

Original Research Article

BACTERIOLOGICAL AND PHYSICO-CHEMICAL ANALYSIS OF SURFACE WATER OBTAINED FROM UKE RIVER IN KARU, NASARAWA STATE.

ABSTRACT

Aim: To determine the bacteriological and physicochemical properties of the surface water obtained from Uke River.

Place and Duration of Study: This study was carried out in Uke Community, Karu LGA, Nasarawa state and the Department of Biological sciences, Bingham University, Karu, between March and April 2016.

Materials and Methods: Water samples were collected randomly from five points at the Uke River for five weeks. The total heterotrophic bacteria count, fecal coliform count and total coliform count were used to determine bacterial contamination. Biochemical tests and gram reaction was used to identify the bacterial isolates. Physico-chemical analysis was carried out using standard measures.

Results: Six bacterial genera which include *Salmonella* spp, *Staphylococcus* spp, *Escherichia* spp, *Pseudomonas* spp, *Enterococcus* spp and *Klebsiella* spp were isolated from the water samples. *Escherichia coli* had the highest frequency of 23(43%). The mean total heterotrophic count, total coliform count and fecal coliform count was 2.3×10^2 , 2.4×10^2 , and 2.6×10^2 respectively

Conclusion: The bacteriological and physicochemical analysis of the surface water indicates the presence of bacteria in the water which suggests the water is not fit for drinking without proper processing.

KEY WORDS: Bacteria, Uke River, Fecal Coliform, Water

1. INTRODUCTION

The accessibility to safe water and sanitary means of excreta disposal are universal needs and indeed basic human rights. However, many of the world's population lack access to adequate and safe water [1].

Water is vital to the existence of all living organisms; however, this valued resource is increasingly being threatened as a result of upsurge in human population. Consequently, the demand for high quality water for the both domestic and economic purposes has been noticeably on constant increase [2]. Water quality is defined in terms of its chemical, physical and biological contents. The water quality of rivers changes with seasons, human activities and geographical areas. These factors provide basic scientific information about water quality parameters, ecological relevance and toxicological threshold values to protect specific water user [3].

Rivers are the source of freshwater to man. Flooding remains a source of pollution for rivers in Nigeria. Surface waters are heavily polluted from several sources especially after rainfall [4]. Sources of pollution include runoff water from farmlands carrying fertilizers, manure, animal and human waste matter, motor oils from the highways and lots of trash from gutters and drainages. World Health Organization (WHO) essential parameters of drinking water quality are fecal *Escherichia coli* and total coliforms, chlorine residual, turbidity, pH, dissolved oxygen content, and temperature [5].

39 According to UNICEF report, about 800 million people in Asia and Africa are living without access to
40 safe drinking water. Consequently this has caused many people to suffer from various diseases [6].
41 However, access to safe drinking water has improved over the last decades in almost every part of
42 the world especially Nigeria, but approximately 1.1 billion people still lack access to safe water and
43 over 2.6 billion worldwide lack access to adequate water and sanitation which causes water illnesses
44 such as Cholera, diarrheal disease, Botulism, *E. coli* infection, Dysentery, Legionellosis,
45 Leptospirosis, Salmonellosis, Typhoid fever, and Vibrio illness [7].

46 The greatest risk to public health from microbes in water is associated with consumption of drinking-
47 water that is contaminated with human and animal excreta [8]. Human faeces can contain a variety of
48 intestinal pathogens which cause diseases ranging from mild gastro-enteritis to the serious dysentery,
49 cholera and typhoid. The most predominant waterborne disease, diarrhea, has an estimated annual
50 incidence of 4.6 billion episodes and causes 2.2 million deaths every year [9].

51 Faecal coliform bacteria are used as an indicator for the presence of any of these water borne
52 pathogens. The presence of these indicative organisms is evidence that the water has been polluted
53 with faeces of humans or other warm-blooded animals [4,10]. The Uke River is a source of drinking
54 water to the members of the community and it's characterized with human activities such as bathing,
55 washing, swimming and construction of blocks. Although some studies have been carried out on
56 surface water resources in Nigeria, there is paucity of information on the bacteriological analysis of
57 Uke River which informed this study.

58 **2. MATERIALS AND METHODS**

59 **2.1 Study area**

60 This study was carried out in Uke local government area, Nasarawa State. This community is located
61 in the middle belt of Nigeria at longitude 8°32'N 8°18'E and Latitude 8.533°N 8.300°E and is
62 characterized by a tropical sub-humid climate with two distinct seasons; wet and dry seasons. Monthly
63 temperature ranges from 20°C to 34°C and annual rainfall ranges from 1100mm to about 2000mm. Uke
64 is located about 26 kilometers South-East of Abuja, the country's capital town. It is regarded as a
65 suburb of Abuja due to its close proximity to Nigeria's Federal Capital Territory [11].

66 **2.2 Sample collection**

67 Water samples was collected from five (5) different water sites indicated as location A, B, C, D, E and
68 a COMPOSITE (F) which includes all samples. Water samples from these locations were collected in
69 duplicates into sterile glass bottles (250 ml) which were labeled appropriately and transported to the
70 laboratory for bacteriological and physico-chemical analysis.

71 **2.3 Bacteriological Analysis**

72 Blood agar and MacConkey agar were prepared using manufacturers direction [12]. Bacteria isolates
73 were characterized on the basis of the colonial morphology and Gram stain reaction. Biochemical
74 tests such as catalase, Coagulase, Motility, Indole, and Oxidase tests were carried out [13].

75 **2.3.1 Total heterotrophic bacteria count**

76 The spread plate method was used. Ten-fold serial dilution of each water sample was prepared
77 aseptically in physiological saline of 10^{-1} up to 10^{-4} and 0.1 ml aliquot of each dilution was plated on

Nutrient agar plates in triplicate. All incubations were conducted at 37°C for 24 hrs under aerobic conditions and plates containing 30 to 300 colonies were selected and counted. The number of colony-forming units per ml (cfu/ml) was calculated by multiplying the number of colonies by the dilution factor. Also, sub-culture was carried on MacConkey agar and Mannitol Salt agar for identification of bacteria species.

2.3.2 Total coliform count

This was determined by Most Probable Number (MPN) index technique using the three tube assay (3-3-3 regimen). Ten-fold serial dilution of 10^{-1} to 10^{-5} was prepared. The first set of five tubes had 10 ml of double strength broth (MacConkey broth), the second and third set had 10ml single strength broth (Lactose broth). All the tubes contained Durham tubes. The three set of tubes received 10 ml, 1 ml and 0.1 ml of water samples. They were carefully labeled and incubated at 37°C for 24 hours for estimation of total coliform. Acid production was determined by color change in tubes from reddish purple to yellow and gas production was checked for by entrapment of gas in the durham tubes [13]

2.3.3 Faecal coliform count

Faecal coliform count was determined using Eosin Methylene Blue medium employing the streaking culture technique. A loopful of broth from positive tubes was streaked onto EMB agar plate for pure cultures. The plates were incubated at 37°C for 24 hrs. Colonies on EMB agar plate were further identified as fecal coliforms. On Eosin Methylene Blue (EMB) agar, *E. coli* strains appeared as greenish metallic sheen colonies [14].

2.4 Physicochemical analysis

The water samples from each collection point were examined for physical and chemical properties such as colour, temperature, total dissolved solids, alkalinity, conductivity, pH and total suspended solids [10]. The temperature of each sample was determined using mercury-bulb thermometer and this was recorded at the point of collecting the water before the bottle was recapped. The pH readings of the water samples were taken using pH meter Wag WT 3020. Conductivity was measured using the electrical conductivity meter. The pH meter was standardized with buffer 4, 7 and 9 before being used [15].

3. RESULTS

Table 1 shows the morphological, biochemical characteristics and Gram reaction of the bacterial isolates.

Table 2 represents the frequency of bacteria isolates recorded in Uke River. *Escherichia coli* had the highest frequency of 23(43%). *Pseudomonas* spp, *Staphylococcus aureus* and *Klebsiella* spp had a frequency of 18%, 16 %, and 12% respectively. *Streptococcus* spp and *Bacillus* spp had a prevalence of 6% and 4% respectively. *Enterococcus* spp and *Salmonella* spp showed the least occurrence of 2%.

114 The mean total heterotrophic count was 2.3×10^2 cfu/mL. The mean total coliform count was
 115 2.4×10^2 cfu/100mL. The mean fecal coliform count was 2.6×10^2 cfu/ml as shown on Table 3. Table 4
 116 represents the mean and standard deviation of physico-chemical parameters analyzed in this study.

117 **Table 1 Characterization and identification of isolates from Uke River**

Isolates	Cat	Coa	Oxi	Ind	Mot	Gram staining	Morphology	Organism present
1	+	-	-	+	+	-rod	Milky colonies	<i>Escherichia coli</i>
2	+	+	-	-	-	+cocci	Yellow/gold	<i>Staphylococcus spp</i>
3	-	-	-		+	-cocci	milky	<i>Enterococcus spp</i>
4	+	+	-	-	-	-rod	Pink mucoid	<i>Klebsiella spp</i>
5	+	-	+	-	+	-rod	Creamy colonies	<i>Pseudomonas spp</i>
6	+	-	-	-	+	-rod	White colonies	<i>Salmonella spp</i>
							Milky colonies	
7	-	-	-	-	-	+cocci	Pale pink	<i>Streptococcus spp</i>
8	+	-	-	+	+	+rod		<i>Bacillus spp</i>

118 **Keys:** Cat= Catalase, Coa= Coagulase, Oxi= Oxidase, Ind= Indole, Mot= Motility

119 **Table 2. Frequency of bacteria isolated from Uke River**

Bacteria	Frequency (%)
121 <i>Escherichia coli</i>	23(43%)
122 <i>Staphylococcus aureus</i>	9(16 %)
123 <i>Enterococcus spp</i>	1(2%)
124 <i>Klebsiella spp</i>	7(12%)
125 <i>Pseudomonas spp</i>	10(18%)
126 <i>Salmonella typhi</i>	1(2%)
127 <i>Streptococcus spp</i>	3(6%)
128 <i>Bacillus spp</i>	2(4%)
129 Total	56

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132 **Table 3. Mean Total Heterotrophic, Total Coliform and Fecal Coliform counts of the water**
 133 **samples taken for five weeks from the Uke River.**

	Sampling Period	Total Heterotrophic count (TH) (cfu/mL)	Total Coliform count (cfu/100mL)	(TC) Fecal coliform count (x10 ² cfu/ml)
134	Week 1	2.3×10 ²	2.9×10 ²	2.6×10 ²
135	Week 2	2.5×10 ²	2.5×10 ²	2.2×10 ²
136	Week 3	2.27×10 ²	2.2×10 ²	1.2×10 ²
137	Week 4	1.8×10 ²	1.69×10 ²	2.0×10 ²
138	Week 5	2.67×10 ²	2.9×10 ²	2.3×10 ²
139	Mean	2.3×10 ²	2.4×10 ²	2.6×10 ²

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141 **Table 4. Mean and Standard Deviation of Physico-chemical Parameters**

PARAMETERS	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	WHO LIMIT(2006)
TEMPERATURE(°C)	31.333	27.167	28.5	28	29	NONE
S.D(+/-)	1.36626	0.75277	1.04881	0.89443	1.41421	
CONDUCTIVITY(µs/cm)	34.167	33	32.333	34.167	35.5	1400
S.D(+/-)	13.9016	11.6392	12.0179	12.7144	13.2455	
ALKALINITY(mg/L)	1.417	1.333	1.917	1.75	1.5	50
S.D(+/-)	14.8932	12.9176	13.8251	14.278	14.5928	
TDS(mg/L)	8148	19815	1723.33	17555	749.5	1500
S.D(+/-)	17584.7	40209.3	412.427	40487.2	202.729	
TSS(mg/L)	11.583	16.167	11.25	10.917	11.117	0.01
S.D(+/-)	24.8553	16.1667	11.25	10.9167	11.1167	
pH	7.85	8.002	7.643	7.645	7.89	6.5-9.0
S.D(+/-)	12.4868	10.656	11.4558	11.2152	11.5887	

142 KEYS: TSS (Total Suspended Solids), TDS (Total Dissolved Solids), S.D (Standard Deviation)

143 4. DISCUSSION

144 The bacteriological assessment of Uke River reveals the presence of bacterial contaminants and this
 145 is in agreement with the findings of Doughari et al [16] and May et al [17] who conducted similar
 146 studies in Gudu stream Abuja, and Ebutte River in Ehor community, Edo state, Nigeria.

Total heterotrophic counts ranged from 1.8×10^2 to 2.67×10^2 from the five sampling points of Uke river and these results exceeds the World Health Organization standard for heterotrophic bacteria in potable which states that the total heterotrophic bacteria count should not be more than 100 cfu/ml [18].

The alarming high number of total coliforms and faecal coliforms per 100 mL obtained from the water samples indicates high level of faecal contamination of the river water which potentially poses a high health risk for the inhabitants of the community. This agrees with Chessbrough [19] who stated that high coliform counts are an indication of high faecal contamination. Faecal streptococci counts indicate more contamination with human excrement than animal excrement.

None of the sampling points of the water sources complied with World Health Organization standard for coliform in water. The total coliform and fecal count for all samples were extremely higher than the WHO standard for coliform bacteria in water which is zero total coliform per 100ml of water [20].

Similarly, the health guidelines for the use of wastewater in agriculture and aquaculture states that water to be used for irrigation of crops that is likely eaten uncooked and water to be used for sports and public parks in unrestricted regions should not exceed 10 3per 100 mL faecal coliforms [21]. Additionally, the water quality was unacceptable as per EPA's (Environmental Protection Agency) standard of zero (0) fecal colony/100 mL of water to be used in irrigation of any food crops not commercially processed including crops eaten raw [22].

Escherichia coli had the highest frequency (43%) of bacteria isolated from the water which is contrary to the WHO guideline value of zero (0) *E. coli* per 100 mL of drinking water [18]. Similarly, Khalid et al [23] also recorded a high frequency of *Escherichia coli* in Tigris River, Baghdad. Physico-chemical parameters such as the P^H , total suspended solids and total dissolved solids were above the World Health Organization Standards.

5. CONCLUSION

The physico-chemical and bacteriological analysis of Uke River from this study is a definitive proof that the water is unsafe for consumption as coliform counts were more than the international permissible levels recommended by World Health Organization. Thus, this water is unfit for drinking, bathing, washing of farm produce or for any other agricultural purpose except if it is adequately treated. Public awareness and a total halt of indiscriminate dumping of refuse and faeces into the river will go a long way to reduce bacterial contamination.

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