefore the water in the six water bodies is above National and International Standards for drinking water in terms of turbidity. Which means the water is rejected for drinking as per this parameter is concern.

Laboratory analysis indicated that nitrate is high in Banguna pond with 76.6mg/L mean concentration and lower in Kwari pond with a mean of 44.7mg/L. It is also higher in Yalwandanziyal reservoir with a mean of 67.7mg/L than Rimingodo reservoir with a mean of 58.4mg/L. Results for Nitrate analysis in the water samples indicate that the highest level of nitrate recorded is 76.6mg/L in Banguna pond and the lowest is 44.7mg/l in Kwari pond. These levels when compared with NAFDAC max allowable limit of 10mg/l, SON's standard of 10mg/l, WHO's highest desirable limit of 10mg/l, WHO max permissible limit of 50 mg/l, FEPA's approved standard of 20mg/l are above the standard except that of Kwari pond with 44.7mg/l which is not up to WHO maximum permissible limit of 50mg/l (Table 1 and 2). Base on this the water in the five water bodies is rejected except Kwari pond which is below

as far this parameter is concern. It is in line with findings of (Bichi, 2009).

In terms of alkalinity, it can be seen that Gasal pond water is the most alkaline of all with a mean alkalinity of 60mg/L while Gadawa pond is having the lowest level of 28mg/l. Data from the laboratory analysis indicates that among the water bodies alkalinity ranges from 60mg/L in Galas pond to 28mg/L in Gadawa pond. The National and International standards indicate that the WHO highest desirable limit is 100mg/l the NAFDAC standard is 100mg/l that of SON is 100mg/l (Tables 1 and 2). Therefore the level of alkalinity is not above the standards. The six water bodies are accepted for drinking regarding this parameter.

Laboratory analysis shows that the Level of chloride was discovered to be higher in Yalwananziyal reservoir with a mean of 6.3mg/L and lower in Gasal pond with 5.4mg/l, among the reservoir chloride is higher in Rimingado reservoir with mean of 6.3mg/l. The pond with highest level of chloride is Gadawa with 6.2mg/l mean chloride and Gasal is having the lowest mean chloride of 5.4mg/L. The level of chloride in the six water bodies ranges between 6.3mg/l to 5.4 mg/l. The standard of WHO is 200mg/l as highest desirable, the maximum permissible limit or action level is 250mg/l. The NAFDAC's standard is 100mg/l, SON's standard is 100mg/l (Tables 1 and 2). This shows that the level of Chloride is within the allowable limit of these standards. It means the water is accepted for drinking regarding this parameter.

Result shows that pH level is almost uniform among the water bodies with little variations. Kwari pond is having the highest pH value of 8.52 and Banguna is having the lowest mean pH value of 7.90. Considering the reservoirs Yalwandanziyal have the highest pH value 8.41 while Rimingado is having the lowest pH of 8.34. The pH has no known health effects but may however, have consequences with other properties of water e.g dissolution of lead occurs more rapidly at acidic pH level. Also corrosion and incrustation of metals are influenced by pH. Even water treatment process is affected by the level of pH in the water (Tables 1 and 2). It can be stated therefore that the six water bodies are free from the danger of pH since it is low throughout. It is in line with findings of K.D.H.E (2000) in Kansas.

The WHO highest desirable phosphate limit is 10mg/l and maximum permissible limit is 15mg/l. NAFDAC allowable limit is 10mg/l, SON standard 20mg/l. The mean concentration in each of the six water bodies is above the standard limit of 10mg/l and FEPA approved limit is 20mg/l. The mean concentration in each of the six water bodies is above the standards except Kwari pond with 16.7mg/l

which is below FEPA's standard the water bodies contained high level of phosphate which is above standards, it is therefore not recommended for drinking (Tables 1 and 2). It is contrary to the findings of Moshood and Mustapha (2008) in Oyun reservoir in Kwara state, Nigeria.

Table 1 Mean concentration of physical and chemical parameters of three samples of water collected in the six water bodies in Rimingado Local Government Area, Kano

Water bodies	R/Gado reservoir	Y/Danziyal Reservoir	Banguna Pond	Gadawa Pond	Kwari Pond	Gasal Pond
Parameter/Location	11°58.502 ¹ N 08°15.423 ¹ E	11°56.750 ¹ N 08°18.444 ¹ E	11°56.750 ¹ N 08°18.536 ¹ E	11°55.514 ¹ N 08°20.602 ¹ E	11°58.763 ¹ N 08°16.059 ¹ E	11°52.101 ¹ N 08°17.982 ¹ E
DO in mg/l	13.2	21	13.5	16.5	14.2	15.3
BOD in mg/l	186	624	696	294	529	331
Phosphate in mg/l	21	22	19.8	20.8	16.7	20.1
Nitrate in mg/l	58.1	67.7	76.6	69.1	44.7	59.7
Alkalinity in mg/l	36	40	36	28	48	60
PH at 20°C	8.34	8.41	7.90	8.42	8.52	8.38
Turbidity (N.T.U)	114	328	434	168	249	184
Chloride in mg/l	6.0	6.3	5.8	6.2	5.9	5.4
Colour (TCU)	2.0	2.0	3.0	10.0	18.0	19.0
Taste	Un/Obj	Un/Obj	Un/Obj	Un/Obj	Un/Obj	Un/Obj
Odour	Un/Obj	Un/Obj	Un/Obj	Un/Obj	Un/Obj	Un/Obj

Source: Field/ Laboratory work, 2007, Un/Obj = Unobjectionable.

Table 2 Permissible Limits of Physical and Chemical Parameters in Drinking water.

Parameter	ALLOWED LIMITS					
	NAFDAC	SON	WHO D Min	WHO Max	FEFA	Little (1975)
PH at 20°C	6.5 - 8.5	6.5 – 8.5	7.0 - 8.9	6.5- 9.5	6 – 9	7 – 9
Turbidity	5.0 NTU	5.0NTU	5.0 NTU	5.0NTU	NA	5.0 NTU
Alkalinity	100 mg/L	100 mg/L	100 mg/L	100 mg/L	NA	100 mg/L
Chloride	100 mg/L	100 mg/L	200 mg/L	250 mg/L	600 mg/L	250 mg/L
Nitrate	10 mg/L	10 mg/L	10 mg/L	50 mg/L	20 mg/L	0.1 mg/L
Phosphate	10 mg/L	mg/L	10 mg/L	NIL	NA	No limit
DO	NIL	NIL	NIL	NIL	NA	No Limit
BOD	NIL	100 mg/L	50 mg/L	50 mg/L	50 mg/L	NA
Manganese	2.0 mg/L	0.05 mg/L	0.1 mg/L	0.4 mg/L	NA	NA
Sulphate	100 mg/L	0.01 mg/L	0.01 mg/L	0.07 mg/L	5 mg/L	250 mg/L
Aluminium	0.5 mg/L	NS	0.2 mg/L	0.2 mg/L	NA	0.25 mg/L
Potassium	10.0 mg/L	10.0 mg/L	NS	NS	NA	NA
Lead	NA	NA	0.01 mg/L	0.001 mg/L	<1 mg/L	0.01 mg/L
Iron	NA	NA	0.1 mg/L	0.01 mg/L	20 mg/L	0.3 mg/L
Colour	3.0TCU	3.0 TCU	3.0TCU	15.0 TCU	7 TCU	10 TCU
Taste	Un/Obj	Un/Obj.	Un/Obj.	Un/Obj.	Un/Obj.	Un/Obj.
Odour	Un/Obj	Un/Obj.	Un/Obj.	Un/Obj.	Un/Obj.	Un/Obj.

Source Little (1975) WHO (1983) NAFDAC (2002) and FEFA, (2002).

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study has been carried out to assess the water quality of some ponds and reservoirs for drinking purpose in Rimingado Local Government area Kano State. It is clear that the reservoir and pond waters which people of Rimingado Local Government area are taken directly without treatment contain unacceptable levels of BOD, phosphate, nitrate, turbidity, colour, alkalinity and odour which are hazardous to human health. The presence of these physical and chemical parameters at high level in the water rendered it to be of poor quality and not recommended

for drinking. The conclusion is that surface water in the study area is polluted therefore not recommended for drinking without treatment.

5.2 Recommendations

With particular reference to the findings of this research, the following recommendations were made. People should device means of treating the water locally to reduce some of the toxicity. It is also recommended that, government should improve the water treatment plant in the area. Similarly, the two minor reservoirs in the local government area should be dredged and their main inlets should be clean.

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