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Evaluation of the Bacteriological Pollution of the Waters of the Lake of Sonfonia Commune of Ratoma (Republic of Guinea) 2021

Mohamed Lamine Komara[1*], Cheick Ahmed Tawel Camara[2], Nènè N'koya Bangoura[3], Kande Bangoura[4], Sekou Traore[5]

[1]Department of Biology Gamal Abdel Nasser University of Conakry, Conakry, Republic of Guinea
[2]The Biochemistry Degree Programme Gamal Abdel Nasser University of Conakry, Conakry, Republic of Guinea
[3]Laboratory of the Center for Environmental Studies and Research (CERE), Conakry, Republic of Guinea
[4]Scientific Research Center of Conakry Rogbané (CERESCOR), Conakry, Republic of Guinea
[5]Department of Advanced Studies and University Research at the Ministry of Higher Education, Scientific Research and Innovation, Conakry, Republic of Guinea
Email: *komaramohamedlamine@gmail.com

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Abstract

The quality of surface waters is often altered by the presence of bacteria of faecal origin, as a result of untimely discharge of solid and liquid waste from households. The Sonfonia Lake located in the commune of Ratoma is under the influence of various forms of pollution resulting for the most part from anthropic activities. Field visits, interviews with resource persons and bacteriological analysis were carried out to assess the level of this pollution. Two water sampling campaigns were carried out during the low-water period and two others during the flood period of 2021. The comparison of the levels of faecal contamination bacteria in the present study with a previous one carried out in 2018 on the waters of the same lake, indicates an increase in the level of faecal coliforms and faecal streptococci that exceed the indicator values recommended by the WHO. These results show that Lake Sonfonia is polluted. This could be related to the increase in anthropogenic and demographic activities during the last four years. On the other hand, the analysis of the results showed the absence of pathogenic germs such as salmonella. The Mann-Whitney U statistical test was used to compare the value of the means of each of the variables observed during the two seasons.

Keywords

Surface Water, Anthropogenic, Lake Sonfonia, Wastewater, Faeces

1. Introduction

Water pollution is a serious problem for the environment because of the various discharges into lakes [1]. Untreated wastewater from riparian communities is the main source of organic water pollution [2]. They cause a degradation of the quality of surface water, compromising the future of the water body. In developing countries 90 to 95 of all wastewater and 75 of all industrial wastes, on average are discharged into surface waters without any treatment [3].

Studies have dealt with the impact of poor sanitation on surface water quality in cities in Asian and sub-Saharan African countries: [4] [5] and [6] etc. They conclude that this bacteriological and nitrogenous pollution of the waters would come from poor sanitation of excreta.

Currently the situation of Lake Sonfonia is alarming, it has become a wild dump, all liquid waste and household wastewater are constantly dumped there.

Given its advanced level of pollution, it is no longer used as a source of drinking water by the Guinea Water Company (SEG). As a contribution to monitoring and pollution protection efforts, we have chosen this study: Assessment of bacteriological pollution of the waters of Lake Sonfoia Commune of Ratoma (Republic of Guinea) 2021.

To carry out this study, we carried out field visits, interviews with resource persons who allowed us to identify the different water sample collection points for bacteriological analysis.

According to reports, the lake was developed by French settlers to irrigate the vast banana plantations near the lake.

This interview made it possible above all to know the various uses made by the local population, namely: watering vegetable crops, fishing, washing rolling machinery, swimming, etc. exposing them to a health risk.

The main objective: To contribute to the improvement of the drinkability of the water of Lake Sonfonia for sustainable use.

2. Equipment and Methods

2.1. Study Area

Lake Sonfonia is located near the suburbs of Foulamadina and Sonfonia, the landmarks general university lansana county of Conakry, the Blue zone of sonfonia. The length of Lake Sonfonia is about 2.5 km and 100 to 200 m wide in places. The depth varies between 6 to 7 meters in the rainy season and between 3 to 4 meters in the dry season. The lake is fed by a natural source of groundwater, it houses the drinking water treatment point of the SEG (**Figure 1** and **Figure 2**).

2.2. Sampling and Sampling

The sampling was carried out at six stations according to human activities and pressure from local populations. Each station has been geo-located as shown in **Table 1**.

Figure 1. Image of Lake Sonfonia 2021.

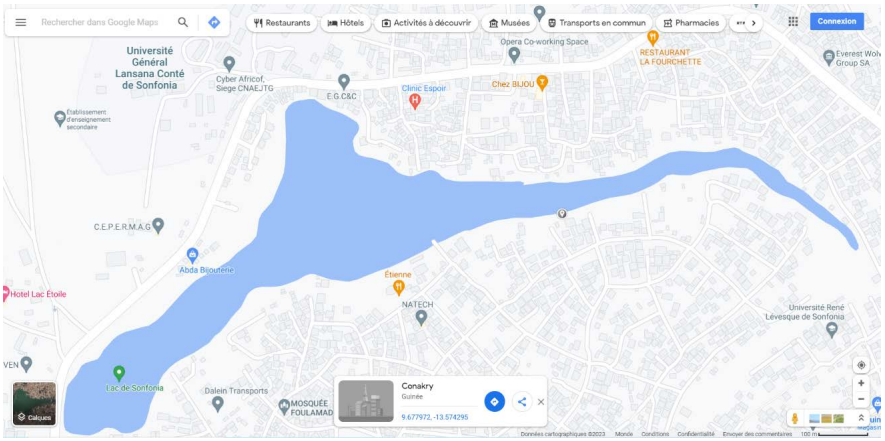

Figure 2. Map of Lake Sonfonia on Google maps.

Table 1. Stations and geographic coordinates.

Stations	North latitude	West Longitude.
SEG	NO: 09˚40'28.6"E	WO: -13˚34'55.5"N
YAT	NO: 09˚40'26.4"E	WO: -13˚34'58.1"N
FLM	NO: 09˚40'26.5"E	WO: -13˚34'54.0"N
SOC	NO: 09˚40'43.1"E	WO: -13˚34'25.6"N
BLZ	NO: 09˚40'40.9"E	WO: -13˚34'47.9"N
USF	NO: 09˚40'46.1"E	WO: -13˚34'46.2"N

At each station, two sampling campaigns were carried out during low water periods corresponding to the dry season March 2021 and two others during flood periods corresponding to the rainy season August 2021. The collection, transport and storage of samples were in accordance with the protocol defined by [7] and [8] (**Figure 3**).

2.3. Determination of Bacteriological Parameters

The enumeration of the germs sought was done by the membrane filter technique and the culture of the germs was carried out on cardboard culture media (NKS) (see **Figure 4**: filtration device with aspirator and culture media on cardboard). The

following culture media were used for sprout incubation: Azide for faecal streptococcal (SF) (Figure 5 and Figure 6); isolation Chromocult for the isolation of Total Coliforms (TC), Fecal Coliforms (CF) and *Escherichia coli* (*E. coli*) (Figure 7 and Figure 8) and finally Bismuth Sulfite for the isolation of Salmonella.

Before use, the SCN are moistened with 3.5 ml of distilled water using a pasteur pipette.

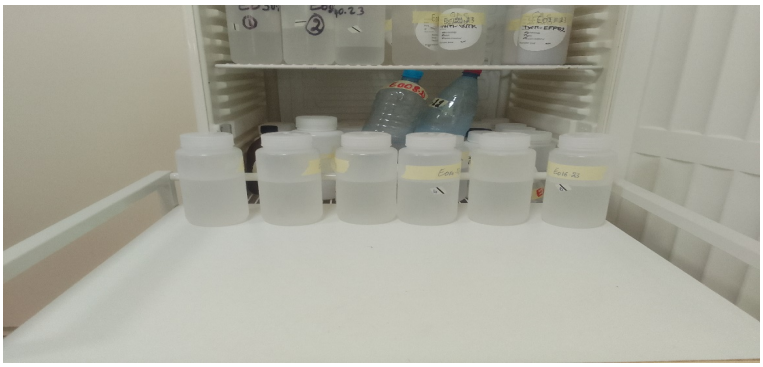

Figure 3. Vials containing water samples to be analysed.

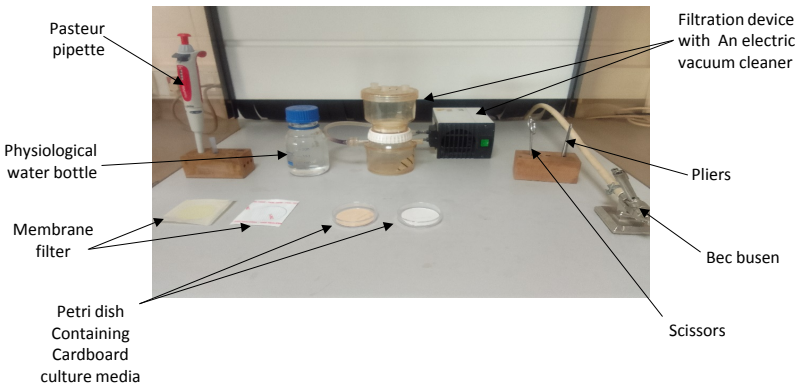

Figure 4. Materials and consumables used.

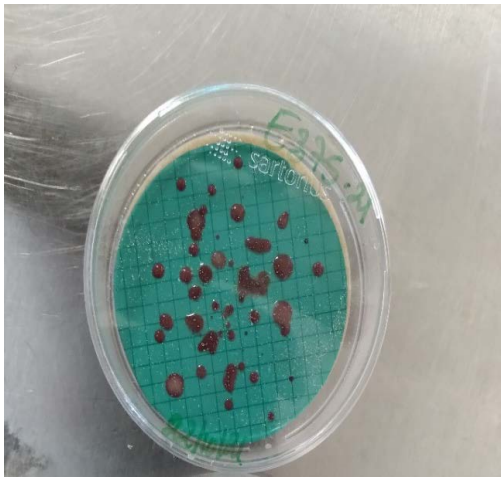

Figure 5. A petri dish containing Azide culture medium on a green background for the isolation of faecal streptococci.

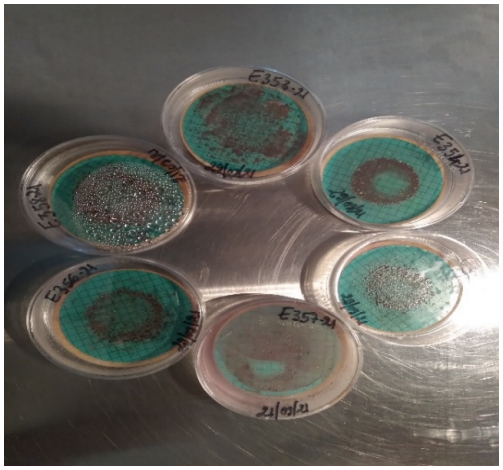

Figure 6. Six petri dishes containing the Azide culture medium on a green background corresponding to the water samples taken at the various stations for the isolation of faecal streptococci.

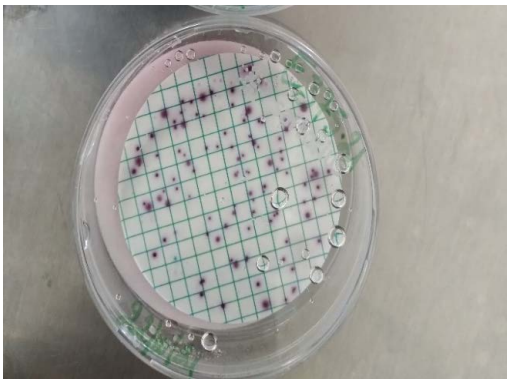

Figure 7. A petri dish containing chromocult culture medium on a white background for the isolation of faecal coliforms and *Escherichia coli*.

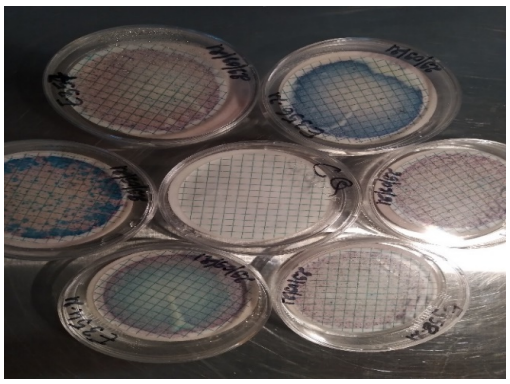

Figure 8. Six petri dishes containing the chromocult culture medium on a white background corresponding to the water samples taken in the different stations for the isolation of faecal coliforms and *Escherichia coli* and a control petri dish in the center.

The 250 ml water sample to be analyzed was diluted successively: (dilution factor 1/10, 1/100 and 1/1000). 100 ml of water was filtered through a membrane filter (0.45 micron; dark green gridded green) or (0.45 micron; black grid white).

All bacteria present in the sample are retained on the surface of the membrane, which is then deposited on the sterile NKS using forceps. The NKS incubated in the Petri dishes with the lid are deposited in the incubator. The reading is made in 24 hours or 48 hours at a temperature varying between 22˚C - 44˚C.

Faecal streptococci have been counted by counting typical colonies of red to red-brown and smooth-edged (Figure 6), faecal coliforms form pink-red colonies (Figure 8). *Escherichia coli* grew as dark blue colonies at violettes.la confirmation of *Escherichia coli* was made by the addition of a drop of Erlich kovacs reagent. The principle of this reaction is based on the ability of *Escherichia coli* to split tryptophan into an organic compound indole thanks to the enzyme tryptophanase. This compound reacts with the reagent dimethylaminobenzaldehyde, to form a dark red coloration, indicating the presence of indole and thus confirms the Indole/Tryptophanase positive character of the *Escherichia coli* colony.

Salmonella will form lightly coloured colonies with a brown to black centre surrounded by a black halo (fish's eye). All these operations take place under the hood in the presence of busen burner flames.

The number of colonies counted is expressed in colony-forming units per 100 ml of water (UCF/100 ml). The analyses of the water samples were carried out at the Guineo-German Medical Laboratory BP: 4529 Conakry E-mail: Info@lga-guinee.com.

3. Results

Table 2 and Table 3 give respectively the results of the bacteriological analysis of the water samples for the month of March 2021 and August 2021.

Table 2. Results of analysis of water samples March 2021.

Parameters	SF		CT		CF	*E. coli*		Salmonella
Conditions Incubation	22˚C 24H	37˚C 48H	22˚C 24H	37˚C 48H	44˚C 24H	22˚C 24H	37˚C 48H	37˚C 48H
SEG	80	1200	200	10,000	25	15	120	0
YAT	100	3000	500	50,000	235	34	180	0
FLM	50	2000	450	9500	100	150	200	0
SOC	300	1000	800	9000	300	322	1200	0
BLZ	40	3000	150	3000	18	53	80	0
USF	30	750	120	2000	450	18	45	0

Table 3. Water sample analysis results August 2021.

Parameters	SF		CT		CF	*E. coli*		Salmonella
Conditions Incubation	22˚C 24H	37˚C 48H	22˚C 24H	37˚C 48H	44˚C 24H	22˚C 24H	37˚C 48H	37˚C 48H
SEG	8	800	100	9600	0	9	42	0
YAT	26	2600	71	6600	16	22	86	0
FLM	12	1200	92	8700	14	54	90	0
SOC	18	1800	69	6400	78	416	802	0
BLZ	32	3200	31	2600	0	10	22	0
USF	6	600	83	7800	5	4	32	0

4. Discussion

4.1. Faecal Pollution Indicator Bacteria

The detection of faecal pollution in a natural environment is usually done by looking for germs indicating faecal contamination, that is to say specific bacteria of the intestinal flora, which are not necessarily themselves pathogenic, but whose presence indicates the existence of faecal contamination, therefore an epidemiological risk. Total coliforms (TC), faecal coliforms (CF) and faecal streptococci (FS) are the main indicators of faecal contamination. It should be noted that the use of total coliforms as an indicator of faecal contamination is increasingly contested because of the heterogeneity of this group of bacteria, some species of which may be of waterborne or telluric origin. On the other hand, the species *Escherichia coli*, which belongs to the group of faecal coliforms, seems to be one of the best indicators of a potential health risk [9].

The analysis in Table 2 and Table 3 shows: The levels of bacteria indicative of faecal contamination differ from one station to another and according to the sampling period.

During the dry season with the low water flow high loads of bacteria were observed: 3000 CFU/100/ml of SF at the station (YAT); 450 CF CF/100 ml (USF); 50,000 CFU/100 ml CT (YAT) and 1200 CFU/100 ml *E. coli* (SOC). On the other hand in the rainy season the maximum values observed are respectively: 2600 CFU/100 ml of SF at the station (YAT); 78 CFU/100 ml CF (SOC); 9600 CFU/100 ml CT (SEG) and 802 CFU/100 ml *E. coli* (SOC).

The ratio R = CF/SF (the number of faecal coliforms and the number of faecal streptococci) in the different stations does not clearly indicate the origin of faecal pollution. Sometimes faecal pollution is strictly animal due to the presence of animal breeding such as oxen near the lake or even other animals such as (margouillats, migratory birds, cat, dog etc.), are permanent there. Their excreta will contaminate the water body with runoff, rainwater and leaching from agricultural land loaded with manure. Sometimes strictly human because of domestic wastewater, but also the transformation of the lake shore into a defecation site for the local

population. Some reports indicate a mixed origin predominantly animal, others mixed predominantly human origin at the end of other uncertain origin [10].

The presence of these indicators in water indicates faecal contamination [11]. The presence of *E. coli* in the various stations confirms this contamination by feces but also the possible presence of other pathogenic germs [12]. The stations (YAT) and (SOC) close to residential areas receive discharges of sewage, domestic wastewater has recorded peaks in bacterial load values.

The comparison of the levels of faecal contamination bacteria of the present study with a previous one carried out in 2018 on the waters of the same lake, indicates an increase in the content of fecal coliforms and faecal streptococci that exceed the maximum concentration allowed by the WHO and MDDEFP (62 CFU/100 ml in SF and from 200 to 1000 CFU/100 ml in CF), for surface waters, classifying the waters of Lake Sonfonia as of poor bacteriological quality.

4.2. Pathogenic Bacteria in the Water of Lake Sonfonia

The search for pathogenic bacteria such as salmonella in water usually requires a concentration step. Since Salmonella may be present in small numbers and have been altered in the aqueous environment, its search in water requires pre-enrichment [13]. Analysis of the results indicates a notable absence of salmonella. The lack of reagent for pre-enrichment could probably explain in part the notorious absence of salmonella at the various stations.

4.3. Statistical Studies

Stata 15 software was used for statistical analysis of the data. Because the sample size is small, the Shapiro-Wilk normality test indicated that the variables studied are not normally distributed. It was preferable to use a non-parametric test. For this we used the Mann-Whitney U-test to compare the value of the means of each of the variables observed during the two seasons as shown in **Table 4**.

The test results reveal that, on average, there are statistically significant differences between the values of the two seasons (March and August) of the following

Table 4. Results of tests to compare the means of bacteriological parameters of water samples collected in March and August 2021.

Parameters	Incubation conditions	P-value	Decision-making
SF	T = 22˚C in 24 hours	0.0065	P-value < 0.05 so the differences observed during the two seasons are statistically significant at 5%.
CT	T = 22˚C in 24 hours	0.0039	
CF	T = 44˚C in 24 hours	0.0133	
SF	T = 37˚C in 48 hours	0.8095	
CT	T = 37˚C in 48 hours	0.4233	P-value < 0.05 so the differences observed during the two seasons are statistically significant at 5%.
E. coli	T = 22˚C in 24 hours	0.3367	
	T = 37˚C in 48 hours	0.1495	

parameters: SF (22˚C in 24 h), CT (22˚C in 24 h) and CF (44˚C in 24 h) in their respective incubation conditions. On the other hand, it appears from our study that there are on average no statistically significant differences between the values of these two seasons (March and August) for the parameters SF (37˚C in 48 h), CT (37˚C in 48 h) and *E. coli* (22˚C in 24 h and 37˚C in 48 h) with indicated incubation conditions.

5. Conclusion

At the end of this study, we find that the concentration of faecal contamination bacteria exceeds the maximum concentration allowed by the WHO for surface waters. The presence of *E. coli* confirms water contamination by feces. On the other hand, the analyses did not detect pathogenic germs. Our study also showed that variations in the concentration of bacteria in both seasons actually depend on incubation conditions. The main source of pollution is due to anthropogenic activities, *i.e.* discharges of household waste and domestic wastewater into the lake without any prior treatment. Binding measures must be taken by the authorities for an integrated management of this ecosystem threatened by various pollutants.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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