Volume 1, 2024 (Maiden Edition)

ASSESSMENT OF PHYSICAL AND BACTERIOLOGICAL PARAMETERS OF BOREHOLE WATER QUALITY FOR POULTRY PRODUCTION IN MAIDUGURI METROPOLIS, BORNO STATE, NIGERIA

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Abstract

The study assesses the physical and bacteriological parameters of borehole water quality for poultry production In Maiduguri Metropolis. Low yield of egg, spread diseases, mortality chickens and bird flu may not be unconnected with condition of groundwater in the area, which needs to be investigated. Groundwater samples from 10 boreholes and 10 tanks in Maiduguri Metropolis were sampled and analysed. The samples were collected in wet and dry seasons for various physical water quality parameters and bacteriological contaminants. The study showed that most of the physical parameters were within the limits recommended for poultry production. All the water samples were found to be tasteless and odourless, with temperatures ranging from 21.5 - 36.5℃, Turbidity 2 – 7 NTU, Colour 6 – 14 TCU, TDS 180 – 870mg/L, Coliform bacteria $0.01x10^2$ - $0.14x10^2$, Escherichia coli $0.01x10^2$ - $0.13x10^2$, and Clostridium perfringens spore $0.01x10^2$ - $0.08x10^2$. The study concluded that in terms of physical parameters, most of the tested samples are safe, although some parameters in both seasons exceeded standard values, while based on bacteriological parameters, all the water sources are harmful and not suitable for poultry production. The study recommended that poultry farmers should establish a mini water testing and treatment system that will enable them to conduct regular testing of physical parameters of borehole water and microbiological contaminants.

Keywords: *Borehole, Water Quality, Poultry, Production, Northeastern Nigeria.*

Introduction

Water occupies a special place among natural resources. Water is the basis of life on earth; it is the main component of the environment and essential constituent for life. It is a colorless, tasteless, and odourless chemical compound. Water is also fundamental for sustaining a high quality of life, and for economic and social development. Just like other natural resources, water resources are limited at any location on earth at any time, and they should be used rationally for sustainable development (United Nations, UN-Water, 2015).

Water in Africa is an important issue encompassing the sources, distribution and economic uses of the water resources on the continent. Overall, Africa has about 9% of the world's fresh water resources and 11% of the world's population (World Bank, 2016). Water's crucial role in accomplishing the continent's development goals is widely recognized. Africa faces endemic, poverty, food insecurity and pervasive underdevelopment, with almost all countries lacking the human, economic and institutional capacities to effectively develop, improve their water quality and manage their water resources sustainably (Millenium Development Goal Report, 2012). Water is the single most critical nutrient to health and wellbeing. It is a necessary agent in all body processes and is the most critical nutrient for the production of poultry, this explains the relevance of water in the wellbeing and performance of poultry chickens.

Most poultry farmers live in peri-urban areas which lack portable water for both livestock and human consumption. Water quality attributes can have a direct or indirect effect on bird's performance. Poor water quality can retard growth, curtail egg production, or produce lower egg quality. Feed conversion, for example, has been positively correlated to the presence of sulfate and copper concentrates in the water, and livability with potassium, chloride, and calcium. Body weight is positively influenced by water hardness and dissolved oxygen and negatively influenced by total bacteria and a pH less than 6.0 (Animal and Food Sciences University of Kentucky: Retrieved 2022).

Water related diseases caused by insufficient safe water supplies coupled with poor sanitation and hygiene causes hundreds of deaths in the poultry industry, mostly within 7 days of hatched.

Birds in Nigeria suffered pathogenic Avian Influenza, Chronic Respiratory Disease (CRD), Colibacillosis, Fowl Typhoid, Avian Metapneumovirus (aMPV), Infectious Coryza, Fowl Pox (Avian Pox, Avian Diphtheria), Fowl Cholera (Avian Cholera, Pasteurellosis, Avain hemorrhagic septicaemia), Black head (Histomonosis, Enterohepatitis) and Salmonellosis as a result of water contamination (Animal and Food Sciences University of Kentucky: Retrieved 2022). Between 2006 and 2008, a total of 939,620 poultry mortality has been recorded in Nigeria due to the outbreak of pathogenic Avian Influenza (HPA1) H5N1. HPA1 causes up to 100% mortality to domestic chickens (Akanbi and Taiwo, 2014). In 2017, Avian Metapneumovirus (aMPV) causes over 11,000 deaths mostly to chickens in Maiduguri metropolis (Maiduguri Veterinary Hospital [MVH], 2017). The outbreak of Bird Flu ravages several farms within the metropolis in August 2021, an over 13,000 mortalities has been recorded (Business Day, 2021), the casualties has raised a serious concern in the study area and possibility of borehole water contamination has been the leading edge of this research, because most of the farms are located on industrial layout and densely populated communities with no waste-water treatment and no adequate water supply that is why the study aims at assessing Physical and Bacteriological Parameters of Borehole Water Quality for Poultry Production in the area for effective poultry production.

Materials and Methods

The Study Area

Maiduguri metropolis is the capital of Borno state located between latitude 10^{0}00''00' and 14^{0}00'00'' North of the equator and longitude 11^{0}00'30'' and 14^{0}45'00'' east of the Greenwich Meridian (Figure 1). The area lies some 320m above sea level and it occupies a total area of 3000 sqkm (Ministry of Land and Survey Maiduguri, 2008). It lies on a vast open plain which is flat or gently undulating. The landscape is developed on the young sedimentary rocks of the Chad Formation. The River Ngadda and some short course rivers drain the northern part of the plateau and flow north east towards the Lake Chad. River Yedsaram and its tributaries take their source on the Mandara Mountains and flow north east towards the Lake Chad (Daura, 2002: Nyanganji, 1994). Köppen-Geiger's climate classification system classifies Maiduguri's climate as hot semi-arid (BSh). It is characterized by semi-arid and hot season, with mean annual temperature of 250°C (Nigeria Meteorological Agency, 2008). The vegetation found in Maiduguri metropolis is tropical Sahel Savannah consisting of mainly grasses with few droughts' resistant trees (Bukar *et al.,* 2021). The soil of the area is clay in nature which varies in colour, texture, structure, physico-chemical and other essential characteristics from the hilly south to the northern dune landscape. Maiduguri Metropolis has an estimated population of 904,696 people out of which 473,125 were male while 431,571 were female (NPC, 2021).

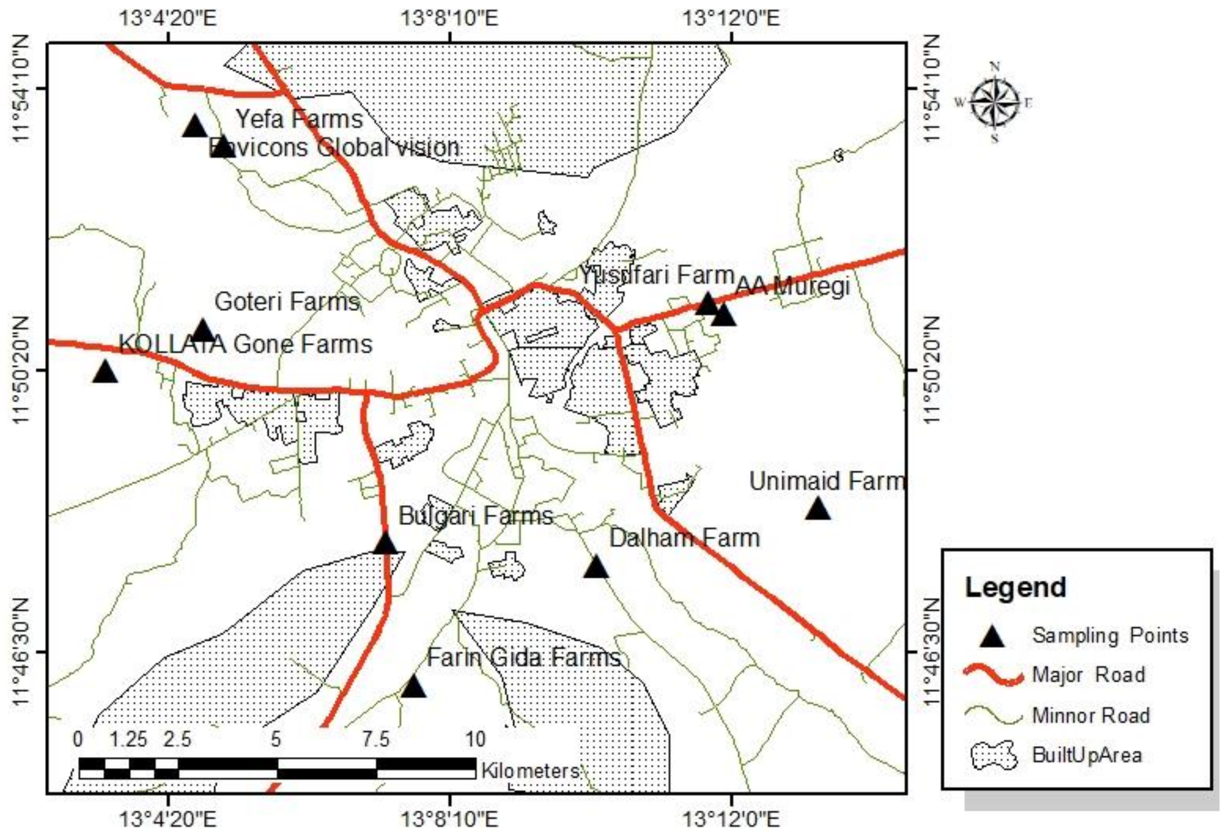

Figure 1: Map of the Study Area Showing the Study Locations
Source; Geospatial Services 2021

Population and Sampling

The target population for this study is the poultry farms within Maiduguri metropolis. All farms that houses more than two thousand birds constituted the sample size for this study. For that it can be seen that ten (10) of such available farms were purposively selected for the study because they are the only ones.

Water Samples Collection

The water samples were collected in both wet and dry season in the months of August, September and January, march respectively.

Laboratory Techniques

Apparatus

Digital pH meter (Model Hanna), Environmental thermometer, Turbidimeter, Spectrophotometer, Flame photometer, Water checker, Coliform counter, Lamotte test kits, Lamotte smart spectrophotor, Colorimeter, Forceps, Direct reading titrator, Universal sample holder, Vacuum pump, Funnel, Filter, Phone, Test tubes, Test tube racks, Beakers, Sterile plastic bottles, Syringes, pipettes, Dilution bottles, Graduated cylinders, Erlenmeyer flasks with metal caps, Metal foil, Covers, or screw caps, 1-L filtering flask with side tube and Filtering flask, Incubator, Microscope, Petri dishes, Glass slides.

Reagents

Buttered ammonium reagent, Stabilizing reagent, Hard butter reagent, Manganese indicator reagent, Chloride reagent A, Chloride reagent B, Chloride reagent #1, Chloride reagent #2, Nitrate powder cap, Sulphate reagent, Ammonium molybdate, Methyl orange indicator, TDS reagent (A), TDS reagent (B), Demineralized water, Methyl orange indicator, Ammonium chloride buffer, Sodium cyanide, PAR indicator, Sodium absorbed powder, Zinc buffer powder, Formaldehydes solution, Zinc indicator solution, Sulfuric acid, Sodium hydroxide, Hardness reagent 5, Hardness reagent tablet 6, Hardness reagent 7, Hardness titration reagent, Sulfuric acid, Distilled water, Phenolphthalein indicator, Sodium arsenite solution and Acid-Zirconyl SPADNS reagent.

Culture Media

A broth agar (membrane lauryl sulphate) was used as nutrient and the bacteria were incubated in a petri dish at 37°C for 24h and 44.5^{o}C respectively.

Methods

Water samples were collected in clean and sterile plastic bottles with screw caps for the analysis. All the samples were labelled with appropriate codes (YSB and YST) for proper identification. The Y indicating first letter of the farm's name, B indicating borehole water while T indicating tank water respectively.

Data Analysis

For the data analysis, descriptive statistics (tables and charts) were used in analysing the data of physical and bacteriological parameters obtained from the laboratory tests..

Results and Discussions

Physical parameters

The result presented in Table 1 indicated the temperature of the water samples on-site, with borehole water sample from YEB and BGB having the highest temperature of 33^{o}C on-site during the wet season while GFB having the lowest temperature of 28.5^{o}C. The result indicated that the borehole water sample from BGB has the highest turbidity level of 6.0 NTU followed by EGB with 5.0 NTU while GFB having the lowest (28.5) during the wet season. In terms of colour, borehole water sample from GFB has the highest colour unit of 15 TCU while FGB having the lowest colour unit (7.0 TCU) during the wet season. It is indicated that borehole water sample from YEB has the highest TDS level of 480mg/L while YSB having the lowest (240mg/L) during the wet season. The result showed that, the appearance and odour detected for all the water samples for both of the two seasons were found to be clear and unobjectionable. The overall mean score for physical parameters of borehole water in wet season is: Temperature (31.39^{o}C), Turbidity (4.0 NTU), Colour (10.4 TCU), Total Dissolve Solid (344.1mg/L).

The result in Table 2 indicated that during the dry season borehole water sample from KLB has the highest temperature of 29.6^{o}C while DFB having the lowest (27.4^{o}C) on-site, GFB has the highest turbidity level of 7.0 NTU while AMB having the lowest turbidity of 2.0 NTU. Based on the result, KLB and YSB has the highest colour unit of 11.0 TCU each while FGB and BGB having the lowest colour unit of 6.0 TCU each. GFB and BGB has the highest turbidity level of (870mg/L) and (610mg/L) respectively, while FGB having the lowest TDS (340mg/L). The result showed that, the appearance and odour detected for all the water samples for both of the two seasons were found to be clear and unobjectionable. The overall mean score for physical parameters of borehole water in dry season is: Temperature (28.39^{o}C), Turbidity (4.3 NTU), Colour (8.9 TCU), Total Dissolve Solid (469mg/L).

For tank/reservoir water, the result presented in Table 3 indicated that GFT has the highest temperature of 36.5^{o}C and KLT having the lowest (28.0^{o}C) on-site, UFT has the highest turbidity of 5.0 NTU and KLT having the lowest level of 2.0 NTU, DFT has the highest TCU of 11.0 and YST having the lowest (8.0 TCU), YET has the highest TDS (425mg/L) while AMT has the lowest TDS (279mg/L). The result showed that, the appearance and odour detected for all the water samples for both of the two seasons were found to be clear and unobjectionable. The overall mean score for physical parameters of tank/reservoir water in wet season is: Temperature (30.68^{o}C), Turbidity (3.7 NTU), Colour (9.7 TCU), Total Dissolve Solid (346.35mg/L).

The result presented in Table 4 showed that DFT has the highest temperature of 23.9^{o}C, while YST, UFT, and AMT having the lowest (22.0^{o}C) each on-site. FGT, GFT and YST has the highest turbidity of 5.0 NTU each while KLT has the lowest turbidity. AMT has the highest TCU (12.0) while GFT recorded the lowest TCU (6.0). FGT and YET are having the highest TDS of 560mg/L each while YST has the lowest TDS of 240mg/L. The overall mean score for physical parameters of tank/reservoir water in dry season is: Temperature (22.47^{o}C), Turbidity (3.9 NTU), Colour (8.7 TCU), Total Dissolve Solid (379mg/L). The results also indicated that in all the farms NTU is within FAO limit except for GFB KBL and YSB farms which is slightly above while colour, odour, taste, TDS and temperature are within the acceptable limits in all the farms.

Table 1: Mean Concentration of Physical Parameters of Borehole Water in Wet Season

PHYSICAL PARAMETERS Borehole Water – Wet Season						
Farms	**T℃**	**T(NTU)**	**Colour(TCU)**	**TDS(mg/L)**	**Odour(OU_E/m^3)**	**Taste**
1. FGB	31.3	5	7	380	Unobjectionable	Unobjectionable
2. YEB	33.0	4	9	480	-	-
3. BGB	33.0	6	8	441	-	-
4. EGB	30.5	5	12	476	-	-
5. DFB	29.9	3	8	280	-	-
6. KLB	31.0	4	10	259	-	-
7. GFB	28.5	2	15	388	-	-
8. YSB	32.0	4	12	240	-	-
9. UFB	32.6	3	11	250	-	-
10. AMB	32.1	4	12	247	-	-
MEAN	**31.39**	**4**	**10.4**	**344.1**	-	-
FAO, 2019	**None**	**5**	**15**	**1000**	None	None

Field/Laboratory Work: 2022/23

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Table 2: Mean Concentration of Physical Parameters of Borehole Water in Dry Season

PHYSICAL PARAMETERS Borehole Water – Dry Season						
Farms	**T℃**	**T(NTU)**	**Colour(TCU)**	**TDS(mg/L)**	**Odour(OU$_E$/m^3)**	**Taste**
1. FGB	27.8	4	6	340.0	Unobjectionable	Unobjectionable
2. YEB	28.0	3	10	390.0	-	-
3. BGB	29.1	5	6	610.0	-	-
4. EGB	27.6	4	10	180.0	-	-
5. DFB	27.4	3	10	560.0	-	-
6. KLB	29.6	6	11	410.0	-	-
7. GFB	28.2	7	8	870.0	-	-
8. YSB	29.0	6	11	460.0	-	-
9. UFB	28.0	3	10	360.0	-	-
10. AMB	29.2	2	7	510.0	-	-
MEAN	**28.39**	**4.3**	**8.9**	**469**	**-**	**-**
FAO, 2019	**None**	**5**	**15**	**1000**	None	None

Field/Laboratory Work: 2022/23

Table 3: Mean Concentration of Physical Parameters of Tank/Reservoir Water in Wet Season

PHYSICAL PARAMETERS Tank/reservoir water – Wet season						
Farms	**T℃**	**T(NTU)**	**Colour(TCU)**	**TDS(mg/L)**	**Odour(OU$_E$/m^3)**	**Taste**
1. FGT	31.5	4	7	372.5	Unobjectionable	Unobjectionable
2. YET	32.1	4	9	425	-	-
3. BGT	32.1	4	9	398	-	-
4. EGT	28.3	3	10	333	-	-
5. DFT	28.5	3	11	358	-	-
6. KLT	28.0	2	10	356	-	-
7. GFT	36.5	4	14	342	-	-
8. YST	29.1	4	8	290	-	-
9. UFT	30.3	5	10	310	-	-
10. AMT	30.4	4	9	279	-	-
MEAN	**30.68**	**3.7**	**9.7**	**346.35**	**-**	**-**
FAO, 2019	**None**	**5**	**15**	**1000**	None	None

Field/Laboratory Work: 2022/23

Table 4: Mean Concentration of Physical Parameters of Tank/Reservoir Water in Dry Season

PHYSICAL PARAMETERS Tank/Reservoir Water – Dry Season						
Farms	**T℃**	**T(NTU)**	**Colour(TCU)**	**TDS(mg/L)**	**Odour(OU_E/m^3)**	**Taste**
1. FGT	23.4	5	8	560.0	Unobjectionable	Unobjectionable
2. YET	21.5	4	9	560.0	-	-
3. BGT	22.7	4	10	410.0	-	-
4. EGT	22.3	4	10	280.0	-	-
5. DFT	23.9	3	7	420.0	-	-
6. KLT	23.0	2	7	290.0	-	-
7. GFT	21.9	5	6	360.0	-	-
8. YST	22.0	5	8	240.0	-	-
9. UFT	22.0	4	10	320.0	-	-
10. AMT	22.0	3	12	350.0	-	-
MEAN	**22.47**	**3.9**	**8.7**	**379**	**-**	**-**
FAO, 2019	**None**	**5**	**15**	**1000**	None	None

Field/Laboratory Work: 2022/23

The high temperature could be attributed to climate of the area, friction and pressure as water moves through confined or narrow channels or fractures in the subsurface. High temperature in drinking water can have significant effects on poultry performance, particularly during hot weather conditions. Poultry are sensitive to heat stress, and the temperature of their drinking water plays a crucial role in maintaining their well-being. Elevated water temperature can lead to an electrolyte imbalance in poultry. Heat stress increases the loss of electrolytes through panting and sweating, and when birds drink warm water, it may further disrupt their electrolyte balance. Electrolyte imbalances can affect normal cellular functions, muscle activity, and overall metabolic processes, negatively impacting poultry performance. The high turbidity in tank water could be attributed to the turbidity of the borehole water in which the tank has been fed, the suspended particles could settle down the tank, thereby causing increase turbidity, likewise the colour and total dissolve solid. Reduced water intake is a common consequence of turbid water on poultry, as the water becomes unpalatable, leading to dehydration and decreased overall health. Digestion can be impaired due to the presence of suspended particles and pathogens, resulting in poor nutrient absorption, reduced growth, and lower egg production in layers. Poultry rely on water for thermoregulation, so consuming turbid water compromises their ability to regulate body temperature, leading to increased stress levels. This elevated stress weakens the immune system, making birds more susceptible to diseases.

Discolored water could be attributed to the presence of contaminants such as algae, sediment, or organic matter. Borehole water in agricultural areas can have elevated TDS levels due to the use of fertilizers, pesticides, and irrigation practices. Excess TDS in drinking water can negatively impact egg quality, leading to thin or weak eggshells, decreased hatchability, and reduced egg production, causing economic losses for poultry farmers. The findings of this study is contrary to the work of Ibn Abubakar *et al.,* (2018) that conducted a research in Maiduguri, who observed that, the temperature of all the water samples are below 30℃ and also the findings of Mustapha *et al.,* (2013) at Maiduguri, they observed that, the temperature of all the water samples are within the range of 26.6 - 30℃ . The current finding is in congruent with the work of Falowo and Ojo (2020) at Ese Odo area of Ondo state, they found that, the turbidity of most of the water samples are largely below 5 NTU with an exception of 5 samples from 5 sampling point and all the water sample tested are odourless and tasteless.

Bacteriological Parameters

The result presented in Table 5 showed that DFB and AMB have the highest concentration of coliform bacteria with a value of 7 colonies each, EGB has the lowest concentration with a value of 1 colony. DFB has the highest concentration of *E. coli* with a value of 12 colonies, EGB has the lowest concentration of *E. coli* (2). DFB has the highest concentration of *clostridium spores* with a value of 8 colonies, BGT, GFT, YST and UFT has the lowest concentration of 1 colony each. The overall mean concentration for bacteriological parameters of borehole water in wet season is: Coliform bacteria (4.6), *E. coli* (5.3), and *Clostridium* (3.0).

The result obtained from Table 6 showed that BGB has highest concentration of coliform bacteria in dry season with a value of 3 colonies, while EGB, KLB and AMT were having the lowest concentration with a value of 1 colony each. DFB also has the highest concentration *E. coli* with a value of 7 colonies, while YEB and GFB were having the lowest concentration of 1 colony each. KLB has the highest concentration of 3 colonies of *clostridium*, while BGB has the lowest concentration with a value of 1 colony, and no colony of *clostridium* was detected in FGB and YEB, likewise no colony of *E. coli* was detected in EGB. Plate 2 below shows a four week's flocks in KL farm. The overall mean concentration for bacteriological parameters of borehole water in dry season is: Coliform bacteria (1.8), *E. coli* (2.4), and *Clostridium* (1.6).

Data presented in Table 7 indicated that AMT has the highest concentration of coliform bacteria with a value of 14 colonies, KLT has the lowest concentration with a value of 2 colonies. DFT has the highest concentration of *E. coli* (13 colonies), EGT recorded the lowest concentration of 2 colonies. DFT has the highest concentration of *clostridium* with 8 colonies, BGT, GFT and UFT are having the lowest concentration of 1 colony each. The overall mean concentration for bacteriological parameters of tank/reservoir water in wet season is: Coliform bacteria (7.2), *E. coli* (6.4), and *Clostridium* (3.7).

Result presented in Table 8 indicated that EGT, KLT, GFT, UFT, and AMT are having uniform value of 3 colonies of coliform bacteria each, while FGT, YET, BGT, DFT and YST also have uniform value of 2 colonies each. DFT has the highest concentration of 9 colonies of *E. coli* while YET recorded the lowest concentration of 1 colony. EGT and UFT has the highest concentration of clostridium with a value of 2 colonies each, while YET, BGT, DFT, KLT, GFT, YST and AMT are having the lowest concentration of 1 colony each, and no colony of *clostridium* was detected in FGT, likewise *E. coli* in EGT. The overall mean concentration for bacteriological parameters of borehole water in wet season is: Coliform bacteria (2.5), *E. coli* (3.3), and *Clostridium* (1.1). Plate 3 below depicted borehole water connected to battery cage in UF farm.

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Table 5: Mean Concentration of Microbiological Parameters of Borehole Water in Wet Season

BACTERIOLOGICAL PARAMETERS Borehole Water – Wet Season			
Farms	**Coliform**	**E. coli**	**Clostridium**
1. FGB	$0.04x10^2$	$0.05x10^2$	$0.03x10^2$
2. YEB	$0.02x10^2$	$0.04x10^2$	$0.03x10^2$
3. BGB	$0.03x10^2$	$0.06x10^2$	$0.01x10^2$
4. EGB	$0.01x10^2$	$0.02x10^2$	$0.04x10^2$
5. DFB	$0.07x10^2$	$0.12x10^2$	$0.08x10^2$
6. KLB	$0.02x10^2$	$0.04x10^2$	$0.03x10^2$
7. GFB	$0.06x10^2$	$0.04x10^2$	$0.01x10^2$
8. YSB	$0.05x10^2$	$0.03x10^2$	$0.01x10^2$
9. UFB	$0.09x10^2$	$0.05x10^2$	$0.01x10^2$
10. AMB	$0.07x10^2$	$0.08x10^2$	$0.05x10^2$
MEAN	**4.6**	**5.3**	**3.0**
FAO, 2019	**50 cu/ml**	**<100 cu/ml**	**0/100ml**

Field/Laboratory Work: 2022/23 ND = Not Detected

Table 6: Mean Concentration of Microbiological Parameters of Borehole Water in Dry Season

BACTERIOLOGICAL PARAMETERS Borehole Water – Dry Season			
Farms	**Coliform**	**E. coli**	**Clostridium**
1. FGB	$0.02x10^2$	$0.02x10^2$	ND
2. YEB	$0.02x10^2$	$0.01x10^2$	ND
3. BGB	$0.03x10^2$	$0.02x10^2$	$0.01x10^2$
4. EGB	$0.01x10^2$	ND	$0.02x10^2$
5. DFB	$0.02x10^2$	$0.07x10^2$	$0.02x10^2$
6. KLB	$0.01x10^2$	$0.02x10^2$	$0.03x10^2$
7. GFB	$0.02x10^2$	$0.01x10^2$	$0.02x10^2$
8. YSB	$0.02x10^2$	$0.02x10^2$	$0.02x10^2$
9. UFB	$0.02x10^2$	$0.02x10^2$	$0.02x10^2$
10. AMB	$0.01x10^2$	$0.05x10^2$	$0.02x10^2$
MEAN	**1.8**	**2.4**	**1.6**
FAO, 2019	**50 cu/ml**	**<100 cu/ml**	**0/100ml**

Field/Laboratory Work: 2022/23 ND = Not Detected

Table 7: Mean Concentration of Bacteriological Parameters of Tank/Reservoir Water in Wet Season

BACTERIOLOGICAL PARAMETERS Tank/Reservoir Water – Wet Season			
Farms	**Coliform**	**E. coli**	**Clostridium**
1. FGT	$0.04x10^2$	$0.07x10^2$	$0.07x10^2$
2. YET	$0.05x10^2$	$0.04x10^2$	$0.02x10^2$
3. BGT	$0.03x10^2$	$0.08x10^2$	$0.01x10^2$
4. EGT	$0.03x10^2$	$0.02x10^2$	$0.05x10^2$
5. DFT	$0.12x10^2$	$0.13x10^2$	$0.08x10^2$
6. KLT	$0.02x10^2$	$0.07x10^2$	$0.02x10^2$
7. GFT	$0.10x10^2$	$0.03x10^2$	$0.01x10^2$
8. YST	$0.06x10^2$	$0.05x10^2$	$0.03x10^2$
9. UFT	$0.13x10^2$	$0.05x10^2$	$0.01x10^2$
10. AMT	$0.14x10^2$	$0.10x10^2$	$0.07x10^2$
MEAN	**7.2**	**6.4**	**3.7**
FAO, 2019	**50 cu/ml**	**<100 cu/ml**	**0/100ml**

Field/Laboratory Work: 2022/23

Table 8: Mean Concentration of Bacteriological Parameters of Tank/Reservoir Water in Dry Season

BACTERIOLOGICAL PARAMETERS Tank/Reservoir Water – Dry Season			
Farms	**Coliform**	**E. coli**	**Clostridium**
1. FGT	$0.02x10^2$	$0.02x10^2$	ND
2. YET	$0.02x10^2$	$0.01x10^2$	$0.01x10^2$
3. BGT	$0.02x10^2$	$0.03x10^2$	$0.01x10^2$
4. EGT	$0.03x10^2$	ND	$0.02x10^2$
5. DFT	$0.02x10^2$	$0.09x10^2$	$0.01x10^2$
6. KLT	$0.03x10^2$	$0.05x10^2$	$0.01x10^2$
7. GFT	$0.03x10^2$	$0.03x10^2$	$0.01x10^2$
8. YST	$0.02x10^2$	$0.02x10^2$	$0.01x10^2$
9. UFT	$0.03x10^2$	$0.03x10^2$	$0.02x10^2$
10. AMT	$0.03x10^2$	$0.05x10^2$	$0.01x10^2$
MEAN	**2.5**	**3.3**	**1.1**
FAO, 2019	**50 cu/ml**	**<100 cu/ml**	**0/100ml**

Field/Laboratory Work: 2022/23

High concentration of coliform bacteria could be the result of infiltration of contaminated water to ground through septic system failures, agricultural runoff, poor waste disposal or nearby sources of fecal contamination. Coliform bacteria can cause digestive disorders in poultry, such as enteritis. The bacterial formation in the water samples could be attributed to biofilm formation in pipes, and heavy rainfall. Floodwaters can carry fecal matter from various sources, leading to contamination of groundwater sources. *E. coli* can cause digestive disorders in poultry, such as enteritis and colibacillosis. High *clostridium perfringens spore* could be the result of infiltration/percolation of human and animal waste through seepage from septic tanks, sewage leaks, or runoff from agricultural areas. *Clostridium perfringens* is a leading cause of necrotic enteritis, a severe

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gastrointestinal disease in poultry. The number of coliform and E-coli are within the acceptable limits in all the farms but for Clostridium is above the limit since according to the standard is should be zero.

The findings of this study is similar to the findings of Mustapha *et al.,* (2013) at Maiduguri, who reported that, the total coliform counts of all the water samples were generally high. A study conducted by Sarkingobir (2020) at Sokoto, supported this finding also, he found that the water used in the BC and DL systems surveyed contains a higher and more diverse concentration of bacteria. Mustapha *et al.,* (2013) at Maiduguri, stressed that no *E. coli* were detected in all the water samples, which indicated that all the water samples are free from recent faecal contamination, which was against the findings of this study. A study was conducted by Ibitoye *et al.,* (2013) at Sokoto, revealed that all water sources were contaminated with bacteria. The well water had the highest spores load of 1.2×10^3 cfu/ml, followed by borehole water with 5.8×10^2 cfu/ml, while pipe borne water recorded least spores load of (1.6×10^2 cfu/ml). Mustapha *et al.,* (2013) at Maiduguri, stressed that no *E. coli* were detected in all the water samples, which indicate that all the water samples are free from recent faecal contamination, which was against the findings of this study.

Conclusion and Recommendations

In terms of physical parameters, parameters like temperature, turbidity and colour are much more elevated in borehole water during wet and dry season, while TDS is more in concentration in tank/reservoir water during wet and dry season. This could be due to accumulation/settling of dissolved solid at the bottom of the tank. Bacteria are indicators of fecal contamination, suggesting the presence of pathogens that can cause waterborne diseases. Therefore, in terms of microbiological parameters all the water sources are harmful and not suitable for poultry production.

Poultry farmers should establish a system that will enable them to conduct regular testing of physical parameters of borehole water and microbiological contaminants, including coliform bacteria, *Escherichia coli*, *clostridium perfringens* and *salmonella.*

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