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Evaluation of Bacteriological Parameters of Borehole Water, Wells, Taps, and the Milo River in the Urban Municipality of Kankan

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Abstract

The objective of this study is to determine the bacteriological parameters using the Petrifilm method for different water sources used in the urban municipality of Kankan. Sampling was carried out in July 2024 at nine sites according to the rate of exploitation by the local population. This study shows that the levels of pathogenic microorganisms such as fecal coliforms, total coliforms and *E. coli* in ordinary well water and the Milo River are well above the levels recommended by the WHO. The UJNK and CMIS boreholes show no pathology, while the Regional Hospital borehole revealed only the presence of *E. coli*. Overall, water samples from wells, taps, and boreholes at the various sampling sites are polluted according to WHO standards, with varying levels of pollution. This can be explained by the proximity of some sites to toilets but also by the fact that others are located in markets. The fountains installed in the Senkefara neighborhood showed no presence of CF and CT, but a number of *E. coli* greater than 100 populations/100mL. All of these results show that consuming this water without proper treatment exposes the population to serious health risks.

Keywords

Urban Commune, Bacteriological Parameters, Ordinary Wells, Boreholes, Taps, Milo River

1. Introduction

Water is an essential resource for human life and health. However, in many regions, particularly rural and peri-urban areas, access to high-quality water remains a major challenge (Baudart & Paniel, 2014). Water sources such as wells, boreholes, taps, and rivers are often exposed to various forms of contamination, particularly of microbiological origin. This contamination, generally linked to infiltration of wastewater, runoff, surface water or poor agricultural and sanitation practices can lead to the presence of pathogenic microorganisms such as Escherichia coli, fecal coliforms, fecal streptococci, and enterococci (Lawani et al., 2017).

According to the WHO, drinking water must meet microbiological, physicochemical and organoleptic requirements, also known as aesthetic requirements (Kpaibe et al., 2025). Assessing the parameters of these different water sources is essential for determining their potability and preventing the risk of waterborne diseases such as diarrhea, cholera, and typhoid. International standards, particularly those of the World Health Organization (WHO), recommend that water intended for human consumption be completely free of fecal bacteria. However, in many areas, these standards are far from being met, exposing populations to serious health risks. Knowledge of water quality is essential for establishing a management system that will help guarantee water supply in the future (Ghazali & Zaid, 2013).

In 2022, at least 1.7 billion people worldwide used a water source contaminated with fecal matter. Microbial contamination of drinking water due to fecal matter poses the greatest risk to drinking water safety (Géraldine, 2024). In developing countries, two million children under the age of five die each year from waterborne diseases, making access to safe drinking water in households a determining factor in child health (Vissin et al., 2016; Zoungrana, 2021). Microbiological contamination of drinking water can cause the transmission of diseases such as diarrhea, cholera, dysentery, typhoid fever, and polio, resulting in 505,000 deaths each year (Rath, 2021).

In this context, this study aims to analyze the bacteriological quality of water from wells, boreholes, taps, and rivers used by the populations of the urban commune of Kankan. This is the first systematic multi-source survey conducted in the municipality of Kankan. It is part of an approach to prevent water-related risks and improve water resource management, particularly in terms of drinking water supply.

2. Materials and Methods

2.1. Presentation of the Study Area

The urban commune of Kankan "Nabaya" is located between 10˚23'05" north latitude and 9˚18'25" west longitude (**Figure 1**). It is bordered to the east by the rural commune of Balandou; to the west by the rural commune of Gbérédou Baranama; to the north by the rural commune of Karifamoriah, and to the south by the rural commune of Tinti Oulén (Mandjale, 1985). In terms of surface area, it is the second largest city in the Republic of Guinea after the capital Conakry and the largest in the region (Cissé, 2024). Located in the Upper Guinea Region, it is the capital of the Kankan prefecture and covers an area of 334 km^2 with 504,325 inhabitants and 44 inhabitants per km^2. Its geographical position gives it the reputation of being a crossroads city in the sub-region (Konate & Tiranké, 2024).

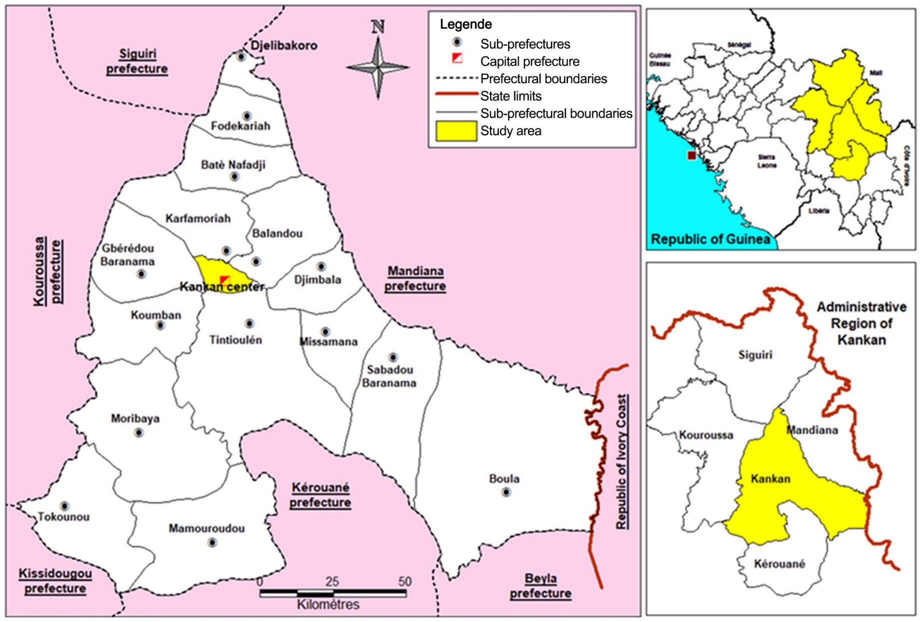

Figure 1. Presentation of the area (Keita et al., 2025).

The city is crossed by the Milo River and watered by other tributaries such as Séngnè Dèbèkoro, Manfénda, Kokoudouni and Gboutouroun. The urban commune of Kankan is characterized by a morphology mainly influenced by the Milo River (tributary of the Niger) with significant population growth on both banks. The landscape is marked by plains and plateaus, with valleys and inland depressions (Ba, 2018). The climate is sub-Sudanese and is characterized by two alternating seasons: a dry season from November to April with very high and constant temperatures (averaging 30˚C) and a rainy season from May to October with rainfall varying between 1100 and 1800 m^3 of water per year (Konate & Tiranké, 2024).

Water samples were collected from nine sites (**Figure 2**), taking into account the urban area, the representativeness of pollution sources, operational feasibility and use by local populations. The geographical coordinates of these different sampling sites are shown in **Table 1** below (Keita et al., 2025).

2.2. Study Framework

The Kankan hydraulic laboratory, located in the energy district of the city of Kankan, served as the setting for these bacteriological analyses. This nationally accredited laboratory (REF N006/11/LARQEKK/DNH) provides reliable and compliant results for the analyses carried out within it.

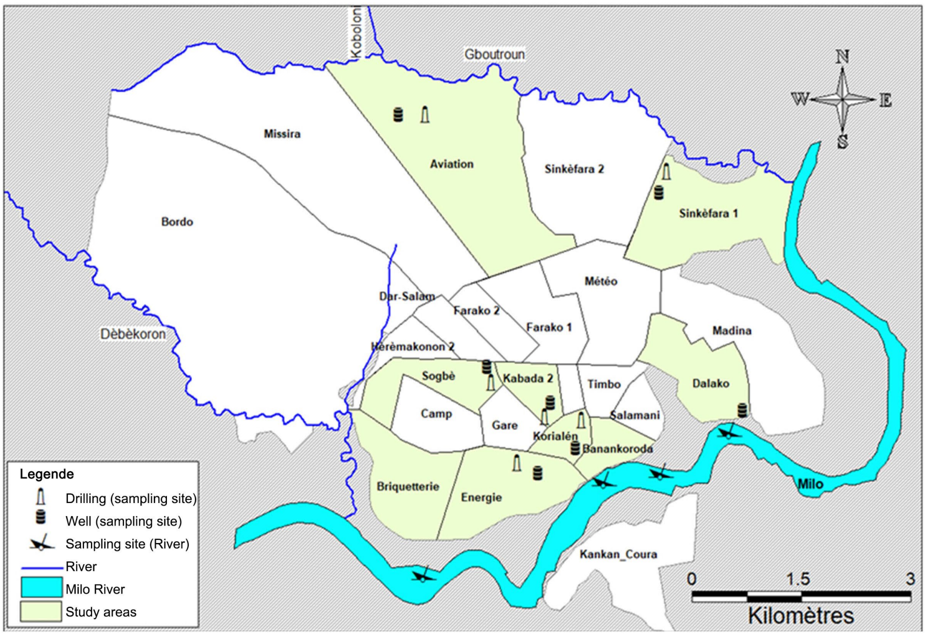

Figure 2. Geographic coordinates of the different sampling sites (Keita et al., 2025).

Table 1. Geographic coordinates of the different sampling sites.

N°	Sites	Type	Latitude	Longitude	Height
1	Mobile intervention and security company	Boreholes	10.409517	−9.315310	417 m
		Wells	10.409517	−9.315310	417 m
2	Sogbè market	Boreholes	10.409687	−9.315310	450 m
		Wells	10.409687	−9.315310	
3	Milo river under the bridge	Milo water	10.367640	−9.296900	
4	University Julius Nyerere of Kankan	Boreholes	10.375112	−9.302122	410 m
		Wells	10.367640	−9.296900	415 m
5	Senkefara	Boreholes	10.403110	−9.288307	401 m
		Wells	10.402395	−9.287368	
6	Slaughter Milo	Boreholes	10.374848	−9.278883	407 m
		Wells	10.376617	−9.275593	404 m
7	Dibida	Boreholes	10.374272	−9.294493	400 m
		Wells	10.374272	−9.294493	400 m
8	Prefectoral Hospital of Kankan	Boreholes	10.368855	−9.304845	421 m
		Wells	10.368952	−9.300985	422 m

2.3. Methods

Samples were taken during the rainy season because pollution is very pronounced during this period due to runoff. Two water samples were taken at each site, with care taken to avoid any alteration or contamination of the samples (Keita et al., 2025). Sampling was carried out in two stages: while it was raining and when the rains became less frequent. Sterile 0.5 L bottles were used to transport the samples to the laboratory, where they were stored at 4˚C until bacteriological analysis. The analysis was carried out within a maximum of 12 hours after sample collection.

Bacteriological analysis is based on the detection of bacteria or test organisms. A total of 108 analyses were carried out, including 36 for total coliforms (TC), 36 for fecal coliforms (FC), and 36 for Escherichia coli (*E. coli*). For this analysis, the Petrifilm method was used to identify and determine the number of bacteria in the various samples taken. The petrifilm used is manufactured in the United States from American materials and imported by 3M. Microbiology petrifilm and 3M are registered trademarks. This method is a quick and easy technique for counting bacteria in food and environmental samples: it is the membrane filtration method. It uses ready-to-use plates that contain all the necessary nutrients and indicators, thus simplifying the process compared to traditional agar methods (Piton & Rongvaux-Gaïda, 1990). The analysis requires equipment such as a syringe for collecting samples, a Petri dish to contain the sample to be analyzed, and an incubator where the analysis is carried out (**Figure 3**). The sample is inoculated onto the plate and then incubated at the appropriate temperature. The bacteria determined include Total Coliforms (TC); Fecal Coliforms (FC) and Escherichia coli at incubation temperatures of 37˚C, 44˚C, and 35˚C, respectively, and incubation times of 24 ± 2 hours. The incubation ranges depend on the resistance of each bacterium, i.e. the temperatures of the environment in which these bacteria can exist. The incubation limit of the plate is 0˚C to 100˚C.

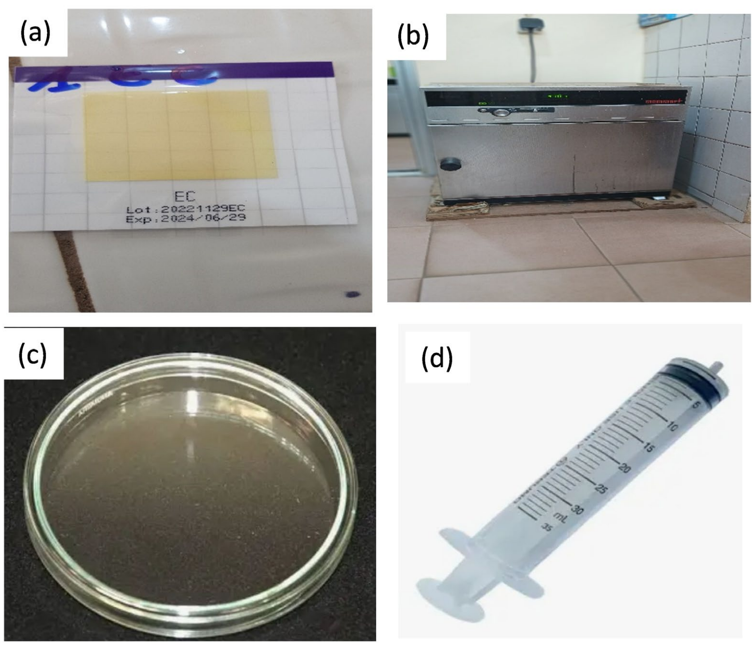

Figure 3. Devices used: (a) Plate, (b) Incubator, (c) Petri dish, (d) Syringe.

3. Results and Discussions

3.1. Ordinary Well Water

The results in Table 2 and Figure 4 show that all the samples of these sites are polluted by the bacterium C.F, C.T. *E. coli*. The contamination is very high in these areas and the health risk is very pronounced. This high level of pollution may be due to various types of waste discarded by traders in these areas and probably by fecal matter, which presents a high risk of waterborne diseases such as cholera, dysentery, and typhoid (Minier, 2023). Although, the CF and CT values in the water samples from the Sogbè and Sénkéfara wells are low, the water still does not comply with the WHO standard, which specifies zero bacteria per 100mL of water sample.

Table 2. Bacteriological parameters of ordinary well water.

N°	Sites	Parameters		
		C.F. Pop/100 mL	C.T. Pop/100 mL	*E. Colis* Pop/100 mL
1	Well Kabada	19	30	100
2	Well Energy	22	12	100
3	Well CMIS	44	10	100
4	Well Dibida	70	100	100
5	Well Sogbe	05	08	100
6	Well Senkefara	02	06	14
	Standards	0/100	0/100	0/100

*Pop = Population.

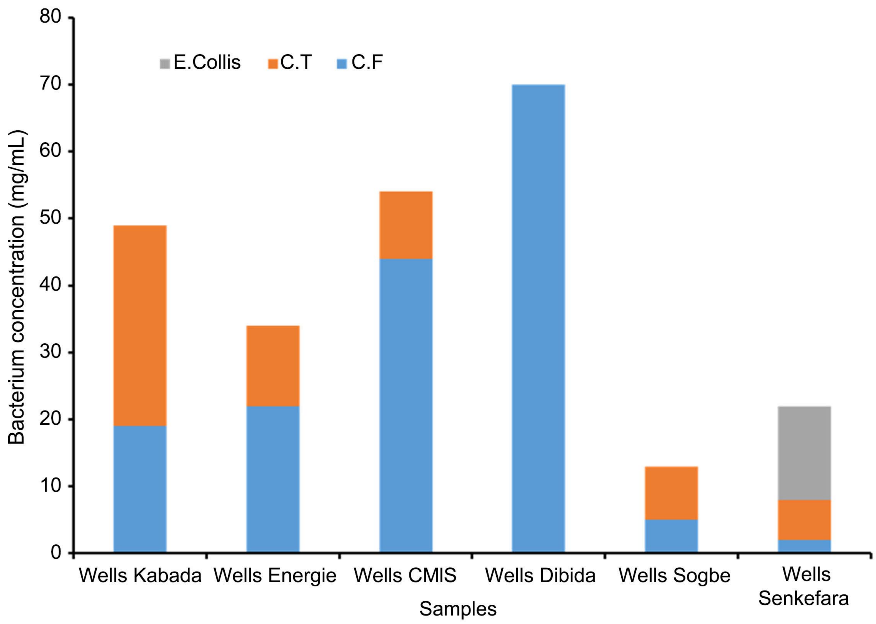

Figure 4. Bacteriological parameters of ordinary well water.

3.2. Tap Water (SEG-Kankan)

The results presented in **Table 3** and **Figure 5** show that tap water samples from the Kabada and Dibida neighborhoods are heavily contaminated, which could cause a high risk of waterborne diseases such as typhoid, diarrhea, cholera (Chippaux et al., 2002). The particular pollution of tap water at the Sogbe market is explained by the fact that the water pipes in this area are constantly leaking, which encourages runoff infiltration and high contamination. In the Briqueterie neighborhood, although there is no direct fecal contamination, the water is slightly polluted and therefore needs to be monitored.

Table 3. Bacteriological parameters of tap water.

N˚	Sites	Parameters		
		C.F. (Pop/100 mL)	C.T. (Pop/100 mL)	*E. Colis* (Pop/100 mL)
1	SEG Kabada	04	01	100
2	SEG Briqueterie	00	01	00
3	SEG Dibida	07	20	100
4	SEG Sogbe	06	00	100
5	SEG Senkefara	00	00	100
	Standards	0/100	0/100	0/100

*Pop = Population.

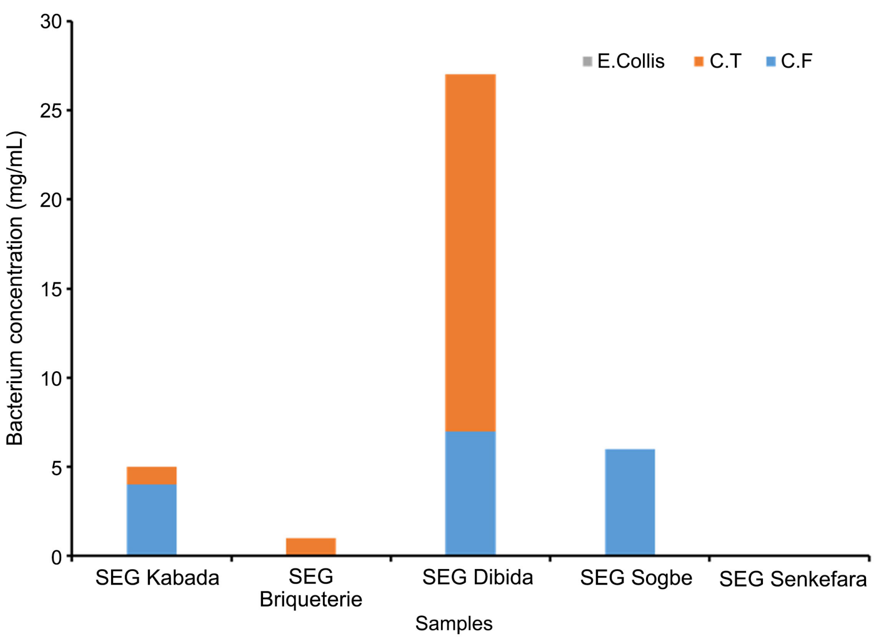

Figure 5. Bacteriological parameters of tap water.

It should be noted that, tap water samples from the Sogbè neighborhood are heavily contaminated with fecal matter and *E. coli*, affecting water quality despite the absence of total coliforms (Bouteleux, 2005).

Although the standard requires zero *E. coli* population/100 mL of water sample, it should be noted that all localities have at least one non-compliant parameter. The most critical cases are those of Kabada, Dibida, Sogbè, and Sénkéfara, with a count of 100 *E. coli* populations/100mL of water sample. The only area where there is no *E. coli* in the water samples is the Briqueterie neighborhood, but there is still C.T. that do not comply with the WHO standard for drinking water.

3.3. Boreholes Water

The results of the bacteriological parameters of the borehole water from the various sites are presented in Table 4 and Figure 6.

Table 4. Bacteriological parameters of borehole water.

N°	Sites	Parameters		
		C.F. (Pop/100 mL)	C.T. (Pop/100 mL)	*E. Colis* (Pop/100 mL)
1	Borehole UJNK	00	00	00
2	Borehole Regional Hospital	00	00	03
3	Borehole CMIS	00	00	00
4	Borehole Dibida market	00	01	01
5	Boreholes Sogbe market	00	100	100
6	Borehole Senkefara market	00	03	02
	Standards	0/100	0/100	0/100

*Pop = Population.

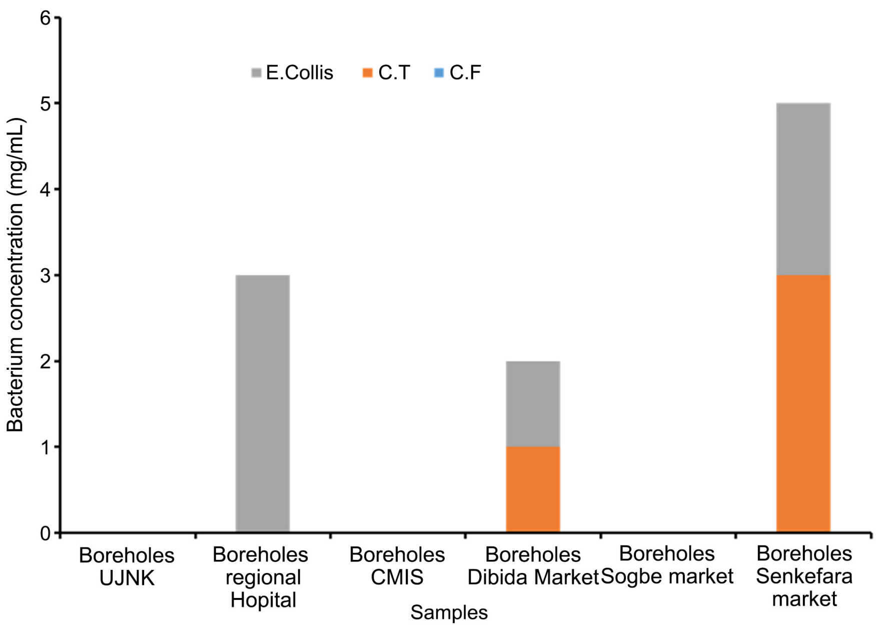

Figure 6. Bacteriological parameters of borehole water.

These results show that water samples from the UJNK and CMIS boreholes comply with WHO standards and therefore pose no risk of contamination, while those from the Regional Hospital, Dibida Market, and Senkefara are slightly contaminated. However, analysis of the water sample from the Sogbè Market borehole shows that the water is heavily contaminated and could pose a real danger to human consumption (Festy et al., 2003). The Same result was obtained by Bah A et al., during the study of Ratoma borehole (Aïssatou & Balde, 2024).

3.4. Surface Water (Milo River)

Table 5 and **Figure 7** present the results of the bacteriological analysis of the water from the Milo River.

Table 5. Bacteriological parameters of Milo River water.

N˚	Sites	Parameters		
		C.F. (Pop/100 mL)	C.T. (Pop/100 mL)	*E. Colis* (Pop/100 mL)
1	Milo Pumping Station	100	100	07
2	Milo slaughter	100	100	100
3	Milo under the bridge	100	100	100
4	Standards	0/100	0/100	0/100

*Pop = Population.

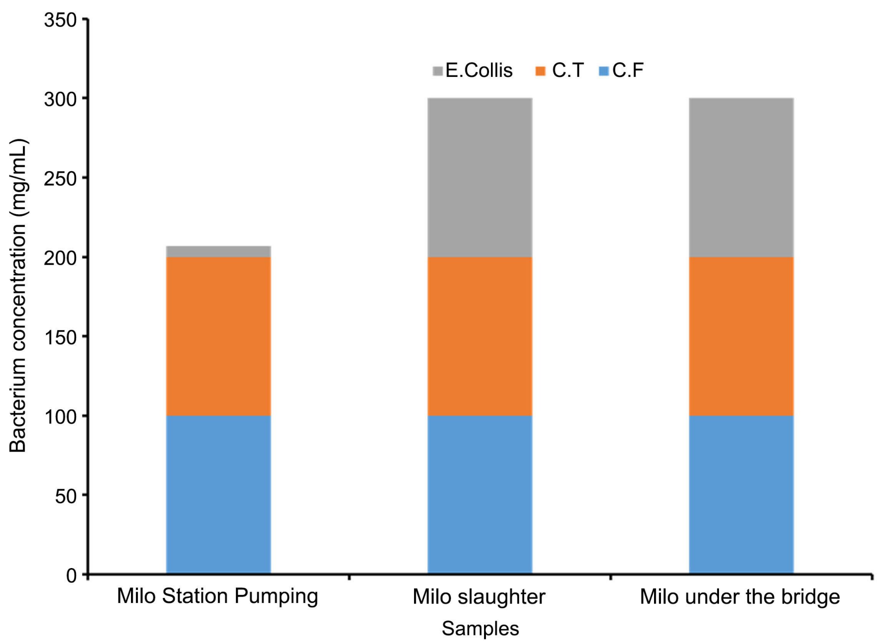

Figure 7. Bacteriological parameters of Milo River water.

Based on these results, all points along the Milo River that were studied show very high levels of bacteriological contamination (**Table 5** and **Figure 7**). This pollution is due to agricultural activities (chemical inputs) in the surrounding area. The WHO standard requires zero (0) coliforms and zero (0) *E. coli* population per 100 mL of water sample. It follows that this water poses a real danger to human consumption and should not be used without appropriate treatment.

In Table 6 are showing the comparative WHO standard and a complaint or noncompliant indicator for each parameter and site.

Table 6. Comparison between the WHO standard and the data obtained for each parameter and sampling site, and an indicator of compliance or non-compliance.

Sites	Standards	Parameters			Indicator	
		C.F. (Pop/100 mL)	C.T. (Pop/100 mL)	*E. Coli* (Pop/100 mL)	Complaint	noncomplaint
Well kabada	0 Pop/100mL	19	30	100		Yes
Well Energy		22	12	100		
Well CMIS		44	10	100		
Well Dibida		70	100	100		
Well Sogbe		05	08	100		
Well Senkefara		02	06	14		
SEG Kabada	0 Pop/100mL	04	01	100		Yes
SEG Briqueterie		00	01	00	Yes	
SEG Dibida		07	20	100		Yes
SEG Sogbe		06	00	100		Yes
SEG Senkefara		00	00	100		Yes
Borehole UJNK	0 Pop/100mL	00	00	00	Yes	
Borehole CMIS		00	00	00		
Borehole Regional Hospital		00	00	03		Yes
Dibida market		00	01	01		
BoreholeSogbe market		00	100	100		
Borehole Senkefara market		00	03	02		
Milo Station Pumping		100	100	07		Yes
Milo slaughter		100	100	100		
Milo under the bridge		100	100	100		
Standards		20 Pop/100mL	50 Pop/100mL	20 Pop/100mL		

This table shows that all sampling sites are polluted, with the exception of the water at the briqueterie, UJNK, and CMIS sites. This high level of pollution is due to the proximity of some of these sites to markets and toilets. The pollution of Milo River is due to chemical inputs used by farmers. Aissatou Bah et al., 2024 made the same observation when studying the characteristics and qualities of borehole water in the municipality of Ratoma.

4. Conclusion

The aim of this study was to assess the bacteriological quality of water from boreholes, ordinary wells, taps, and the Milo River in the urban commune of Kankan. We conducted a sampling campaign at nine sites in the locality during the rainy season. The results indicate that fecal coliforms, total coliforms, and Escherichia coli in a 100 mL sample of water from ordinary wells and the Milo River exceed WHO standards. The UJNK and CMIS boreholes, on the other hand, show no pathology, while the Regional Hospital borehole revealed 03 populations of *E. coli*/100 mL of water. The Dibida market borehole had 1 population of C.T. and E. coli/100 mL of water, compared to 3 populations of C.T./100mL of water and 2 populations of E. coli/100 mL of water recorded at the Senkéfara market. The Sogbè market borehole showed 100 populations of C.T and *E. coli*/100 mL of water.

The results of tap water analysis (SEG) showed that in the Kabada neighborhood there are 04 populations of C.F., 01 population of C.T., and 100 populations of E. coli in a 100 mL water sample. In the Briqueterie neighborhood, there are 00 populations of C.F., one population of C.T., and zero populations of E. coli in the same volume of water sample. The water from the Dibida and Sogbe markets had seven populations of C.F., 20 populations of C.T., and 100 populations of E. coli, and six populations of C.F., 00 C.T. population and 100 E. coli populations, again in 100 mL samples. The water fountain at the Sénkéfara market revealed no cases of C.F. and C.T., but a number of *E. coli* populations equal to 100/100mL of water. Taken together, these results show that these waters are polluted and therefore unfit for consumption by the surrounding populations, and that treatment and regular monitoring measures are essential. The public authorities must take steps such as targeted wellhead protection policies, public awareness campaigns on household water treatment, or systematic disinfection of the municipal tap water.

Authors' Contributions

Aboubacar DIALLO and Cellou KANTE: Investigation, Roles/Writing-original draft, Data.

Gustave TCHANANG: Conceptualization, Methodology; Writing-review & editing, Visualization.

Ansoumane KEITA: Investigation, Roles/Writing-original draft, Data, editing.

Namory Keïta, Kalaya GOUMOU and Jean Marie KEPDIEU: Methodology, Writing-review & editing.

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Conflicts of Interest

All authors certify that they have no affiliation or involvement in any organization or entity having a financial or non-financial interest in the subject matter discussed in this manuscript.

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