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ANALYSIS AND GUIDANCE ON THE BACTERIOLOGICAL QUALITY OF WATER IN DRINKING FOUNTAINS OF PUBLIC SCHOOLS IN THE CITY OF CABEDELO, PB

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ABSTRACT

Water is an indispensable resource for human survival, but water contaminated by pathogens can compromise human health, especially that of children. Thus, this work, which is linked to an extension project, proposed the analysis of the bacteriological quality (total coliforms, thermotolerant and heterotrophic bacteria) and physicochemical (pH) of the water from drinking fountains of 8 (eight) schools in Cabedelo, PB, with the objective of ensuring child well-being. The methods used were the multi-tube technique for coliforms, the standard plate counting technique by Pour Plante for heterotrophic bacteria and pH-metry with AK90 pHmeter, and the results were interpreted according to the Brazilian legislation. Of the 8 (eight) samples analyzed, all were within the parameters regarding pH (pH 6 to 9) and thermotolerant coliforms (indicators of fecal contamination), however 50% (n=4) were positive for total coliforms (indicators of treatment efficiency) and 75% (n=6) for heterotrophic bacteria (indicators of general water quality). These data reveal that students from 50% of the schools in the study were ingesting water unfit for consumption, a potential source of pathogens, which was resolved after the managers were made aware according to subsequent analyses. It is concluded, therefore, that the results obtained constitute a serious problem that can drastically affect the health of children, and it is necessary to take resolutive measures.

Keywords: Water. Microbiology. School. Childhood.

[1] LATTES: http://lattes.cnpq.br/5294725687051092
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INTRODUCTION

Water is one of the most basic resources for the survival of all living beings. However, it is known that, when not properly treated or poorly packaged, it can be a vehicle for pathogenic agents, such as certain bacteria, viruses and other parasites, which can cause a series of infectious diseases, such as gastroenteritis, typhoid fever, cholera and shigellosis, in addition to several parasitic diseases (SAMPAIO; SILVEIRA, 2021; SANTOS *et al.,* 2013 apud MORAES *et al*., 2018), which mainly plague children in underdeveloped or emerging countries, such as Brazil. Thus, according to Brazilian legislation (Brasil, 2021), water made available for human consumption cannot present microbial contamination that constitutes a risk to the health of the population, to ensure this, it recommends the absence of specific bioindicators in a volume of 100 mL of water, which are total and thermotolerant coliforms.

Regarding the recommended bioindicators, the coliform group is the most popular, it is divided into total coliforms and a subgroup, thermotolerant coliforms. Conceptually, total coliforms are gram-negative bacillary bacteria of the *Enterobacteriaceae family,* resistant to surfactants and bile salts that ferment lactose at 35°C with the production of gas, acid and aldehyde, because they encode the enzyme β-Galactosidase, in a period of 24/48h. The main genera of the coliform group are *Citrobacter*, *Enterobacter*, *Klebsiella* and *Escherichia*. Furthermore, thermotolerant coliforms are a select group of coliforms that ferment lactose at 44.5°C with the release of the same metabolic products, as they express, in addition to β-Galactosidase, the enzyme β-Glucuronidase, in a 24-hour period, with its main representative being the bacterium *Escherichia coli* (FUNASA, 2013).

The biomarkers mentioned above are, respectively, indicators of treatment efficiency and fecal contamination (BRASIL, 2021), so they are appreciable indicators of potability that help protect the human population, especially children, from waterborne diseases, which are highly debilitating and potentially lethal (ALENCAR *et al.*, 2020).

Although the current legislation does not require the counting of colonies of heterotrophic bacteria, a group of highly ubiquitous bacteria, this bioindicator is not totally indispensable, because, in addition to indicating the general quality of the water, high concentrations of it can suggest the presence of pathogenic agents and, because they are more resistant to residual free chlorine, it can serve as an indicator of the efficiency of distribution and conditioning in buildings (SILVA *et al*., 2019). Thus, the exclusion of this bioindicator would increase the intrinsic partiality of the analysis itself.

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For this reason, since the water of public schools, which concentrate a large number of children, is a potential source of pathogens (LIMA; RIOS, 2020), the research/extension project "ANALYSIS AND GUIDELINES ON THE BACTERIOLOGICAL QUALITY OF WATER FROM DRINKING FOUNTAINS IN PUBLIC SCHOOLS IN THE CITY OF CABEDELO" proposed the bacteriological and physicochemical (pH) analysis of water samples from drinking fountains from 8 (eight) public schools in the city of Cabedelo, Paraíba, Brazil, regarding their levels of standard bioindicators, with the primary objective of ensuring the potability of water and protecting the health of children.

METHODOLOGY

All the laboratory part undertaken in this project was carried out in accordance with the Practical Manual of Water Analysis of the National Health Foundation (FUNASA) by undergraduate students, who were previously trained and supervised by the professor in charge and by a student with a little more experience.

After permission from the managers of the educational institutions and the Municipal Department of Education of Cabedelo, PB, the water was collected on different days in 8 (eight) public schools in the City of Cabedelo in sterile plastic bottles with 100 (one hundred) µL of 10% Sodium Thiosulfate, a substance that neutralizes the residual free chlorine of the water, soon after the previous drainage and disinfection of the drinking fountain with 70% ethanol. With the conclusion of the reported procedure, the water samples were taken in an isothermal box to the Laboratory of Biology of Microorganisms (BIOMICRO) of the Department of Molecular Biology (DBM) of the Federal University of Paraíba (UFPB) and refrigerated until the analyzes were carried out, which occurred in the first 24 hours after collection, according to FUNASA standards.

In this research, the techniques chosen to perform the bacteriological analysis of water were, as recommended by the Practical Manual of Water Analysis (FUNASA, 2013), respectively, the technique of multiple tubes or the Most Probable Number (NMP), for total and thermotolerant coliforms, where sample volumes, in specific proportions, were inoculated in enriched and selective liquid media, and the standard plate counting technique by Pour Plate or depth technique, for heterotrophic bacteria, where a specific volume of molten solid medium was poured over 1 mL of water. After the analysis of each sample, the results were given in Most Probable Number (NPM) for total and

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thermotolerant coliforms and in Colony Forming Units per milliliter (CFU/mL) for heterotrophic bacteria.

The pH of the water samples was measured using AK90 pH meter, and all samples with a pH of 6 to 9 were considered within normal standards (BRASIL, 2021). To carry out the analyses, the students were previously trained and supervised by those responsible for the research.

The current Brazilian legislation (BRASIL, 2021), as stated in principle, determines that drinking water must be free of total and thermotolerant coliforms in 100 mL of the sample. Until 2021, when ordinance GM/MS No. 888/2021 suspended the mandatory analysis of heterotrophic bacteria, a number of up to 500 CFU/mL of these bacteria was allowed. In this research, it was decided to count only the colonies of heterotrophic bacteria with characteristic morphology.

RESULT

Water samples from drinking fountains in all 8 (eight) public schools were collected and analyzed. Despite the considerable number of water samples examined, none, i.e., 0%, was positive for thermotolerant coliforms (indicators of fecal contamination). However, 50% (n=4) of them were positive for total coliforms (indicators of treatment efficiency) and 75% (n=6) for heterotrophic bacteria (indicators of general water quality), respectively. Thus, according to the current legislation in the country, which requires the absence of total coliforms per 100 mL of water, 50% of the schools in the study unconsciously offer water unfit for consumption to their students and employees.

Regarding pH, an important parameter for chlorination efficiency (FUNASA, 2014), all samples are within the normality standards defined by Brazilian legislation.

Table 1. Results of bacteriological analyses of water samples.

SCHOOL	TOTAIS COLIFORMS	THERMOTOLERANT COLIFORMS	HETEROTROPHIC BACTERIA COUNT.	CONCLUSION
School A	0 NMP/100 mL	0 NMP/100 mL	0 CFU/mL	Potable
School B	900 NMP/100 mL	0 NMP/100 mL	29 CFU/mL	Unfit
School C	130 NMP/100 mL	0 NMP/100 mL	38 CFU/mL	Unfit
School D	0 NMP/100mL	0 NMP/100 mL	41 CFU/mL	Potable*
School E	0 NMP/100 mL	0 NMP/100 mL	0 CFU/mL	Potable
School F	11 NMP/100 mL	0 NMP/100 mL	1 CFU/mL	Unfit
School G	4 NMP/100 ml	0 NMP/100 mL	5 CFU/mL	Unfit
School H	0 NMP/100 mL	0 NMP/100 mL	3 CFU/mL	Potable*

Source: the author.

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*Ordinance No. 888, of May 4, 2021, excluded the need to count colonies of heterotrophic bacteria.

Table 2. Results of the physicochemical analysis (pH).

SCHOOL	ph	CONCLUSION
School A	7,3	Potable
School B	7,0	Potable
School C	7,1	Potable
School D	7,8	Potable
School E	7,5	Potable
School F	8,1	Potable
School G	7,0	Potable
School H	8,0	Potable

Source: the author.

Once the laboratory analyses were concluded, and this work was integrated into an extension project, the results were made available to public schools, which were kept anonymous, and to the Municipal Department of Education of the City of Cabedelo, PB, accompanied by a folder produced by the authors on the risks of ingesting water with indicator microorganisms and how to reduce the risks of biological contamination.

Thus, after the managers were made aware by the research participants, the appropriate measures were taken, which could be confirmed by subsequent analyses, where all positive samples in this work were within the standards of potability, so it can be stated that the project achieved the primary objectives mentioned above.

DISCUSSION

The presence of total coliforms and the absence of thermotolerant coliforms suggests that, although there is no fecal contamination according to this methodology, the water distribution/conditioning system inside schools, such as pipes, water tanks and cisterns, may be impaired, perhaps due to the simple presence of decomposing organic matter inside, and need repairs and immediate adequate cleaning (SAMPAIO; SILVEIRA, 2021), as water contamination in a specialized treatment plant is unlikely and the mere absence of thermotolerant coliforms does not completely exclude the potential presence of pathogenic microorganisms, respectively.

In some samples, a considerable count of colonies of heterotrophic bacteria was obtained, a potential risk to the health of students and employees of public schools, as this parameter indicates the general quality of the water, that is, a high count of heterotrophic bacteria may mean a greater risk of ingestion of water of very poor quality (WHO, 2003 apud SILVA *et al.*, 2019).

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In addition, it is urgent to consider that the high concentrations of total coliforms and heterotrophic bacteria may also be related to the typical rainy season of the state's coast in the second half of the year, the period in which the samples were collected, as the increase in precipitation can cause infiltrations in the building's pipes and reservoirs (SILVA *et al*., 2016).

Despite the low microbiological quality of some samples, all are within normal pH standards, which helps to ensure the efficiency of the chlorination process and to mitigate the risks of microbial contamination (FUNASA, 2014).

CONCLUSION

It is concluded that the results reported above represent a serious problem, because high levels of bioindicators in water can compromise the health of its consumers, in this case the child public, and possible resolutive methods: periodic microbiological screening of water made available for consumption in public schools, disinfection of reservoirs in the appropriate period and provision of pertinent information to those responsible for these establishments.

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