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Microbial safety of community water sources in Mbouo-Bandjoun, Cameroon: a preliminary assessment

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Abstract

Access to safe drinking water remains a critical challenge in sub-Saharan Africa. This pilot study conducted a preliminary assessment of the microbiological quality of drinking water sources in Magom, Mbieng, and Yom (Mbouo-Bandjoun, Cameroon). A cross-sectional design was employed in which 50 water samples (44 boreholes and 6 wells) were analyzed for physicochemical and microbiological quality. Microbiological assessment included total viable count (TVC), coliform quantification, and culture-based identification. The findings revealed widespread bacteriological contamination: 92.0% of the samples exhibited high total viable counts (TVC ≥106 colony-forming units [CFU]/mL) and 88.0% were contaminated with coliforms. Biochemical profiling indicated the presumed presence of Escherichia coli in 84% of sources, confirming extensive fecal contamination. While physicochemical parameters were largely within acceptable limits, statistical analysis identified significant risk factors: proximity to latrine pits (<20 m) and acidic/neutral pH for the total coliform presence, and proximity to agricultural plantations for high TVC. Despite the predominance of modern protected boreholes, drinking water sources in Mbouo-Bandjoun are heavily contaminated, posing a serious risk to public health. Urgent interventions, including enforcing protective distances for latrines and improving community sanitation, are needed.

Introduction

The availability of safe and easily accessible water is fundamental for public health, as it supports essential activities such as drinking, domestic chores, food production, and recreational use. In addition to being a basic human right, access to clean drinking water, sanitary facilities, and good hygiene is crucial for the prevention of infectious diseases. [1] Access to clean drinking water is still a serious problem in Sub-Saharan Africa, where coverage is the lowest in the world, and access is disproportionately poor in rural regions. [2, 3] Furthermore, due to a lack of access to clean water, sanitary conditions, and proper hygiene, the pollution of water sources, especially from human and animal waste, continues to be a major cause of diarrheal illnesses and mortality among children under five in this area. [4, 5]

In Cameroon, despite the recent transformative power of community action to improve access to safe drinking water, a real problem persists with lower coverage in rural areas. [6, 7] The Bandjoun municipality, located in the Western region of Cameroon, has various water resources used by residents for consumption and daily household tasks. These include modern boreholes, refurbished wells, and surface water. Although it is often thought that the presence of these improved water sources ensures a certain level of health safety, their actual microbiological quality can be greatly influenced by local conditions. [8] Indeed, they are exposed to contamination from local sanitation

systems, agricultural runoff, and poor infrastructure integrity. These pollutants can cause serious diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid fever, and polio. [1, 8]

To gain initial insights and guide future research, this pilot study was conducted to provide a preliminary assessment of the microbiological quality of drinking water sources in the locality of Mbouo-Bandjoun and to identify potential environmental and infrastructural risk factors associated with their contamination.

Materials and Methods

Description of the study site

For this pilot study, water samples were collected from various drinking water sources in Mbouo-Bandjoun, West Cameroon. The Bandjoun municipality has a tropical highland climate, with a mean annual temperature of 26°C and an average altitude of 1,440 m above sea level. The area is drained by a dense network of streams and rivers, which are critical local water sources. Geologically, the soils are predominantly ferrallitic, displaying red to reddish-brown coloration. They are largely clayey, formed from the decomposition of crystalline rocks such as granite and gneiss. More critically for this study, the clay-rich, porous nature of these soils suggests a high potential for groundwater and surface water contamination from surface pollutants, as infiltration and runoff may not be effectively filtered. [9]

Study design and sample

A cross-sectional study was conducted between January and March 2024 in three neighborhoods in the town of Mbouo-Bandjoun: Mbieng, Magom, and Yom. A total of 50 water points were identified in this locality and included in this study. Two waves of samples (one in January and one in March) were collected aseptically from these active drinking water points used by the population, including 44 boreholes and 6 dug wells. The size of this sample was deemed sufficient for a preliminary investigation to identify the main trends and hotspots of contamination.

Data collection

For each sampling point, the geographical coordinates were recorded using a GPS device. A structured questionnaire was used to collect data on the type of water source, the type of development (modern or traditional), the presence of and distance to the nearest latrines, other plausible sources of contamination (plantations, factories), and the location in the terrain (hill, plateau, lowland). Physicochemical parameters, including pH, temperature, turbidity, and water colour, were measured on site where possible.

Microbiological analysis

Water samples were transported in coolers to the laboratory and analysed within 6 to 8 hours. Total viable count (TVC) and coliforms were determined using the microbiological analysis method for water analysis, a culture-based colorimetric system used to detect and quantify microorganisms expressed in colony-forming units per milliliter (CFU/mL) in accordance with the manufacturer's recommendations. [10] The presence of E. coli was identified by culture on selective media, including MacConkey agar, followed by a series of biochemical tests (catalase, oxidase, Kligler-Haijna test, and Kovacs' indole test) for definitive identification. At the same time, a Gram stain was performed to confirm the bacterial morphology under the 100x oil immersion objective microscope.

Data analysis

The data were entered into Microsoft Excel and analysed using SPSS. 22 Statistics. Descriptive statistics (frequencies, percentages) were used to summarise the data. A univariate analysis was used to assess the link between each environmental factor and contamination status using Fisher's exact test. [11] The association was assessed using the relative risk (RR) and its 95% confidence interval (95% CI).

Results

Sampling site characteristics and physicochemical parameters

The analysis of the 50 sampled water points in Mbouo-Bandjoun reveals a substantial disparity between infrastructure quality and contamination risk. Most of the water infrastructure comprises modern, protected boreholes (88.0%), primarily located in hilly or plateau

areas. These sites generally exhibit favorable physicochemical characteristics, with near-neutral pH levels (84.0% ranging between 6.1 and 7.9), low turbidity (88.0%), and cool temperatures (88.0% below 25°C). However, these positive features are critically undermined by widespread sanitary risks: 92.0% of all water points are located near pit latrines, and most (60.0%) lie within 30 m, a distance considered highly susceptible to contamination. This proximity creates a serious threat of fecal contamination, indicating that the advantages of improved infrastructure are being undermined by poor source protection. Table 1 summarizes the structural and physicochemical features of the 50 sampled water points.

Microbiological quality of water sources

The microbiological assessment, summarized in Table 2, revealed widespread bacterial contamination across the sampled water sources. All samples (100.0%, n=50) exhibited bacterial growth on nutrient agar, and 92.0% (n=46) showed a high TVC, reaching up to 106CFU/mL. Furthermore, 88.0% (n=44) of the samples were positive for coliforms, with 72.0% (n=36) presenting high loads (≥106 CFU/mL). The biochemical characteristics: glucose and lactose fermentation, gas production, negative oxidase reaction, and positive indole test indicate a predominance of predictive E. coli, confirming recent and widespread fecal contamination.

Risk factors association and water points contamination

Univariate analysis of factors associated with the presence of coliforms from this study (Table 3) identified pH and distance from latrines as the only statistically significant risk factors. Water with an acidic to neutral pH (≤7.8) had a twofold higher risk of contamination than alkaline water (RR=2.00, 95% CI: 1.2-3.94, p=0.001), showing systematic contamination (100.0% vs. 50.0%). Similarly, water points located less than 20 m from latrines had a 13.0% increased risk of contamination (RR=1.13; 95% CI: 1.01-1.28; p=0.021), reaching 100.0% contamination compared to 88.2% at greater distances. No significant associations were found with the type of structure, development mode, location, or turbidity. However, non-significant trends were observed for temperature deviations from the optimal range, the presence of nearby plantations, and topography, with hills having areas showing the highest prevalence (92.9%). Overall, the bacteriological quality of water points appears to be primarily influenced by intrinsic factors such as pH and proximity to fecal contamination sources, which outweigh the effects of the structural or geographical characteristics.

Analysis of the determinants linked to total bacterial contamination (Table 4) identified acidic to neutral pH as a significant factor for high bacterial loads (RR=1.27; p=0.028). Unexpectedly, topography emerged as the most significant factor, with hillside and plateau sites presenting 2.5 to 3 times higher risks than lowlands. Proximity to plantations also significantly increased the risk (RR=1.25; p=0.018). No significant associations were observed with the structural characteristics of the structures or physical parameters, confirming that environmental rather than technical factors mainly influence contamination.

Discussion

This pilot study reveals a serious and persistent public health problem in the municipality of Mbouo-Bandjoun, in the West Region of Cameroon. The stark disparity we observed between modern water infrastructure and actual microbiological safety occurs against a sobering backdrop. A study conducted in 2018 in a major urban center near the Mbouo-Bandjoun locality found widespread bacterial contamination in domestic water sources. The study reported that 91.0% of samples were contaminated with coliforms, half of which had high concentrations exceeding 10 3 CFU/mL. [12] Our findings not only confirm this alarming prevalence of contamination but also reveal that the problem persists despite the context of significant infrastructure investment.

Our findings not only confirm this alarming prevalence of contamination but also reveal that the problem persists despite the context of significant infrastructure investment.

In our area, the water infrastructure is predominantly modern and protected, with 92.0% of sources classified as such and 88.0% being boreholes, suggesting considerable effort to improve water access. Furthermore, the physicochemical quality was largely favorable, with most samples exhibiting near-neutral pH (6.1-7.9), low turbidity, and cool temperatures (<25°C), characteristics generally desirable for drinking water. [13, 14]

However, this positive facade is severely undermined by an overwhelming sanitary risk. A striking 92.0% of all water points are in proximity to pit latrines, with the majority situated at a critically high-risk distance of less than 30 m. [15] This widespread and proximity creates a direct and pervasive pathway for fecal contaminants to infiltrate groundwater, a risk that is exacerbated by the clay-rich, porous soils of the region, which may facilitate subsurface flow. [16]

The direct consequence of this widespread fecal pathway is unequivocally demonstrated in the disturbing microbiological profile. Our findings revealed that bacterial growth was not only ubiquitous but severe; most sources (92.0%) were heavily contaminated (106 CFU/mL), and 84.0% showed direct evidence of fecal pollution via presumptive E. coli.

The risk factor analysis confirmed that bacteriological contamination was primarily driven by environmental and physicochemical conditions, while the structural type of the water point offered no significant protective effect. This underscores a critical limitation of infrastructure-focused interventions. Specifically, the analysis identified proximity to latrine pits, a well-documented source of fecal pathogen contamination [13] and acidic or neutral water levels, which can enhance bacterial survival compared to more alkaline conditions, [17 18 19] as significant risk factors.

Furthermore, topography and land use were critical determinants, elevated areas like hill potential due to the lower water table depth and contaminant concentration, [20, 21] and sites adjacent to agricultural or industrial activities, which are known as water pollution sources, [22] were shown to contribute to the higher risk of severe bacterial loads. Crucially, the type and design of a water point showed no significant protective effect, indicating that engineered solutions are compromised without concurrent management of the surrounding environment.

Limitations

The limitations of this study are primarily due to the size of the sample, as it is only a pilot study, which, while adequate for identifying trends, may restrict the statistical power of more nuanced correlations. The cross-sectional design of this study provides an overview during the dry season and does not account for seasonal fluctuations in the level and quality of the phreatic nappe. Furthermore, the emphasis on quality at the source indicates that the potential degradation of water quality during storage and handling in households has not been assessed.

Conclusions

This preliminary study reveals the levels of fecal contamination in the drinking water reserves of Mbouo-Bandjoun; 84.0% of the samples analyzed showed the presumed presence of E. coli. Despite the prevalence of modern infrastructure, our initial findings strongly suggest that proximity to pit latrines is a significant risk factor, compromising groundwater quality. As an initial investigation, this study highlights an urgent public health threat and identifies key risk factors that require immediate attention. The results provide the evidence needed to support and guide a more comprehensive and detailed investigation. Ultimately, protecting the health of this community will require integrated strategies that address both water access and sanitation, going beyond infrastructure development to active resource protection.

Table 1. Site sampling characteristics and physicochemical parameters.

Parameters	Category/characteristic	Frequency (N=50)	Percentage (%)
Locality	Yom	22	44
	Magom	14	28
	Mbieng	14	28
Water point category	Boreholes	44	88
	Hand-dug wells	6	12
Design and construction	Modern (protected)	46	92
	Traditional (unprotected)	4	8
Proximity to pit latrines	Yes	46	92
	No	4	8
Distance between pit latrine and water point (meter)	<30	30	60
	30-50	10	20
	>50	10	20
Topographic setting	Lowland	6	12
	Hill	28	56
	Plateau	16	32
pH range	6.1-6.9	20	40
	7.0-7.9	22	44
	8.0-8.9	6	12
	9.0-9.9	2	4
Temperature (C)	<25	44	88
	≥25	6	12
Turbidity	Present	6	12
	Absent	44	88

Table 2. Microbiological and biochemical test results.

Parameters	Characteristics	Frequency (N=50)	Percentage (%)
Nutrien agar	Negative	0	0
	Positive	50	100
TVC	Negative	4	8
	Positive	46	92
TVC contamination load (CFU/mL)	<10	4	8
	10	46	92
Coliform	Negative	6	12
	Positive	44	88
Coliform contamination load (CFU/mL)	<10	10	20
	10	4	8
	10	36	72
Gram stain	Gram-negative rods	50	100
	Gram-positive rods	0	0
Colony morphology on MacConkey agar	Yellow on the plate	8	16
	Red/pink on plate	42	84
Glucose fermenter	Negative	8	16
	Positive	42	84
Lactose fermenter	Negative	8	16
	Positive	42	84
Gas production	Negative	8	16
	Positive	42	84
Hydrogen sulfide production	Negative	50	100
	Positive	0	0
Catalase test	Negative	8	16
	Positive	42	84
Oxidase test	Negative	8	100
	Positive	42	0
Indole test	Negative	8	16
	Positive	42	84

TVC, total viable count; CFU, colony-forming unit.

Table 3. Risk factors associated with coliform contamination in water sources.

Factors	Categories	N	Positive (n)	Positive (%)	RR [95% CI]	p-value
pH	Basic (8.1-9.1) (Ref)	8	4	50	1.0	0.001*
	Acidic/neutral (6.1-7.8)	42	42	100	2.00 [1.2-3.94]	
Distance to latrine pit	≥20 m (Ref)	34	30	88.2	1.0	0.021*
	<20 m	16	16	100	1.13 [1.01-1.28]	
Water temperature (°C)	21.1-22.9 (Ref)	18	14	77.8	1.0	0.061
	23.0-24.4	18	18	100	1.29 [1.00-1.65]	
	24.4-27.7	14	10	71.4	0.92 [0.61-1.39]	
Water structure point	Borehole (Ref)	44	36	81.8	1.0	0.572
	Wells	6	6	100	1.22 [0.98-1.53]	
Structure design	Modern (Ref)	46	38	82.6	1.0	1.000
	Traditional	4	4	100	1.21 [0.83-1.76]	
Locality	Magom	14	12	85.7	-	0.933
	Mbieng	14	12	85.7	-	
	Yom	22	18	81.8	-	
Turbidity	Absent (Ref)	44	36	81.8	1.0	0.572
	Present	6	6	100	1.22 [0.98-1.53]	
Topography	Lowland	6	4	66.7	-	0.139
	Hill	28	26	92.9	-	
	Plateau	16	12	75	-	
Contamination source	None (Ref)	20	14	70	1.0	0.085
	Plantation	28	26	92.9	1.33 [0.96-1.83]	
	Factory	2	2	100	1.43 [0.89-2.29]	

*RR, relative risk; *statistically significant; Ref, reference category; CI, confidence interval.*

Table 4. Risk factors associated with total viable count contamination in water sources.

Factors	Category	N	Positive (n)	Positive (%)	RR [95% CI]	p-value
pH	Acidic/Neutral (6.1-7.8)	42	40	95.2	1.27 [0.86-1.87]	0.028*
	Basic (8.1-9.1) (Ref)	8	6	75	1.0	
Contamination source	Plantation and factory	30	30	100	1.25 [1.04-1.50]	0.018*
	None (Ref)	20	16	80	1.0	
Topography	Hill	28	24	85.7	2.57 [1.08-6.14]	0.036*
	Plateau	16	16	100	3.00 [1.20-7.50]	
	Lowland (Ref)	6	2	33.3	1.0	
Water structure point	Wells	6	6	100	1.10 [0.94-1.29]	1.000
	Borehole (Ref)	44	40	90.9	1.0	
Structure design	Traditional	4	4	100	1.10 [0.89-1.35]	1.000
	Modern (Ref)	46	42	91.3	1.0	
Distance to latrine pit	<20 m	16	12	75	1.06 [0.72-1.57]	0.744
	≥20 m (Ref)	34	24	70.6	1.0	
Water temperature (°C)	21.1-22.9 (Ref)	18	16	88.9	1.0	0.355
	23.0-24.4	16	16	100	1.125 [0.893-1.416]	
	24.5-27.7	16	14	87.5	0.984 [0.732-1.322]	
Turbidity	Present	6	6	100	1.10 [0.94-1.29]	1.000
	Absent (Ref)	44	40	90.9	1.0	
Locality	Magom	14	12	85.7	1.05 [0.78-1.41]	0.933
	Mbieng	14	12	85.7	1.05 [0.78-1.41]	
	Yom (Ref)	22	18	81.8	1.0	

*RR, relative risk; CI, confidence interval; *statistically significant; Ref, reference category.*

Author Contributions

Contributions: ALDW, RNB, VC, GC, conception and design of the study; ALDW, RNB, ITK, AMNS, MEDT, MD, data collection and laboratory analysis; ALDW, RNB, drafting the original manuscript; ALDW, RNB, ITK, DLKT, VC, GC, writing, review, and editing. All authors have read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Ethics Statement

Not applicable.

Data Availability

All data generated or analyzed during this study are included in this published article.

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References

1. Drinking-water World Health Organization. .
2. Forum World Economic. Sub-saharan africa’s low water accessibility hits education.|.
3. Galan S. Access to clean drinking water worldwide by region 2024. STATISTA. 2025.
4. Momberg DJ, Ngandu BC, Voth-Gaeddert LE, Cardoso Ribeiro K, May J, Norris SA, et al. Water, sanitation and hygiene (wash) in sub-saharan africa and associations with undernutrition, and governance in children under five years of age: a systematic review. J DEV ORIG HEALTH DIS. 2021;12:6-33.
5. Belay DG, Asratie MH, Aragaw FM, Tsega NT, Endalew M, Gashaw M. Open defecation practice and its determinants among households in sub-saharan africa: pooled prevalence and multilevel analysis of 33 sub-saharan africa countries demographic and health survey. TROP MED HEALTH. 2022;50(28).
6. Nkum CB, Fopa MS, Beyala L, Tchio-Nighie KH, Guenou E, Nanfak A, et al. Mapping water sources and access to drinking water in the lake chad region of cameroon: a cross-sectional study. PAN AFR MED J. 2023;46(98).
7. Organization World Health. The transformative power of community action: improving access to safe drinking water in douala.
8. Adogaye SBB, Rodrigue MB, Martial NPP, Wondeu ALD, Martin SS, Kemogne JB, et al. Assessment of domestic water sources safety: application of the microbiological survey method and microbiological profile of the contaminating bacteria. J WATER RESOUR PROT. 2021;13(5):350-61.
9. Compétences Promouvoir. Villes/villages: bandjoun (régions: ouest / départements : koung khi) – cameroun.
10. The micro biological survey (mbs) method. MBS-HACCP&WATER EASY TEST. 2025.
11. Kim HY. Statistical notes for clinical researchers: chi-squared test and fisher’s exact test. RESTOR DENT ENDOD. 2017;42(2).
12. Mabvouna RB, Adogaye SBB, Nkamedjie PMP, Wondeu ALD, Sobze MS, Kemogne JB, et al. Microbiological quality and genotoxicity of domestic water sources: a combined approach using microbiological survey method and mutagenesis assay (micronucleus test. IN ROOT TIPS OF VICIA FABA IN THE WEST REGION OF CAMEROON. PLOS ONE. 2021;16:0245379. doi:10.1371/journal.pone
13. Organization World Health. Guidelines for drinking-water quality: fourth edition incorporating the first and second addenda.
14. Organization World Health. Guidelines for drinking-water quality: small water supplies - executive summary.
15. Nenninger C, Cunningham J, Mihelcic. A historical and critical review of latrine-siting guidelines. JOURNAL OF WATER, SANITATION AND HYGIENE FOR DEVELOPMENT. 2023;13(10):833–46.
16. Ravenscroft P, Mahmud ZH, Islam MS, Hossain AKMZ, Zahid A, Saha GC, et al. The public health significance of latrines discharging to groundwater used for drinking. WATER RES. 2017;124:192-201.
17. Institute Agriculture. The impact of ph on microbial growth in food. FOOD MICROBIOLOGY. 2023.
18. Mougi A. Ph adaptation stabilizes bacterial communities. NPJ BIODIVERSITY. 2024;3(1):1-7.
19. Wahyuni EA. The influence of ph characteristics on the occurance of coliform bacteria in madura strait. PROCEDIA ENVIRON SCI. 2015;23:130-5.
20. Wei Y, Li Y, Zhang L, Liu C, Meng Q, Yin J, et al. A study on the hydrochemical evolution property and pollution source attribution of groundwater in highly urbanized areas: a case study of shenzhen city. WATER. 2025;17(20).
21. Lei C, Wagner PD, Fohrer N. Effects of land cover, topography, and soil on stream water quality at multiple spatial and seasonal scales in a german lowland catchment. ECOL INDIC. 2021;120(106940).
22. Sial JK, Mahmood S, Kılıç Z, Saeed MM, Iqbal M, Rehman HA. Water pollution from agriculture and industry. INT. J. CURR. ENG. TECHNOL. 2022.