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Evaluation of Bacteriological Pollution of Yamoussoukro Lakes (Côte D'ivoire)

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Abstract: The present study was conducted to evaluate the bacteriological quality of water collected from tropical lake system. For this purpose, nine water sampling stations from Yamoussoukro lake system were monitored between February 2007 and April 2008 for Heterotrophic Plate Count (HPC), total coliforms and faecal coliforms (*Escherichia coli*). Varying levels of bacteriological contamination were recorded in all the stations. Bacterial indicator numbers (log means CFU/ mL) varied from 5.96 to 6.18 for HPC, 5.25 to 5.69 for total coliforms and 3.49 to 4.07 for *E. coli*. Results of this study showed that the water quality has deteriorated in Yamoussoukro lake system. In conclusion, it is important to provide sanitary monitoring program for the water.

Key words: *Escherichia coli*, microbiological pollution, total coliform, tropical lake system

INTRODUCTION

Surface waters from natural lakes and reservoirs are a major source of freshwater for domestic, industrial and agricultural purposes in numerous regions of the world. Environmental pollution, mainly of water sources has become of public interest. Not only the developed countries have been affected but also the developing countries suffer the from impact of pollution (Da Silva and Sacomani, 2001; Koné, 2002; Yarar *et al.*, 2009). Water bodies are constantly used as receptacles for untreated waste water or poorly treated effluents accrued from industrial activities. This may render the water bodies unsuitable for both primary and/or secondary usage (Egboka *et al.*, 1989; Kazi *et al.*, 2009; Strobl and Robillard, 2008).

Microorganisms play a major role in water quality and the most dangerous form of water pollution occurs when faeces enter the water supply (Azizullah *et al.*, 2011; Pritchard *et al.*, 2009). Human faecal material is generally considered to be a greater risk to human health as it is more likely to contain human enteric pathogens. The most important aspect of water quality is its freedom from contamination with faecal matter (Baghel *et al.*, 2005).

The use of bacteria as water quality indicators can be viewed in two ways: first, the presence of such bacteria can be taken as an indication of faecal contamination of the water and thus as a signal to determine why such contamination is present, how serious it is and what steps can be taken to eliminate it; second, their presence can be taken as an indication of the potential danger of health risks that faecal contamination may cause.

The most widely used worldwide indicators are the coliforms bacteria (total coliforms and *Escherichia coli*) (An *et al.*, 2002). Detection of E. coli in surface water was shown in field studies to have significant predictive of value of water being contaminated with enteric pathogens (Hörman *et al.*, 2004; Hörman and Hänninen, 2006).

The main objective of the present study was to evaluate bacteriological and sanitary quality of Yamoussoukro lakes waters from Côte d'Ivoire, a tropical developing country. It was expected that information from this study might help assess the microbiological water quality and its relation to human health in Yamoussoukro.

MATERIALS AND METHODS

Sampling site details: The town of Yamoussoukro is located in the centre of Côte d'Ivoire, 250 km to the north-west of Abidjan at about 6″5′ North latitude. A set of lakes was built there on two connected rivers. Water samples were collected each three weeks from February 2007 to April 2008 from nine different sampling stations of the system which differed by their situation and presence or absence of aquatic macrophytes. These lakes are small, shallow and eutrophic (Parinet *et al.*, 2004) and receive untreated domestic and municipal wastes from the

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Table 1: Variation of bacteria (log mean ± S.E. cfu/mL) at different stations

Sampling stations	*E. coli* (FC)	Total Coliforms (TC)	Heterotrophic Plate Count (HPC)
Station 1	3.91±0.52	5.32±0.47	6.28±0.46
Station 2	3.69±0.35	5.38±0.44	6.29±0.73
Station 3	4.00±0.77	5.29±0.63	6.23±0.61
Station 4	3.61±0.75	5.43±0.59	6.18±0.69
Station 5a	4.07±0.62	5.42±0.59	6.19±0.46
Station 5b	3.91±0.74	5.69±0.56	6.45±0.56
Station 6	3.93±0.94	5.25±0.44	6.18±0.50
Station 8	3.70±0.60	5.53±0.53	6.07±0.46
Station 9	3.49±0.82	5.25±0.44	5.96±0.57
ANOVA F-ratio	44.33*	142.44*	64.96*

*: Statistically significant at $p \leq 0.05$

Table 2: Summary of calculations of ANOVA of microbiological parameters of the lakes

Parameter	Variation	SS	df	MS	F-ration
E. coli	Stations	147.063	8	18.383	44.338*
	Sampling	28.823	14	2.059	1.449^{NS}
Total coliforms	Stations	293.407	8	36.676	142.440*
	Sampling	13.760	14	0.983	0.378^{NS}
Heterotrophic Plate Count	Stations	512.502	8	64.063	64.964*
	Sampling	51.427	14	3.673	0.753^{NS}

*: Statistically significant at $p \leq 0.05$; NS: not significant

city. Water samples from each station were obtained by submerging a sterile container to an approximate depth of 0.5 m. 250 mL and were then placed in a cooler and shipped to the laboratory. All samples were analyzed within 2-4 h of collection.

Bacteriological analysis:

The indicator bacteria used in the study were Hetero Plate Count (HPC), total coliforms and thermotolerant coliforms (*Escherichia coli*). Analytical methods followed normalized French standard methods (AFNOR, Association Française de NORmalisation).

HPC was determined using dilution plate method and standard Plate Count Agar medium (Difco Laboratories) (NF T 90-401). Total coliforms and Escherichia coli were isolated and enumerated, according to NF T 90-414. The selective and recovery media used was lactose Tergitol-7 agar with TTC supplement (Scharlau Chemie)

Statistical analysis of data: All individual result was recorded using Microsoft Excel 2007 software (Microsoft Corporation) and the statistical analysis was performed with the Statistical Package for Social Sciences 18 for Windows (SPSS Inc.). The bacteriological data were transformed in decimal logarithms.

RESULTS

Table 1 show the overall mean of each parameter at different stations. The highest values of Heterotrophic Plate Count (HPC) were recorded in station 5b with mean value of 6.45, while in station 9 the lowest ones were obtained with a mean value of 5.96.

It is apparent from the data that in Yamoussoukro lakes, for Total Coliforms (TC), the same trend was observed as for HPC. The lowest total coliform was also recorded in station 6 (5.25±0.44). Always high count of total coliforms was found at all the study stations.

In station 5a, maximum faecal coliforms bacteria (*E. coli*) count of 4.07 was observed while station 9 had mean value of 3.49.

The bacteriological analysis revealed that the entire samples collected from 9 different stations were contaminated with coliforms and faecal coliforms. The variations of the values within sampling period are non significant in microbiological quality (Table 2).

DISCUSSION

The use of the coliform group, and more specifically *E. coli*, as an indicator of microbiological water quality dates from many years (Bergstein-Ben Dan *et al.*, 1997). This bacteria is used as indicator of potential presence of pathogenic microorganisms in natural and treated waters and it is the standard means of assessing the microbiological quality of waterbody (Hamilton *et al.*, 2005).

The analysis of Yamoussoukro lakes quality at selected stations has shown that the microbiological quality is deteriorated. All the samples were contaminated with total and faecal coliform bacteria. High concentrations of total and faecal coliform were found in lakes relative to levels typically found in other lakes and surface water (Baghel *et al.*, 2005; Davis *et al.*, 2005; Orozco-Borbón *et al.*, 2006). The presence of coliforms at these stations could also be a result of direct contamination caused by human activities and indirect effect caused by ecological disturbances. People discharge their domestic and/or agricultural wastes as well as human

body wastes directly into the lakes and some domestic animals visit the site for drinking.

The presence of *E. coli* in lake water indicates that the water was contaminated by faecal material of human or other warm-blooded animals, and also indicates the potential for the presence of pathogenic organisms. The feces of animals may contain a variety of pathogenic microorganisms such as *Campylobacter*, *Salmonella*, *Shigella*, *Yersinia*, *Aeromonas*, *Pasteurella*, *Franciella*, *Leptospira*, *Vibrio*, some protozoa and several virus groups (Catalao Dionisio *et al.*, 2000; Sigler and Pasutti, 2006; Yassin *et al.*, 2006). Significant correlations have been observed between illness rates in freshwater users and exposure to *E. coli* (Derlet *et al.*, 2004; Yassin *et al.*, 2006).

This study focused only on the use of total and faecal coliforms as indicators of microbiological water quality. This historical concept is today in debate. Numerous limitations associated with application including ability to multiply after releasing into water column (Solo-Gabriele *et al.*, 2000), non-faecal source (Carrillo *et al.*, 1985; Stewart *et al.*, 2006), inability to identify the source of contamination (diffuse and point pollution) (Kim *et al.*, 2005) have been reported.

CONCLUSION

Water contaminated with bacteria can cause a variety of diseases. Water intended for human use should be safe and aesthetically pleasing. Water sources have different qualities influenced by natural or anthropological pollution.

Yamoussoukro lakes were found to contain high levels of total and faecal bacteria and the microbiological quality is deteriorated. Despite this, no study has addressed the problem.

Additional study should also focus on identifying the local sources of contamination and a determination of whether the indicators microbe are of human, animal or environmental origin (i.e., bacteria source tracking study).

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