ORIGINAL RESEARCH ARTICLE

EVALUATION OF THE MICROBIOLOGICAL QUALITY OF BATHING WATERS IN THE MAMOU REGION (REPUBLIC OF GUINEA)

ABSTRACT

The bacteriologicalquality of bathing water is a major public health issue. The aim of thisstudyis to assess the correlationbetween the bacteriologicalquality of bathing water and the risk of diseaseoutbreaks. The studywas prospective in nature, and ranfrom June to December 2022. Fifty-nine (59) samplesweretakenfrom water sources used for bathing. Conventionalbacteriologicalmethodswereusedduring the work. In Mamou, the resultsshowedthat EI and *E. coli*exceeded WHO threshold values in rivers and streams, with 2/4 (20%) and 8/11 (80%) respectively. Whereas in Pita, Enterococcihadexceededthese standards in 25% of backwaterand 75% of streams, and *E. coli*in 14.28 and 85.71% of rivers and streamsrespectively. *E. coli* (streams: 66.66% and backwater: 33.33%) and *E. coli* (streams: 83.33% and backwater: 16.66%) values exceeded WHO thresholds in Dalaba. Many sites hadbacterialloadsabove WHO thresholds. This wouldbe an important element to saythatthese water sources constitute a real public health issue.

KEYWORDS:bacterialindicators, contamination, bathing water, Mamou.

INTRODUCTION

Throughouthistory, water quality has been an important factor in ensuringhumanwell-being. Today, pollution of the hydrosphereis one of the mostseriousenvironmentalproblems, caused in large part by humanactivities. Microbiological contamination is a form of water pollution caused by the presence of pathogenicmicroorganismssuch as viruses, parasites or bacteria. These can pose a risk to human or animal health [1].

Water, a preciousresource essential to life, has played and continues to play a fundamentalrole in the development of societies. Surface water isused for a variety of purposes. According to [2], they are the source mostthreatened by humanactivities. They are the mostexposed to pollution, as they serve as dumping grounds for various types of waste (domestic, agricultural and pastoral) and as collectors of wastewaterfrombuilt-up areas [3].

Surface waters are the site of abusive discharges of industrial and domestic effluents withoutpriortreatment. These waters are also a place of comfort for people who do not have access to an appropriatedefecation system [4,5].

Over the last few decades, environmental protection has mostly been based on a regulatoryapproach. Today, thanks to a betterunderstanding of receivingenvironments, werealizethat the capacity of theseenvironments to receivedischargesfromvarious sources (industrial, municipal, agricultural) must alsobetakenintoaccount to ensureadequateenvironmental protection. Pollution, whichonly a few decadesagowasconfined to highlyindustrializedregions, isnowbecoming a worldwideproblem, and one thatconcerns us all to a greaterextent [6,7].

In many cases, bathing can presenthealthrisks, linked in particular to the bacteriologicalquality of the water. The main riskisinfectious, linked to the presence of germsthat can cause various pathologies (gastro-enteritis, leptospirosis, dermatitis) [8].

Anthropogenicactivities, the environment and the absence of an effective waste management system have been identified as sources of bacteriological pollution at bathing sites in the CoyahPrefecture [9].

The aim of thisstudyis to assess the correlationbetween the bacteriologicalquality of bathing water and the risk of diseaseoutbreaks.

MATERIALS AND METHODS

METHODOLOGY

STUDY AREA

The Mamou region lies between 9 and 12° north latitude and 11 and 12°53 west longitude. It isbordered by the regions of Labé (to the north), Kindia (to the west), Faranah (to the east) and the Republic of Sierra Leone (to the south).

The Mamou regioncovers an area of 17,074 km². In 2016, the population rose to 781,091 (INS, 2018), withwomenaccounting for 54.56%. It is home to the source of the country's main rivers and those of itssub-region, such as the Konkouré, Bafing, Kokoulo and Kaba.

The Institut de Recherche en Biologie Appliquée de Guinée (IRBAG) islocated to the west, 6 km from Kindia-Ville and 141 km from Conakry. Its mission is to promoteresearch in medicalbiology in fundamental and appliedfields (study of bacterial, viral, parasitic and othergerms).

The studywas prospective and took place from June to December 2022. Bathing water wasused as biologicalmaterial, and 59 samplesweretaken.

Transport

Sampleswereplaced in a speciallypreparedcooler (minus 10°C) to complywith the chain of custodyrequired by the germs to bestudied, thentransported to the laboratorywheretheywereimmediatelyanalyzed or stored in a refrigerator at 4°C prior to furtheranalysis.

Equipment

Petri dishes approx. 49 mm x 9 mm, steriledistilled water, sterilefilter membranes with 0.45 µm pore size and 47 mm diameter, sterile pipettes, autoclave (Pasteur oven), incubator, filtration manifold withfunnels and filterholders, vacuum pump, pH-meterpaper, refrigerator at 2 - 6°C, 250 ml wide-mouthbottles or flaskswithstoppers, disposablesterilegloves, sampling labels, Tryptone-Sulfite-Cycloserine, Mac Conkey Agar, Bile-Esculin-Azide Agar, CollD/PCA, sterile slides, 70% and 95% alcohol, Pasteur pipettes, platinumwires, carboglasses, cooler (sterile), etc. . .

Methods

Membrane filtration and direct platingmethodswereused. Filter 100 ml of eachsample to recoverbacteriafrom a filter. Write the samplenumbers and filtered volumes on the Petri dishes.

After filtration, the funnel (cup) isremoved and the recoveredfilterplaced on top in a Petri dish (selective culture medium) (first option). Pick up the filterusingsterile forceps, place it in a sterile Petri dish and washwithsteriledistilled water using a pipette (second option). Finally, take 0.5 microliterthrough a sterileöse or platinumwire and inoculate in selective culture medium.

Then place the Petri dishes in inverted position in an incubator at 35°C ± 0.5°C or 44◦C for 24 hours ± 2 hours as soon as possible after the filtration maneuver. Inverting the Petri dishesprevents condensation on the membranes.

At the end of incubation, a readingistaken and the results are expressed as the number of germs per 100 ml of filtered water (Intestinal Enterococci and *Escherichia coli*). Thesegerms are counted in comparisonwithcurrentEuropean Union and WHO values, in order to interpret the results and determine the level of bacteriological pollution in the bathing water, and thusassess the healthriskinvolved (ref. tablebelow).

Table 1:Proposed guide values (European Union) and threshold values for bathing water (WHO).

Indicator germs	**Guide values**	**Threshold values not to beexceeded**
Intestinal enterococci	**100 germs/100ml**	**200 germs/ml**
Escherichia coli	**250 germs/100ml**	**500 germs/ml**

RESULTS

Table 2: Distribution of bacteriological pollution indicatorgerms by water source in MAMOU Prefecture

Water sources	**Number of tests**	**Control bacterial germs RSA**	**CT**	**IE**	***E. coli***
Flow	4	4(26.66%)	4(26.66%)	4(26.66%)	3(20.00%)
Streams	14	13(30.23%)	13(30.23%)	11(25.58%)	6(13.95%)
Backwater	1	1(25.00%)	1(25.00%)	1(25.00%)	1(25.00%)
TOTAL	**19**	**18**	**18**	**16**	**10**

Fromthis table, it can beseenthat at the rivers, all 4 sampleswere positive for Sulfite-reducers, Total Coliforms and IE with 26.66% each, and *E. coli* wasfoundin 3/4 of the samples (20%). Streamswere the mostcontaminated, with RSA and TC the mostrepresented, with 13 positive samples (30.23% each), whileIE and *E. coli*werepresentin 11 and 6 samplesrespectively (25.58% and 13.95%).

Table 3: Distribution of bacteriological pollution indicatorgermsaccording to water sources in the Prefecture of PITA

Water sources	**Nomber of tests**	**Control bacterial germs RSA**	**TC**	**IE**	***E. coli***
Rivers	1	1(100%)	0	0	0
Flow	1	2(28.57)	2(28.57)	2(28.57)	1(14.28)
Streams	24	22(32.35%)	24(35.29%)	13(19.11%)	9(13.25%)
Backwater	3	1(12.50%)	3(37.50%)	3(37.50%)	1(12.50%)
TOTAL	**29**	**25**	**28**	**17**	**11**

Analysis of samplesfromrivers, streams and backwatershowed the presence of RSA, TC, IE and *E.coli*, whileriversshowed the presence of RSA with 1 positive sample, i.e. 100%. The study of the single samplefrom the riversshowed the presence of RSA, TC, IE and *E. coli*, i.e. 25% each. On the other hand, the 24 samplestakenfrom the streams all gave positive results for TC (35.29%), 22 were positive for RSA (32.35%) and 13 and 9 samplesrespectivelywere positive for IE and *E. coli*, i.e. (19.11%) and (13.25%).

Table 4: Distribution of bacteriological pollution indicatorgermsaccording to water sources in the Prefecture of DALABA

Watre Sources	**Nomber de of tests**	**Control bacterial germs RSA**	**CT**	**IE**	***E. coli***

Streams	8	8(28.57%)	8(28.57%)	8(28.57%)	4(14.28%)
Backwater	2	1(28.57%)	2(28.57%)	2(28.57%)	1(14.28%)
Dam	1	1(33.33%)	0	1(33.33%)	1(33.33%)
Total	**11**	**11**	**10**	**11**	**6**

This table shows that the TCwerenegative for the dams, while the RSA, IE and *E. coli*were positive with 1/1 samplegiving 33.33% each. SamplestakenfromBackwaterwere positive for RSA, TC and IE, with 2 positive samples (28.57% each) and 1 positive sample (14.28%) for *E. coli.* As for the streams, itisclearthat the control germs are all present, with 8 positive results (28.57%) for RSA, TC and IE and 4 positive results (14.28%) for *E. coli*.

Table 5:Bacterialload of bathing water (intestinal Enterococci and *Escherichia coli*) in the MAMOU Prefecture

Water sources	**Positive samples exceeding WHO threshold values I E**	**%**	***E. coli***	**%**
Flow	2/4	20.00	2/3	33.33
Streams	8/11	80.00	4/6	66.66
Backwater	0/1	0.00	0/1	0.00
Total	**10/16**	**100**	**6/10**	**99.99**

Analysis of the data in this table suggeststhat the backwaterhave not been contaminated by faecalmatter. In some places, samplestakenfromrivers and streamsshowed positive results for enterococci (2/4), i.e. 20.00% and (8/11), i.e. 80.00% respectively, and for *E. coli* (2/3), i.e. 33.33% and (4/6), i.e. 66.66%, with values exceedingthose of the World Health Organisation.

Table 6:Bacterialload in bathing water (intestinal Enterococci and *Escherichia coli*) in the Prefecture of PITA

Water sources	**Positive samples exceeding WHO threshold values IE**	**%**	***E. coli***	**%**
Flow	0/1	0.00	1/1	14.28
Streams	6/13	75.00	6/9	85.71
Backwater	2/3	25.00	0/1	0.00
Total	**8/17**	**100**	**7/11**	**99.99**

Table 6 reports thatonlysamplestakenfromriverswere positive for enterococci, but thesesamplesdid not give values higherthan the WHO threshold values compared to *E. coli*, for which the thresholdswereexceeded (14.28%). However, of the 13 samplesfrom the streamswhereIE wereencountered, 6 gave values above the WHO standards (75.00%) while 6/9 (85.71%) wereabove the values for *E. coli*. Backwaters, 2/3 (25.00%) with positive samples for enterococcishowed values above the healthassessment standards proposed by the WHO (2011) and these standards were not exceeded in the samplewhere*E. coli*wasencountered (0/1).

Table 7:Bacterialloads of bathing water (intestinal enterococci and *Escherichia coli*) of the Prefecture of DALABA

Water sources	**Positive samplesthatexceeded WHO threshold values**			
	E I	**%**	***E. coli***	**%**
Streams	**5/8**	**83.33**	**2/4**	**66.66**
Backwater	**1/2**	**16.66**	**1/1**	**33.33**
Dams	**0/1**	**0.00**	**0/1**	**0.00**
Total	**6/11**	**99.99**	**3/6**	**99.99**

Table 7 shows that the enterococci values thatwereobtainedfromstreams and backwaters are higherthan the WHO standards with 5/8 (83.33%) and 1/2 (16.66%). In the same sources, *E. coli*also gave values above the threshold values proposed by the sameorganization.

DISCUSSION

During the study, bacterialgermsincluding: ASR, CT, EI, and *E. coli*wereencountered.

In Mamou, all the sources fromwhichsamplesweretaken and whereenterococci and *E. coli* wereencountered, the values foundwerelargelyhigherthan the standard values (threshold values accepted by the WHO).

Our data were close to thoseobtained by [10] Ivoire in 2015, whichindicatedthat collectors hadbacterialloadswellabove the threshold of 103 CFU/100 ml set by the guide developed by the world body in charge of the health system in 2006. The sameauthorhadindicatedthatfaecalcoliformswere the mostpresent. The averagefecalcoliform (CF) loads of the different sites studiedvariedfrom 2.5x105 microorganisms/ml collected at Cocody to 2.5x106 coliforms/ml on the Ebrié lagoonside. Fecalstreptococciwerefound but withlower concentrations thanthose of fecalcoliforms. Resultsthatdifferfromthoseobtainedduring the currentsurvey.

The high concentrations of faecalstreptococciobservedfromsamplestaken in Cameroon by [11] wereprobably the respective consequences of the discharge of water from the sewers of the University of Ngaoundere, the regional capital of Adamawa located on the shores of Lake Dang (E3), the excrement of raisedpigs (Mardock river) and the wastefrom the municipal slaughterhouse of the city (E9), sewagedischargesfrom the central prison (E12) and the regionalhospital (E13) and finally thecollected water from the city centre (E15). The presence of fecalstreptococciwith high concentrations in places brought the results of [11] closer to those of the presentsurvey.

The high density of *E. coli*, a more specificindicatorbacterium of faecal pollution [12] in the water sampleexamined, clearlyindicated contamination by faecalmaterial and the epidemiologicalriskposed by theirdischargewithouttreatment [13]. Certainly, the presence of theseenterobacteriaceae, although non-pathogenic in theirvastmajority, shouldseriously suspect that of severalotherpathogenicmicroorganisms [14,15] such as *salmonella* (typhoidfever) and *Vibrio cholerae* (cholera) [10]. Resultssimilar to those of the presentstudy.

The bacteriologicalanalysis of the water sources studied gave loadshigherthan the WHO standard (intestinal enterococci: 200 germs/100ml and *E. coli*: 500 germs/100ml) in theirmajority. The data obtained in Benin fromresearchconducted by [15] are similar to ourresults.

Analyses of the sampletakenfrom the part frequented by washermen on the Banco River confirmed the presence of the germstargeted by the study. The loadings of *E. coli* (1322 CFU/100ml) and enterococci (2067 CFU/100ml) determined in this portion wereabove the tolerablethresholds set. The high averageloads of indicators for *Escherichia coli*, faecalstreptococci and sulphito-reducinganaerobes, in particular, indicatedthat the Banco River (in Côte d'Ivoire) issubject to faecal pollution [16].

The existence of garbage dumps alongwatercourses (biomedical, household and otherwaste), the practice of agriculture (gardening), the practice of livestockfarming (extensive and intensive), the connection of toiletevacuationcanals and watercourses (installation of toiletsalongwatercourses), open defecationalongwatercourses, the practice of laundry, the discharge of wastewaterwithoutanypriortreatment process and runoff (the environment) couldbe sources of contamination of bathing waters in the Mamou region.

The origin of the pollution can benatural or anthropogenicaccording to [17] reported by [18]. Agriculture, whichapplies in a diffuseway, industries that are the source of very diverse and oftenlocalizeddischarges, and domesticactivities or landfillswere the sources of anthropogenic pollution [17, 18, 19]. The major factors of contamination of domestic water studied by Hounsounou Espérance O. et al. in 2016 are close to thoseidentifiedduring the study of Mamou'sbathing waters.

CONCLUSION

The bacteriologicalindicators of pollution usedwere all encountered in the bathing waters of Mamou. Of the water sources in whichenterococci and *E. coli* have been encountered, the majority have yieldedbacterialloadsabove the threshold values proposed by the WHO. Enterococci and *E. coli*remain the best indicators of old and recentfaecal contamination, respectively.

The presence of indicatorgerms, althoughmostly non-pathogenic, certifies that of pathogenicmicroorganisms. Classicalbacteriologicalmethodswereused.

The resultsshowedthatanthropogenicactivities, the environment and the lack of an effective waste management system wouldplay a role in the bacteriological contamination of bathing waters in the Mamou Region. It is for thisreasonthatitwouldbe important to integratethis issue as a public healthpriority.

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