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An assessment of total coliform levels of some portions of River Gongola in Adamawa State, Nigeria

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ABSTRACT

Bacteriological assessment of River Gongola in Adamawa State was carried out in the following locations along Rivers Gongola; Bare (RGBW), Dasso (RGDW), Behind dam east ($RGD_{BE}W$), Dam west bank1 ($RGD_{W1}W$), Dam west bank2 ($RGD_{W2}W$), Bobere (RGD_BW), Behind dam west ($RGD_{BW}W$), Dam east bank 1($RGD_{E1}W$), Dam east bank2 ($RGD_{E2}W$) Kiri (RGD_KW). The sampling was done in the months of February, March, April, 2007 representing dry season and in the months of August, September and October 2007 representing wet season. The poor plate method was used for determination of total coliform. It revealed high values (59.7 to 308.3 CFU/100ml of water) in wet season compared to those of dry season (12.1 to 100.7 CFU/100ml of water). This may be as result of runoff from animal faeces due to rains and these values were higher than the WHO/NAFDAC recommended standards.

Key words: Kiri-dam, bacteriological assessment, surface water, ecological risk, pollution.

INTRODUCTION

The provision of water for domestic and other uses in rural and urban centers is one of the most intractable problems in Nigeria today. Access to adequate water of good quality is essential to health, food production and sustainable development. Every human use of water, whether for drinking, irrigation, and industrial processes or for recreation has some quality requirements in order to make it acceptable. This quality criterion can be described in terms of physical, chemical and biological properties of such water [1].

Water pollution occurs when a body of water is adversely affected due to addition of large amounts of materials to the water (organic or inorganic contaminants) making it unfit for intended use. Such water is considered polluted. Two forms of water pollution exist; point source

and nonpoint source. Point sources of pollution occur when harmful substances are emitted directly into a body of water. This includes effluent sewage treatment works, or of waste from factories. While nonpoint source delivers pollutants indirectly through environmental changes, for example fertilizer or herbicide application is carried into streams by rain in form of run-off which in turn affects aquatic life. Technology exists for point sources of pollution to be monitored and regulated although political factors may complicate matters. Nonpoint sources are much more difficult to control. Pollution arising from nonpoint sources account for majority of contaminants in streams and lakes. As part of a prospective cohort study among triathletes to determine a relationship between the microbiological quality of fresh bathing water and the risk of acquiring an intestinal infection assessed by Medema et al., [2] indicates that, the exposure of the triathletes to microbiological contaminants that were influenced by sewage effluents and agricultural run-off, showed significant differences in thermotolerant coliform concentration between locations, depths and ties when samples were taken weeks before the exposure. Also during swimmers exposure, significant difference occurred in microorganism levels at the different sampling points over the swimming course. The risk of an intestinal infection also correlated positively with the concentration of thermotolerant coliforms and *Escherichia coli* but not with the other parameters. And at the fresh water sites, only the ratio between the geometric mean density of *Escherichia coli* and thermotolerant coliform was constant. The ratio between the other parameters related to faecal pollution varied considerably.

Study location

Adamawa State was administratively created in 1991 from the northeastern half of former Gongola state. Adamawa is bordered on the north and northwest by Borno and Bauchi states respectively, on the West and Southwest by Taraba state, and on the Southeast and East by the Republic of Cameroon. Adamawa State is located within latitude 9^o 11' N to 9^o 20' N and longitude 12^o 23' E. The study area is River Gongola (Kiri-dam) in Numan and Shelleng local government areas and River Benue in Jimeta-Yola of Adamawa State. Jimeta-Yola is located within latitude 9^0 11' N to 9^0 20' N and longitude 12^0 23' E and covers an area of about 305 Km^2. The Benue River constitutes the major drainage system in the area. It is less than 150m above mean sea level. The mean annual rainfall in Yola is 859.3 mm and 917.9 mm in Yola [3].

The Mandara Mountains lie in the northeastern part of the state along the Cameroon border, and the Shebshi Mountains rise to Mount Dimlang (2,042 m) in the state's southeastern portion. Adamawa State is largely covered by short-grass savanna and is drained westward by the Benue River and its tributaries, including the Gongola, Taraba, and Pai rivers.

Adamawa State is multi-ethnic; few among the tribes are Fulani, Bachama, Mbula, Mumuye, Higi, Chamba, Margi (Marghi), Hausa, Kilba, Gude, Lunguda, Yungur, Kanakuru, and Bata peoples. All these groups except the Hausa traders are primarily engaged in crop farming and livestock herding (cattle, goats, sheep), but fishing is also important along the riverbanks. Peanuts (groundnuts), cotton, sorghum, millet, rice, and corn (maize) are the main crops. Peanuts and cotton are exported, as are cattle, dyed skins, and gum Arabic.

Cottage industries include leatherwork, calabash decoration; mat weaving, pottery making, metalwork, canoe carving, and cloth dyeing. Industries are all agriculturally based and include a sugar-processing plant near Numan, a timber industry at Yola, and a cotton ginnery at Lamurde.

The state's road system is limited. Yola, the site of the State capital is served by an airport, and the Benue River allows for river transport. The population of the State is 3,168,101[4].

River Gongola

River Gongola is the principal tributary of the Benue River. It rises in several branches (including the Lere and Maijuju rivers) on the eastern slopes of the Jos Plateau and cascades (with several scenic waterfalls) onto the plains of the Gongola Basin, where it follows a northeasterly course. It then flows past Nafada and takes an abrupt turn toward the south. Its lower course veers to the southeast and, after receiving the Hawul (its chief tributary, which rises on the Biu Plateau), it continues in a southerly direction before joining the Benue, opposite the town of Numan, after a journey of 531 km. During the dry season, however, the upper Gongola and many of its tributaries practically disappear, and even the lower course becomes unavailable [5].

Almost all of the Gongola Basin lies in a dry savanna area. The basin has been enlarged by the Gongola's capture of several rivers that formerly flowed to Lake Chad—the sharp southerly bend east of Nafada is the result of the capture of the upper Gongola, and the Gungeru, another tributary from the Biu Plateau, is also a captured stream. The Gongola's floodplains are covered with a fertile black alluvial soil. Cotton, peanuts (groundnuts), and sorghum are grown for export to other parts of the nation; but millet, beans, cassava, onions, corn (maize), and rice are also cultivated.

The government built the Kiri Dam (completed in 1984) on the river near Numan to provide irrigation and electricity for its Gongola sugar plantation project. The basin is also used as grazing ground for livestock.

The study area is River Gongola (Kiri-dam) in Numan and Shelleng local government areas and River Benue in Jimeta-Yola of Adamawa State. Jimeta-Yola is located within latitude 9^0 11' N to 9^0 20' N and longitude 12^0 23' E and covers an area of about 305 Km^2. The Benue River constitutes the major drainage system in the area. It is less than 150 m above mean sea level. The mean annual rainfall in Yola is 859.3 mm and 917.9 mm in Yola [3].

The area is not highly industrialized; the functional industries are the Bajabure industrial complex, Savanna Sugar Company Plc, Yola oil mill and AFFCOT Nig. Ltd. Others are small-scale industries like the Naggae Company and some small-scale metallurgical works are also present [6].

Kiri-dam located on river Gongola in Shelleng L.G.A. in the state is mainly constructed in order to supply water to the Savannah Sugar Co. in Numan, Numan LGA for irrigation purpose. However, a lot of fishing activities take place there. The economic resources are mainly agricultural, and crops such as groundnuts, maize and guinea corn are grown here. Adamawa State is an important breeding center for cattle, sheep and goat.

These sources of water supply are susceptible to pollution due to heavy human dependency on these river waters. Notably there is indiscriminate dumping of waste and agricultural practices

taking place in the area. Waste disposal in the areas is through open dump for solid waste, pit latrines, septic tank for human wastes. Coliforms should not be present in water and if present it indicates presence of swage [7]. Liquid wastes are admitted through the major drainage networks and emptied into the river Gongola. Hence, the necessity of monitoring the pollution level of the river water bodies in this area.

Objective of the study

The study establishes the sanitary quality and suitability of the water for general use. It is meant to assess the degree of contamination of any water body by wastes arising from human or animal sources. The absence or presence of coliform group of bacteria has been the principal indicator of degree of pollution of any water for domestic and other uses. The presence of coliform group of bacteria in a water body means pollution has occurred in it. This can increase disease transmission.

The present study is therefore to determine the total coliform levels in River Gongola and make recommendations on possible ecological risk associated with it.

MATERIALS AND METHODS

Study area

The study areas is portion of River Gongola which include: Bare, Dasso, Behind Kiri dam west bank Kiri dam west bank I, and Kiri dam East bank I behind Kiri dam East bank, kiri dam east bank II, Kiri dam west bank II, Kiri, Bobere. All the areas are in Adamawa State, Nigeria.

These bodies of water are the main source of water for irrigation, fishing, domestic and industrial purposes in the area. The sediments and water samples were collected from the above-mentioned locations.

Water Sampling

Samples which are representatives of the water bodies were collected and examined. These samples were collected at the study areas. Water samples were collected by lowering pre-cleaned plastic bottles into the bottom of the water body, 30cm deep, and allowed to over flow before withdrawing. Forty three sampling points were used and the sampling points are approximately 100m away from each other. A total of 200 samples were analyzed. Samples were collected in the months of February, March, April (dry season) and August, September, October (wet season) in the year 2007.

Samples for determination of total coliform were collected in sterilized bottles labeled and stored in ice-coolers and taken to the laboratory immediately for analysis.

Methods of Analysis

For the purpose of this study, total coliform (*Escherichia coli*) was assessed using membrane filtration technique (pour plate method) as described by Monica [8]. Pour plate technique is usually the method of choice for counting the number of colony-forming bacteria in fluids [9] and it enables even distribution of cells throughout the media. It is more precise than the streak plate method [10].

Data Analysis

Results were presented as mean±SD. The Pearson's correlation analysis, Analysis of Variance (ANOVA) with Scheffe post hoc test and the student t-test were used for the statistical analyses of results obtained at 95% confidence level using Microsoft Excel 2007 package.

RESULTS AND DISCUSSION

Total coliform counts in surface water of River Gongola during Wet and dry seasons are presented (Tables 1 and 2) and Figure 1 shows the mean seasonal variations of total coliform in River Gongola. The seasonal variations of total coliform in River Gongola revealed higher values in the wet season in the range of 59.7±3.4 CFU/100ml from River Gongola Dasso Water to 308.3±7.8 CFU/100ml from River Gongola Dam Kiri Water compared to dry season which ranged between 20.1±2.8 CFU/100ml from River Gongola.

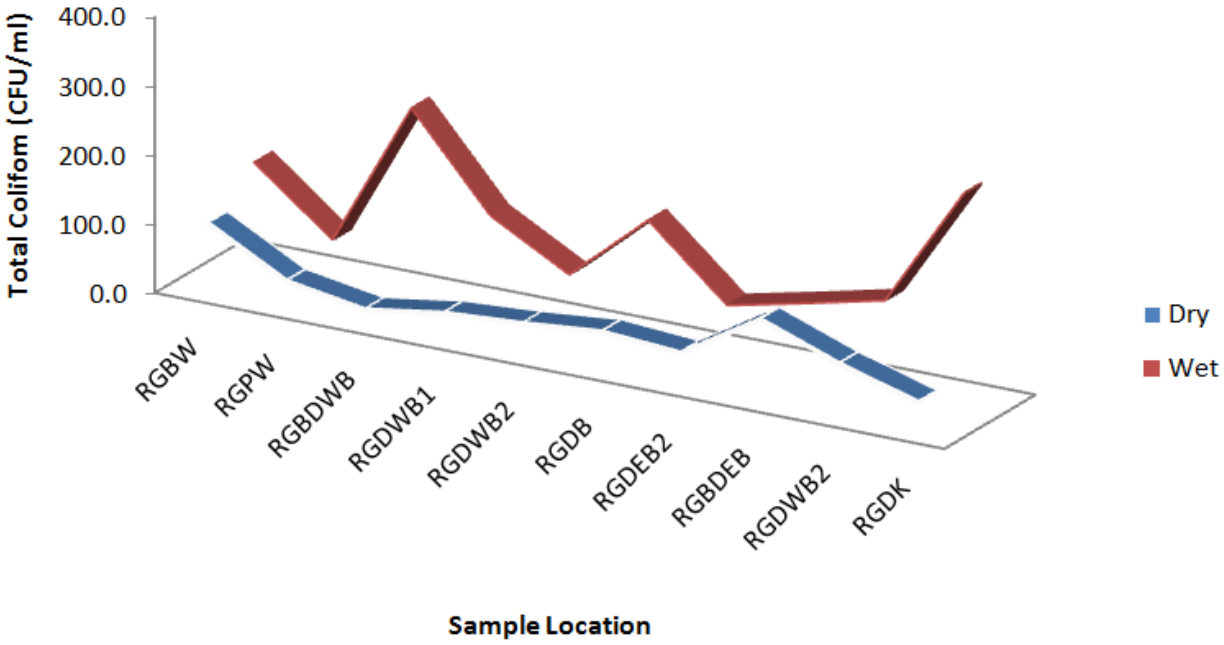

Figure 1: Mean variation of total coliform count in River Gongola

Table 1: Total coliform counts in surface water of River Gongola during Wet season

S/N	LOCAITON/CODE	Total coliform (CFU/100ml)
1	River Gongola Bare water (RGBW)	150.3±7.48
2	River Gongola Dasso Water (RGDW)	59.7±3.41
3	River Gongola Dam Behind west bank Water (RGDW)	273.3±8.41
4	River Gongola Dam West bank 1Water ($RGD_{W1}W$)	140.0±7.32
5	River Gongola Dam East bank1 Water ($RGD_{W1}W$)	77.0±6.44
6	River Gongola Dam Bobere Water ($RGD_{B}W$)	178.3±2.98
7	River Gongola Dam East Bank II Water ($RGD_{E2}W$)	77.7±6.25
8	River Gongola Dam West bank II Water ($RGD_{WB2}W$)	130.0±13.07
9	River Gongola Dam Kiri Water ($RGD_{K}W$)	308.3±7.14

Note: Each value is mean ± sd of 3 observations

Table 2: Total coliform counts in surface water of River Gongola during Dry season

S/N	LOCAITON/CODE	**Total coliform** (CFU/100ml)
1	River Gongola Bare water (RGBW)	100.7±8.56
2	River Gongola Dasso Water (RGDW)	39.0±4.33
3	River Gongola Dam Behind west bank Water (RGDW)	20.1±7.14
4	River Gongola Dam West bank 1Water ($RGD_{W1}W$)	37.7±4.21
5	River Gongola Dam East bank1 Water ($RGD_{W1}W$)	45.3±5.09
6	River Gongola Dam Bobere Water ($RGD_{B}W$)	12.1±3.11
7	River Gongola Dam East Bank II Water ($RGD_{E2}W$)	48.0±3.66
8	River Gongola Dam West bank II Water ($RGDW_{B2}W$)	77.5±4.22
9	River Gongola Dam Kiri Water (RGDKW)	44.3±9.42
1	River Gongola Bare water (RGBW)	100.7±8.56

Note: Each value is mean ± sd of 3 observations

Dam Behind west bank Water and 100.7±8.5 CFU/100ml in River Gongola Bare water. This figures differ from one location to another and they agree with that reported by Ogugbuaja and Kinjir [11] and work of Maitera and Shinggu [6].

These results showed that River Gongola was grossly polluted with coliform organisms. It may be as a result of indiscriminate dumping of waste and human faeces passed around the river bank which were washed into the river during rains. The high total coliform counts in the water body may also be as a result of contributions from the tributaries. These values were higher than the WHO [12] and NAFDAC [13] recommended standards. The results generally revealed that the portions of River Gongola assessed in this work were within safe limits for irrigation and fishing activities but not for direct domestic utilization.

CONCLUSION

The result of the total coliform levels of river Gongola in Adamawa State is high in the wet season 59.7±3.4 to 308.3±7.8 CFU/100ml compared to dry season which ranged between 20.1±2.8 and 100.7±8.56 CFU/100ml. This may be as a result of run-off from tributaries into the rivers and faeces from animals.

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