

Original Research Article

QUALITY EVALUATION OF EARTH DAM AND POND WATER IN GELLA, MUBI SOUTH LOCAL GOVERNMENT AREA

Abstract

The present work was to evaluate the quality of ponds and earth dam water of Gella town in Mubi South Local Government Area of Adamawa State in order to examine its suitability for drinking and domestic purposes. Four ponds and an earth dam water samples were collected each during dry seasons between the months of November to April 2015/2016. The samples were analyzed using arithmetic mean and standard deviation which was then compared with the World Health Organization (WHO) and NAFDAC standard. Physicochemical parameters were studied using standard methods, concentrations of heavy metals determined using atomic absorption spectroscopy and bacteriological analysis conducted using standard methods. Result of the analyses revealed that the water samples were slightly acidic to slightly alkaline ($\text{pH } 5.60 \pm 0.17 - 7.20 \pm 0.12$). The calcium concentration in water studied were all below that of magnesium concentration which was between 0.94 ± 0.01 to $2.17 \pm 0.01 \text{ mg/L}$ and these magnesium concentrations were within permissible WHO and NAFDAC recommended standard limits. While the coliform count were above WHO and NAFDAC standards for drinking water, and the water samples were good for drinking and domestic purposes. Regular monitoring of the water quality of the area and provision of industrial motorized borehole water for easy distribution to the community have been strongly recommended.

Keywords: Gella, coliform, pond, physicochemical, water

1.0 INTRODUCTION

Water quality is fundamental to health, poverty alleviation and community development. Safe water has been explicitly recognized by the Covenant on Economic, Social and Cultural Rights (CESCR) as a fundamental human right in November 2002. According to the United Nations, over 1.1 billion people lack access to safe drinking water, of which nearly two thirds live in Asia

(World Health Organization [1]. As a result of inadequate access to safe drinking water over 10,000 people die each day from avoidable water-related diseases ([2]. Reports by Food and Agricultural Organization revealed that in African countries, particularly Nigeria, water related diseases had been interfering with basic human development [3]. The common sources of water that are available to local communities in Nigeria are fast being severed by a number of anthropogenic factors, of which pollution remain the most dominant problem. Water pollution occurs when unwanted materials with potentials to threaten human and other natural systems find their ways into rivers, lakes, wells, streams, boreholes or even reserved fresh water in ponds, dams, homes and industries. The pollutants are usually pathogens, silt and suspended solid particles such as soils, sewage materials, disposed foods, cosmetics, automobile emissions, construction debris and eroded banks from rivers and other waterways. Some of these pollutants are decomposed by the action of micro-organisms through oxidation and other processes. The major problem is the re-concentrations of these harmful substances in natural food chain [3,4]. During the decomposition process, natural bacteria and protozoan in the water source utilize the oxygen dissolved in the water. This could significantly reduce the oxygen level to less than two parts per million (<2ppm), therefore the respiratory conditions of aquatic species would be seriously affected. Consequently, fishes, bottom-dwelling animals and even marine plants can be contaminated and/or killed, creating significant disruption in the food chain. On the other hand, when this contaminated water is directly consumed without proper treatment (a common practice in local communities), spread of diseases such as typhoid, dysentery, cholera, hepatitis etc. will occur.

In Nigeria today research indicates that, majority of the common water sources are polluted, resulting to serious outbreak of these and other diseases. The major issues of national and international interest are how these water pollution problems could be fully assessed and mitigated, proper knowledge and planning are thus essential. This paper aimed at evaluating the quality of ponds and earth dam water in Gella town, Mubi South Local Government Area of Adamawa state in order to provide data and information on the physical properties, chemical properties and heavy metals concentration of pond and dam water in this area. The data information that will be generated can serve as a guide in monitoring water contamination; it will also be useful in creating a baseline data of pond and dam water quality in the area under study.

2.0 MATERIALS AND METHODS

2.1 STUDY AREA

The study was carried out in Mubi South Local Government Area of Adamawa state during the dry season between the months of November to April 2015-2016. Mubi is about 240 km from the State capital, Yola. It is located on latitude 10.159834 and longitude 13.299765. According to the 2003 population projection Mubi South has a population density of 187.2 per square kilometers. Mubi is situated at lower contour of Mandara Mountains separating Nigeria from Cameroon. The climate controls the amount of water that is available at the surface and subsurface at a given time. Virtually all rivers are dry, during the dry seasons.

2.2 SAMPLE COLLECTION

Five ponds and one Bogga earth dam (Figure 1) water samples were collected randomly at Gella, Mubi South Local Government Area Adamawa State. The water was collected using sterile 1000 cm³ polyethylene bottles. The water samples were preserved with HNO₃.

2.2 TEMPERATURE AND pH

The temperature and pH of the water samples were measured at the point of collection according to the method described by Alexander [5]. The pH was measured using pocket sized pH meter while the temperature was measured with the help of mercury-in-glass thermometer graduated up to 110°C.

2.3 MEASUREMENT OF COLOR

The color of water samples was determined spectrophotometrically using the method of Gimba [6]. A DR 2000 (HACH) Spectrophotometer at wavelength of 450nm was used.

2.4 MEASUREMENT OF TOTAL DISSOLVE SOLID (TDS) AND ELECTRICAL CONDUCTIVITY (EC)

The Total Dissolved Solids and Electrical conductivity was measured using a TDS/conductivity meter as described by Ishaku *et al.* [7]. 200mls of distilled water and 200mls of water sample was poured into two separate beakers. The TDS / conductivity meter switched on, and its sensor rod was dipped into the beaker containing distilled water which was given a reading

85 0.00mg/Liter TDS. After that, the sensor rod was dipped into the second beaker containing water
86 sample, the TDS/conductivity was then display the TDS value in mg/Liter.

87 **2.5 MEASUREMENT OF TURBIDITY**

88 Turbidity was measured using DR 2000 (HACH) spectrophotometer using the method of
89 Mustafa *et al.* [8].

90 **2.6 MEASUREMENT OF BIOCHEMICAL OXYGEN DEMAND (BOD), CHEMICAL** 91 **OXYGEN DEMAND (COD) AND DISSOLVE OXYGEN (DO)**

92 Biochemical oxygen demand (BOD), Chemical oxygen demand (COD) and Dissolve oxygen
93 (DO) were determined as describe by Onwughara *et al.* [9]. Five-day Biochemical Oxygen
94 Demands (BOD₅) was determined titrimetrically after incubation in tightly stoppered BOD
95 bottles in the dark at 20°C. Dissolve oxygen content of the sample water was determined using
96 digital dissolved oxygen meter

97 **Calculation of COD:**

$$98 \text{ COD (mg/Ltr)} = \frac{\text{ml of blank} - \text{ml of sample}}{A \times \text{volume of sample used}} \times 100$$

99 Where A= Total volume of KMnO₄ 0.0125M added to the samples.

100 **2.7 DETERMINATION OF HEAVY METAL**

101 Magnesium, calcium and heavy metals was determined using Atomic Absorption
102 Spectrophotometer (Buck Scientific 210) as described by Babagana *et al.* [10]. In determination
103 of magnesium, calcium and heavy metals concentration using Atomic Absorption
104 Spectrophotometer (Buck scientific 210) was used. The water sample was aspirated into the
105 instrument after all the necessary set up and standardization procedures. Atomic vapor was
106 produced as the sample drop on the acetylene flame, a beam of monochromatic light with a
107 wavelength at which only the element of interest was absorbed, passed through the flame. The
108 atom of the element in flame absorbed some amount of light which was corresponding to its
109 concentration. This was detected on the display unit read as the absorbance. A calibration curve
110 of each element was plotted using the absorbance of the standard against their corresponding
111 concentration and was used to determine the concentration of the elements in the samples.

2.8 BACTERIOLOGICAL ANALYSIS

The bacteriological analysis was carried out according to Uwama [11]. Five sterile test tube was placed on a test tube rack. 9ml of sterile saline was prepared and added into each of the five sterile test tube. m1:10 serial dilution of *E. coli* broth up to 10^5 was made and 0.2ml of 10^{-5} dilutions was transferred into duplicate nutrient agar plate and the plate was labelled. A sterile glass spreader was used for sterilizing, by dipping it into alcohol and burn off alcohol over flame. The 0.2ml of 10^5 dilution was spread evenly over the plate and allowed to dry. The agar plate was incubated by inverting it at 37°C for 24hours this was repeated for 10^{-6} , 10^{-7} dilutions. The total Coliform Unit was examined and counted. The results were recorded. The number coliform unit was calculated using the formula

Number of CFUs per ml = $1/\text{vol. plated} \times \text{dilution factor} \times \text{average no. of colonies}$.

2.9 STATISTICAL ANALYSIS

Mean and standard deviation were used for statistical analysis and the results were presented as mean $\pm$ standard deviation.

3.0 RESULTS AND DISCUSSION

3.1 RESULTS

The result of physicochemical parameters of ponds and earth dam waters of Gella, compared with NAFDAC and WHO values shows that pH 5.60 ± 0.17 - 7.20 ± 0.12 , temperature 30.00 ± 0.00 - 25.00 ± 2.28 $^\circ\text{C}$, electrical conductivity 3.56 ± 0.33 - 6.40 ± 0.04 μs , total dissolve solids 4.75 ± 0.06 - 8.27 ± 0.15 mg/L, color 2.0 ± 0.0 - 3.0 ± 0.00 TCU, turbidity 5.00 ± 0.89 - 226.17 ± 21.0 NTU, chemical oxygen demand 1.59 ± 0.23 - 4.27 ± 0.27 mg/L, biochemical oxygen demand 2.31 ± 0.13 - 5.17 ± 0.21 mg/L, dissolve oxygen 9.91 ± 0.19 - 19.40 ± 0.33 mg/L (Table 1).

The result of heavy metals concentration of ponds and earth dam waters of Gella compared with NAFDAC and WHO values shows that calcium 19.79 ± 0.01 - 28.21 ± 0.00 , magnesium 0.94 ± 0.01 - 2.17 ± 0.01 , iron $BD-1.14 \pm 0.01$, manganese 0.11 ± 0.03 - 1.70 ± 0.03 (Table 2).

The result of the total coliform count in earth dam and pond waters in Gella ranged from 510 to 6100 CFU/100ml (Table 3).

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Table1: Physicochemical parameters of Gella ponds and earth dam water.

Parameters	Pond 1	Pond 2	Pond 3	Pond 4	Earth Dan	NAFDAC	WHO
pH	6.40±0.10	5.80±0.00	5.90±0.00	5.60±0.17	7.20±0.12	6.5-8.5	6.5-8.5
Temp (°C)	28.70±1.03	30.00±0.00	29.00±0.07	25.30±2.42	25.00±2.28	NA	30-32
E.C (µs)	5.83±0.19	3.87±0.51	4.12±0.01	3.56±0.33	6.40±0.04	1000	1000
TDS (mg/L)	7.88±0.27	3.87±0.51	6.33±0.12	4.75±0.06	8.27±0.15	500	500
Color (TCU)	2.0±0.00	3.0±0.00	2.0±0.00	2.0±0.00	3.0±0.00	15	15
Turbidity (NTU)	92.83±5.04	138.00±1.41	28.50±2.12	5.00±0.89	226.17±21.03	5	5
DO (mg/L)	12.08±0.34	10.95±0.09	10.12±0.18	9.91±0.19	19.40±0.33	7.5	7.5
COD (mg/L)	2.29±0.42	3.68±0.91	28.50±2.12	1.59±0.23	4.27±0.27	7.5	7.5
BOD (mg/L)	3.35±0.36	4.56±0.61	5.00±0.01	2.31±0.13	5.17±0.21	6.0-9.00	6.0-9.00

All measurement are mean ± standard deviation of 3 replicate analysis and are in mg/L except for pH, temperature (°C), electrical conductivity (µs), color (TCU), turbidity (NTU).

NAFDAC =National Agency for Food Drug and Control

WHO =World Health Organization

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150 Table2: Heavy metal concentration in Gella ponds and earth dam water.

	Calcium	Magnesium	Iron	Manganese	Zinc
Pond 1	23.43±0.18	2.18±0.06	0.58±0.01	1.25±0.02	BDL
Pond 2	28.21±0.00	1.11±0.00	0.77±0.00	0.89±0.00	BDL
Pond 3	26.61±0.00	2.17±0.01	1.12±0.01	0.11±0.03	BDL
Pond 4	19.79±0.01	0.94±0.01	BDL	0.12±0.01	BDL
Dam	24.48±0.01	2.11±0.05	1.14±0.01	1.70±0.03	BDL
Range	19.79±0.01- 28.21±0.00	0.94±0.01- 2.17±0.01	BDL- 1.14±0.01	0.11±0.03- 1.70±0.03	
NAFDAC	75	75	0.3	0.05	5.0
WHO	75	75	0.3	0.05	5.0

151 All measurement are mean± standard deviation of 3 replicate analysis and are in ppm

152 NAFDAC =National Agency for Food, Drug and Control

153 WHO =World Health Organization

154 BDL= Below Detectable Limits

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156 Table 3. Bacteriological counts of Gella ponds and earth dam waters

Sample	Dilution	Average (cfu)
Pond 1	10 ⁻¹	5.1×10 ²
Pond 2	10 ⁻²	5.21×10 ⁴
Pond 3	10 ⁻³	6.1×10 ³
Pond 4	10 ⁻⁴	5.2×10 ³
Dam	10 ⁻⁵	1.9×10 ³

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162 Figure 1: Water fetching at Gella Earth dam

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164 3.2 DISCUSSION

165 The pH of the study area ranges from 5.60 ± 0.17 to 7.20 ± 0.12 at Pond 4 and Bogga earth
 166 dam respectively (Table 1). The result which is within the range of the WHO and NAFDAC
 167 standard for drinking water. The pH is the measure of hydrogen ion concentration (H^+) and
 168 negative hydroxide ion (OH^-) in water. It indicates whether the water is acidic or alkaline. In
 169 pure water, the concentration of positive hydrogen ion is at equilibrium with the concentration of
 170 the negative hydroxide ions, and the pH measures exactly 7 on a pH scale ranging from 1-14
 171 [12]. The factors that affect pH are acidic rainfall, presence of hard water as well as presence of

172 +soap thus high pH recorded at Bogga earth dam may be due to presence of soap and heavy
173 element such as calcium and magnesium.

174 The results of temperature (Table 1) were within 29.00 ± 0.00 - 25.00 ± 2.28 . The lowest
175 temperature was recorded at Bogga earth dam while the highest was recorded at Pond 2 this were
176 also within the range of similar work carried out [13]. It has been suggested that solar radiation,
177 clear atmosphere and low water level increase the temperature of water body [5]. This was so
178 because pond 1 and Bogga earth dam are directly subjected to sun ray but the volumes of water
179 in Bogga earth dam are more than that of the pond this could be why the temperature of the Pond
180 is higher than that of the earth dam.

181 Electrical conductivity is the numerical expression of the water's ability to conduct an electric
182 current it depends on the total concentration, mobility, valence and temperature of the solution of
183 ions [13]. Electrolytes in solution dissociate into positive (cations) and negative (anions) ion and
184 impart conductivity. Most dissolved inorganic substances are in the ionized form in water and
185 contribute to the conductance [14]. In this study the electrical conductivity varies from 3.56 ± 0.33
186 (pond 4) - 6.40 ± 0.04 (earth dam). High level of electrical conductivity is an indication of high
187 TDS. The electrical conductivity of the study area was all within WHO and NAFDAC standard
188 for drinking.

189 The total dissolve solid (Table 1) were between 4.75 ± 0.06 mg/L for ponds and $4 - 8.27 \pm 0.15$
190 mg/L for earth dam. In natural water total dissolved solid (TDS) consist mainly of inorganic salts
191 such as carbonates, chlorides, sulphates, phosphates, nitrates, magnesium, calcium, sodium, iron
192 etc. and small amount of organic matter and dissolved gases [13].

193 The turbidity of the water in study area ranged from 5.00 ± 0.89 - 226.17 ± 21.0 mg/L. The water
194 turbidity is the physical parameter, which measures the cloudiness of water. It is arise as a result
195 of particles suspended or dissolved in water that scatter light making the water appear cloudy or
196 murky. Generally, turbidity has no direct health effects; however, it can interfere with
197 disinfection and provide a growth medium for microbes [12]. The high turbidity value in earth
198 dam and other ponds was because they were open and dusts were blown into the water during
199 dry season causing suspension on the water with a corresponding increase in turbidity of the

200 water. In this study only the water from pond 4 is within WHO and NAFDAC standard for
201 drinking water.

202 The biochemical oxygen Demand (BOD), and dissolved oxygen (DO) had the highest
203 concentration at earth dam. The biochemical oxygen demand (BOD) values ranged from
204 2.31 ± 0.13 mg/L to 5.17 ± 0.21 mg/L and dissolved oxygen (DO) was from 9.91 ± 0.19 mg/L to
205 19.40 ± 0.33 mg/L while the BOD was within WHO permissible limit. However, the DO were all
206 above the WHO and NAFDAC permissible standards respectively. This is an indicative of a
207 slight pollution of the surface water which might be attributed to washing of organic wastes by
208 rainfall into the water body. The COD values fell below WHO permissible limit.

209 Calcium is an essential constituent for various functioning of the human body. It low
210 concentration in drinking water may cause defective teeth and rickets [5]. It is essential for
211 nervous system, cardiac function and coagulation of blood. The standard desirable limit for
212 calcium in drinking water is 75mg/L [15]. Calcium hardness has been classified as 0-20 mg/L
213 (Soft); 20-40 mg/L (moderately soft); 40-80 mg/L (moderately hard); 80-120 mg/L (hard), >120
214 mg/L (very hard) [16]. Calcium distribution in the water samples showed that all the samples
215 COD lies within the standard permissible limit of drinking water.

216 The concentration of magnesium in water is comparatively less than calcium possibly due to
217 lesser occurrence of a laxative effect result, and relative abundance in rocks [5]. The WHO
218 standard maximum permissible concentration of magnesium in drinking water is 50mg/L. In this
219 study, the magnesium concentration were between 0.94 ± 0.01 to 2.17 ± 0.01 mg/L and the
220 magnesium concentration of the samples were within similar study done by Ishaku et al. [7] and
221 were within WHO and NAFDAC standard limit.

222 Iron concentration (Table 2) varies from BD- 1.14 ± 0.01 mg/L. Iron in drinking water may be
223 present as geological sources, industrial waste and domestic discharges and also from mining
224 products. Excess amount of Iron (more than 10mg/kg) causes rapid increase in respiration, pulse
225 rate, coagulation of blood vessels and hypertension [5]. Iron is one of the heavy metal which is
226 necessary for health it play a role in human nutrition; it help in the formation of protein
227 hemoglobin, which transport to all cells of the body [10]. The standard desirable and the

228 maximum permissible limits of iron in drinking water is 0.3ml/L and 1.0mg/L respectively
229 according to WHO [15].

230 Manganese occurs naturally in many surface water and groundwater sources and in soils that
231 may erode into these waters. However, human activities are also responsible for much of the
232 manganese contamination in water in some areas Manganese compounds may be present in the
233 atmosphere as suspended particulates resulting from industrial emissions, soil erosion, volcanic
234 emissions and the burning of MMT-containing petrol [17]. In this study the value of manganese
235 concentration varies between 0.11 ± 0.03 - 1.70 ± 0.03 this were similar to the study by Maitera and
236 Sudi [18]. The entire samples were within WHO and NAFDAC standard for drinking water.

237 The color of the water sample was between 2.0 ± 0.00 - 3.0 ± 0.00 all the samples were within WHO
238 and NAFDAC standard of 15TCU for drinking water. Drinking water should ideal have no
239 visible color. Color in drinking-water is usually due to present of colored organic matter
240 (primarily humic and fulvic acid) associated with humus fraction of soil. Color has also been
241 strongly influenced by the present of iron and other metal, either as natural impurities or as
242 corrosion product. It may also result from the contamination of water source with industrial
243 influents and may be the first indication of hazardous situation [15].

244 The result of the total coliform count (Table 3) it ranges from 510 to 6100 CFU/100ml. The
245 result were similar to the result obtained by Maitera *et al.* [18]. These results showed that the
246 dam and pond was grossly polluted with coliform organisms. It may be as a result of
247 indiscriminate dumping of waste and human feces passed around the earth dam and pond which
248 were washed into the pond and dam during rains. These values were higher than the WHO and
249 NAFDAC [19] recommended standard

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251 **4.0 CONCLUSION AND RECOMMENDATION**

252 **4.1 CONCLUSION**

253 This study has provided information on the level of physicochemical and heavy metal
254 concentration of water sample from pond and earth dam in Gella town Mubi Local Government
255 Area of Adamawa State. The study was aim at determining the concentration of some

physicochemical parameter and heavy metal concentration such as pH, temperature, total dissolve solid, turbidity, electrical conductivity, color, DO, BOD, COD, manganese, zinc, iron, calcium and magnesium from pond and dam and comparing them with WHO standard for drinking water. Considering the result of the study the following conclusion were made:

The water from ponds were slightly more acidic than the water from dam that was slightly neutral. The water from ponds were slightly below WHO and NAFDA standard limit. Other water physicochemical parameter and heavy metals were within WHO standard except the turbidity of ponds that were above WHO standard.

4.2 RECOMMENDATION

The water bed of Gella lies on solid rock, the only solution to perennial water shortage in the area is industrial borehole and or dam equipped with treatment/motorized distribution facility. The authors wish to recommend for regular monitoring of the water of the study area as human activity are regularly changing the concentration level of these water parameters. It is also recommend that the states, Federal Government and NGO's to provides an industrial motorized bore hole water for easy distribution to the community in order to avoid waste of life and cost of treatment of waterborne diseases.

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