Monitoring the bacteriological quality of manual drilling water in the Tandjilé region in Chad

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Abstract

The assessment of water quality consists of counting bacteria indicating fecal contamination or detecting the presence of pathogenic bacteria using standardized or validated methods of classical microbiology. Our present study aims to determine the bacteriological quality of drilling water in the Tandjilé region of Chad.

Our method used was based on qualitative and quantitative research on suspected total coliforms, Echerichia Coli and fecal enterococci were analyzed according to the standard routine methods of the French Association for Normalization (AFNOR).

Microbiological analysis shows the presence of indicators of fecal contamination such as total coliforms, Escherichia coli and fecal enterococci.

The number of strains detected in 100 ml were E. coli (7 /29 samples), fecal Streptococcus (6 /29 samples) and total coliforms (29/29 samples), respectively from borehole water. The contamination rate of E. coli is 24.13%, total coliforms 100% and 20.68% of fecal enterococci in boreholes. The high number of these microorganisms is more than the values recommended by the WHO for the quality of drinking water. Corrective and urgent measures are needed to improve the quality of these water resources, rich in pathogens, which are health risks, and the causes of infectious diseases such as gastroenteritis, diarrhea, typhoid and skin diseases.

Keywords: Monitoring, bacteriological quality, manual drilling water, Tandjilé region, Chad

Introduction

The question of water arises acutely, both globally and in countries with weak water resources.

In Chad, as in most developing countries, the management of water resources is becoming increasingly problematic.

However, the water needs of the population of Tandjilé region have increased tenfold with the increase in this region of Chad for the past two decades. Tandjilé, like the large regions of Chad, is experiencing a galloping demography with poorly controlled urbanization. This situation has favored the emergence of peripheral neighborhoods contrasting with the downtown area. These often populous neighborhoods are located on sites that lack sanitation, hygiene and above all health and social infrastructure, as well as a drinking water supply network.

According to the 2019 UN report, 4.7 million Chadians did not have access to safe drinking water from improved sources.

Poor quality water can carry many organic and inorganic microorganisms and toxic substances.

Generally the sources of so-called water-borne diseases are these pollutants, especially microbiological (Escherichia Coli, total coliforms, fecal Enterococcus, etc.) which are responsible for epidemics which threaten the health of the Chadian population.

According to the World Health Organization, water intended for consumption and for household needs should not contain pathogenic microorganisms; no 100 ml sample of drinking water should contain sulfite-reducing anaerobic bacteria, coliforms and streptococci [1].

According to Chippaux et al. [2], the origin of pollution can be attributed to poor sanitation and household waste collection, the transfer of pollutants from the surface layers of the soil, the drawing conditions and the structure of works. The objective of this study was to assess the bacterial contamination of borehole water in the city of the Tandjilé region in order to measure the health risks to which are exposed the people who use them for their needs.

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Materials and methods

Sampling

Sampling was performed using a randomized full block arrangement with three treatments and ten replicates each, for a total of 29 samples. Samples were taken from each water point for microbiological analysis according to WHO standards. For our samples, the samples were taken in places where human activities are frequent.

The samples were placed in previously sterilized 1 liter glass vials [3]. These water samples were carefully labeled and stored in a cooler at 4 ° C. They were then sent to the laboratory accompanied by a sampling sheet containing all the information such as the origin and date of the sampling, the sanitary conditions of the sampling point.

Bacteriological analysis

The germs sought in the 29 samples of the waters analyzed are total coliforms, fecal coliforms (E.coli) and intestinal enterococci. These data are part of the monitoring of drinking water quality.

The standardized routine methods of the French Association for Standardization (AFNOR)[4] were used for the detection and enumeration of germs contaminating water. The agar incorporation method has been used for the detection and enumeration of total coliforms and fecal streptococci.

Escherichia coli was tested using Brilliance™ E. coli medium (Code CM1046, OXOID) according to the instructions in the technical data sheet for the medium.

The culture medium dishes were incubated with respective temperatures shown in table 1.

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Table 1: Germs sought and counting methods in the waters analyzed

Germs wanted	Culture media	Standard methods	Temperature / Incubation time
Total coliforms	VRBL	NF V08-050	36±1°C/24h
Escherichia coli	Brillance E. coli	(CM 1046) Brilliance^{TM} E. coli ⁄ coliform selective agar	36±1°C/24h
Fecal streptococci	Slanetz and Bartley	NF T 90-416	36±1°C/48h

Data processing

The results were analyzed by SYSTAT 11. The analysis of variance was carried out by ANOVA (One-way analysis of variance).

The difference between the samples was determined by Tukey's multiple comparison test, by a safety factor of 95% and a degree of freedom at risk of 5%.

Results

Microbiological quality of the water analyzed: The results of the microbiological analyzes showed that the borehole water was all contaminated by most of the germs sought.

The variance analysis showed that the microbiological quality of the drinking water varies significantly depending on the sampling areas and it appears that the water from the Tandjilé 1 and 2 boreholes has a 10% contamination rate with Echerichia coli, 100% Total Coliforms and 10% fecal Enterococci. On the other hand, the Mayo kebbi 2 and 3 we identified 50% of Echerichia coli, 100% of total coliforms and 20% of fecal enterococci and the Mayo Kebbi 4 gave us 100% of the total coliforms, 11.11% by E. coli and 33.33% by fecal streptococci.

The overall result shows us that out of 29 samples analyzed, 24.13% of the water was contaminated by Echerichia coli, 100% by total coliforms and 20.68% by fecal enterococci.

Figure 1 and Table 2 respectively show the percentage of contaminated water samples as a function of the content of fecal coliforms, E. coli and fecal streptococci in this region.

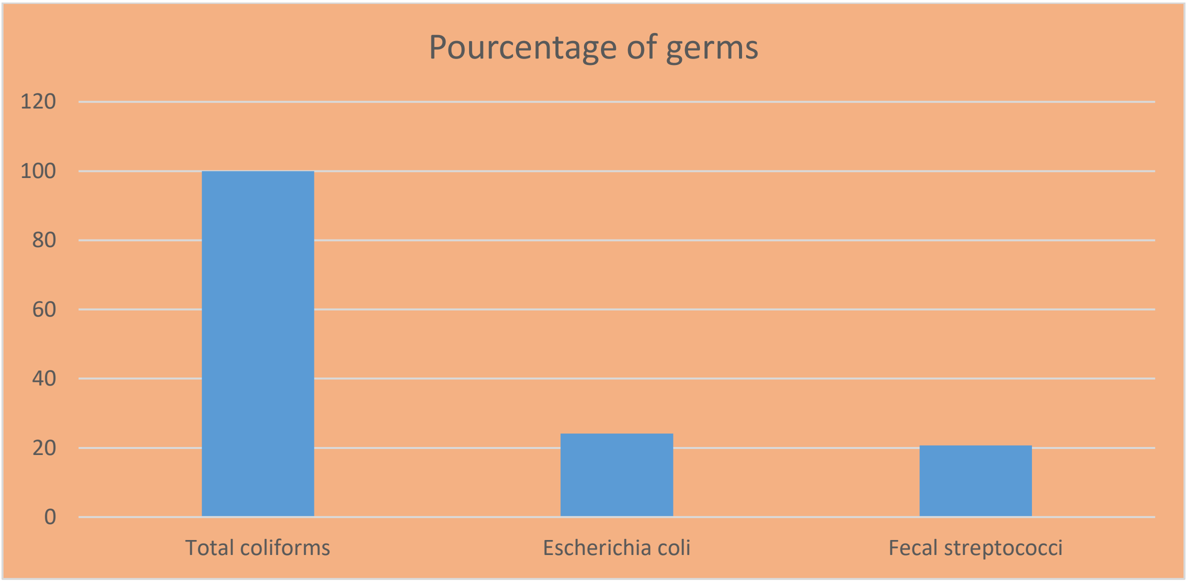

Figure 1: Percentage of total coliforms, fecal enterococci and Escherichia Coli in the waters analyzed.

Table 2: Number of samples taken by sector and the bacteriological quality of their water

Sampling area	Number of wells	Water quality	Germs found
Tandjilé 1 and 2	10	unacceptable	Total coliforms, Escherichia coli, Fecal streptococci
Mayo kebbi 2 and 3	10	unacceptable	Total coliforms, Escherichia coli, Fecal streptococci
Mayo kebbi 4	9	unacceptable	Total coliforms, Escherichia coli, Fecal streptococci

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An average of 7 Escherichia coli, 6 fecal enterococci and 29 total coliforms were counted in the 29 boreholes. In other words, this drilling water is significantly (p 0.05) more contaminated with fecal enterococci than the other germs, confirming the results in Table 3.

Table 3: Multiple Comparisons

Dependent Variable: Germs

Tukey HSD

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Escherichia coli	Total coliform	-46.700*	10.760	.001	-73.38	-20.02
	Fecal streptococci	.800	10.760	.997	-25.88	27.48
Total coliform	Escherichia coli	46.700*	10.760	.001	20.02	73.38
	Fecal streptococci	47.500*	10.760	.000	20.82	74.18
Fecal streptococci	Escherichia coli	-.800	10.760	.997	-27.48	25.88
	Total coliform	-47.500*	10.760	.000	-74.18	-20.82

*. The mean difference is significant at the 0.05 level.

- The null hypothesis is that there are no differences between germs sought means (i.e., all means are equal).
- Prob > F is the p-value for the whole model test. Since the Prob > F is less than 0.05, reject the null hypothesis.

Conclude that there are differences between at least two of the means

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Discussion

The objective of this work was to study the quality drinking water in the locality of Tandjilé and precarious neighborhoods in this region. The microbiological analysis shows the presence of indicators of fecal contamination, namely total coliforms, fecal Enterococcus and Escherichia coli. This presence shows that the waters are subject to microbiological pollution of human origin [6]. These results are in agreement with those obtained by [7] during their studies on the Assessment of the bacteriological quality of well, borehole and river water consumed in the Doba oil basin in Chad. Their results have showed a high bacterial load with the presence of total coliforms and intestinal enterococci in the waters studied. This high bacterial load could be explained by the sanitation system and the environment of these neighborhoods.

However, poor water quality favors the accumulation of Echerichia coli. The maximum acceptable concentration of E. coli in drinking water has been found to be "no detectable microorganisms per 100 ml volume", and therefore Echerichia coli should be completely absent from drinking water.

Echerichia coli produces toxins that can destroy cells in the human intestine and kidneys, and in severe cases, trigger bloody diarrhea and kidney failure. The bacterium Echerichia coli is recognized as the best bacterial indicator of contamination of fecal origin due to its specificity [8]. However, some strains of Echerichia coli are essential in the digestion of food and produce vitamins K and B. Contamination of borehole water has been attributed to poor management of solid and liquid wastes from human activities. In addition, the contamination of the water table of these waters depends on the permeability of the soil, the depth of the water table, the absence or unsuitability of sanitation structures, poor waste management and the method of drawing [9-8-10-11].

The presence of streptococci in drinking water has been considered as an indicator of fecal pollution, and their main interest lies in the fact that they are resistant to desiccation.

In fact, the urban insalubrity that characterizes the environment of the boreholes in the Tandjilé region enriches the water with bacteria. The population does not have a household waste treatment system, let alone a wastewater collection, treatment and disposal system. Poor management of household garbage and wastewater, contamination of the soil by human excreta results in the water's high content of certain elements which are signs of pollution.

In the Tandjilé region, the method of excreta disposal is dominated by the use of pits. 55% to 60% of the populations this region uses pit latrines and 45% to 40% defect in the open air. These practices are sources of enrichment and contamination of groundwater. The presence of bacteriological contaminants in drinking water can be the cause of waterborne infections such as gastroenterics. Children under five are the most vulnerable to poor drinking water quality.

Conclusion

The data collected during this study made it possible to draw up a portrait of the microbiological quality of the borehole water in the Tandjilé region, which is bacteriologically non-compliant with the guidelines of the World Health Organization and the results of this study calls on all stakeholders working for access to drinking water and health education in hygiene and sanitation, in developing countries.

The results of these analyzes show that this water constitutes a health risk for the populations of the said localities which are largely dependent on the water studied for their needs. These different places therefore constitute endemic areas where populations are subject to many diseases. Preventive actions are necessary because they could make it possible to prevent diseases linked to the poor quality of this water drink.

In addition, it would be important to promote access to drinking water at the entire population of this region. Otherwise, an information, education and communication to the population to make them acquire reflexes favorable to the preservation of water quality from the source of supply up to consumption must be a priority of studies should continue to monitor the evolution of water pollution and bacterial contamination. The health risks related to the quality of water in Chad in general and in precarious areas should challenge everyone in the framework of social well-being prior to any development.

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Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

VRBL: Violet Crystal Agar Neutral Red Bile and Lactose

WHO: World Health Organization

Reference

1. UN Report, September 6, 2019: https://www.secours-islamique.org/tchad-eau-potable-puits-sif.
2. World Health Organization. Guidelines for drinking-water quality, third edition incorporating the first and second addenda, 2008 volume1, Recommendation's, Geneva.
3. Chippaux J-P, Houssier S, Gross P, Bouvier C, Brissaud F, Study of groundwater pollution in the city of Niamey, Niger. Bull Soc Pathol Exot, 2002 94, 2, 119-123.
4. Belghiti ML, Chahlaoui A, Bengoumi D, El Moustaine R. Study of the physicochemical and bacteriological quality of groundwater from the plio-quaternary water table in the region of Meknes (Morocco) Larrhyss Journal, 2013, n ° 14, pp. 21-36
5. AFNOR (French Agency for Standardization). Standard F V08-060. Food microbiology Enumeration of thermotolerant coliforms by counting colonies at 44 ° C. Routine method. Paris, 2016, p10
6. Ahoussi K, Koffi Y, Kouassi A, Soro G., Soro N, Biémi J. Physico-chemical and Bacteriological characterization of water resources in localities located on the outskirts of the groundwater pollution lagoon. Int. J. Biol. Chem. Sci., 2012.4 (6): 364-384.
7. Maoudombaye T., Ndoutamia G and Ngakou A., Evaluation of the bacteriological quality of well, borehole and river water consumed in the Doba oil basin in Chad. International Journal of Recent Scientific Research. June, 2016, p1-7
8. Degbey C, Makoutode M, de Brouwer C. The quality of drinking water in the workplace in Godomey in 2009 in Benin West Africa, J Int Health Trav 2010; p1: 15-22.
9. Yapo OB, Mambo V, Seka A, Ohou MJA, Konan F, Gouzile V, Tidou AS, Kouame KV, Houenou P. Assessment of water quality in wells for domestic use in disadvantaged

 doi:10.20944/preprints202009.0667.v1

neighborhoods of four communes of Abidjan (Ivory Coast): Koumassi, Marcory, Port-Bouet and Treichville Int. J. Biol. Chem. Sci. 2010, 4 (2): 289-307.

10. Coulibaly K. Study of the physico-chemical quality and bacteriological of the well water of certain districts of the district of Bamako; Doctoral Thesis in Pharmacy, Faculty of Medicine of Pharmacy and Odonto-Stomatology, University of Bamako, 2005
11. Boubakar Hassane A. Surface and deep aquifers and urban pollution in Africa: Case of the urban community of Niamey (NIGER), Thesis of the Univ, Abdou Moumouni of Niamey (Niger), 2010.