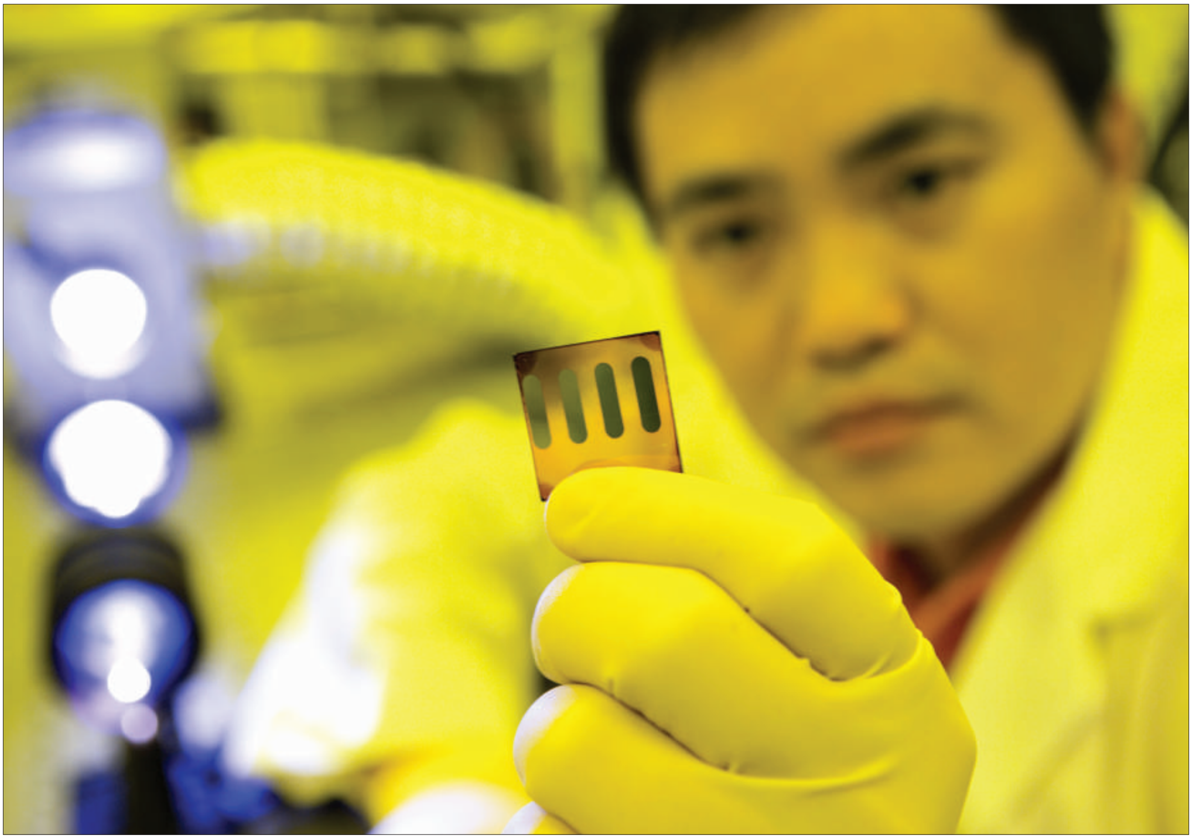

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Research Article
Contamination of Water Tank of Schools: A Public Health Emergency

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Abstract
Background and Objective: Daily consumption, hygiene and food preparation needs are around 190 liters of water for each individual. Allied to the lack of water is its poor distribution and contamination of the resource. The water tank is a tank designed to store water for human consumption. Maintenance-free water tanks are of great importance for the spread of disease. The study aimed to evaluate the influence of reservoirs on the microbiological quality of drinking water in schools. **Materials and Methods:** In this study investigated water supply quality problems of schools due to their storage through physical, chemical and bacteriological analysis. The 39 samples of water used for human consumption collected in public and private elementary and elementary schools. The pH, chlorine and fluorine presented results that were out of the standard established by the law in force. **Results:** Some water samples analyzed showed different results before and after the reservoir, noting a sensitive interference of water quality by the reservoir. Although the average sample of chlorine results after the reservoir was lower than the minimum allowed by legislation, there was little presence of total coliforms. **Conclusion:** There was a significant influence of reservoirs on the microbiological quality of drinking water in schools.

Key words: Quality, water, fecal coliform, total chloroform, pH, chlorine, fluorine

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Of the many uses that water can have, some are closely related to human health, mainly when used as a drink, preparation and food intake[1]. The quality intended for human consumption must be adequate to maintain health. It is defined by potability standards that describe the permitted or tolerated quantities for various elements that may be present in public water supply[2]. All countries have their water supply legislation and must comply with approximately 50 parameters, divided into four groups: microbiological, toxicological agents, organoleptic and operational[3].

Surveillance of water quality for human consumption is a set of actions taken by Public Health agencies to assess the risks of water supply systems and alternative solutions for human health[2]. Infectious microbial agents can cause water-related diseases. The bacterial indicators in water measured are total coliforms (TC) and fecal coliforms (FC). The FC belong to the coliform group and have as habitat the intestinal tract of mammals. *Escherichia coli* are FCs that are preferential indicators of contamination. The permitted TC and HR indices in drinking water are based on epidemiological studies. The FC are related to hygienic conditions and FC to fecal contamination, which indicate the proportion of *E. coli*.

The potability of water guaranteed the treatment process carried out before distribution to the population, which depends on the characteristics of the source that supplies it, as conventional treatments hardly remove some toxic chemical compounds[3]. Large amounts of chlorine are used for use as household disinfectants in drinking water to control bacteria and odors. Its use has disadvantages such as cancer risk for people who consume chlorine water more than 90% more likely. However, without disinfecting drinking water can be caused infectious diseases. Contaminants may be in public water supply systems due to certain faulty hydraulic works or improper treatment practices[4]. Microorganisms and toxic substances may be present in the pipes and may contaminate the water supplied to the population[4].

For a treatment, distribution and storage program to successfully perform its functions, the home storage system must also be efficient. In order to prioritize the health problems of school students, the aim of this study was to investigate the water supply problems of schools in the state of SP-Brazil, of deep and superficial origin through physical, chemical and bacteriological analysis.

MATERIAL AND METHODS

Study area: The samples of drinking were collected from August to October, 2013.

Samples: The 39 samples of drinking water from 20 schools selected from municipal, state and private schools in the city of São Carlos-SP (Brazil). To choose the schools to be sampled, the city map was overlaid, relating the location of the schools with the location of the reservoirs and wells used to supply water to the population. The school's choice depended on location about the source of water from the surface or underground wells used for supply. At each school water samples were collected at two points, one before the reservoir and one after the reservoir.

Samples collected in approximately 500 mL plastic vials with a leakproof protective cap. The vials previously cleaned, containing no substances that could alter any result.

Physicochemical analysis: For this pH analysis, the portable pH meter Cristol Microph 2001 was used.

Turbidity values were determined using the Del Lab-DLM-2000B microprocessor turbidity meter. The water sample was placed in the appropriate glass cuvette and inserted and positioned in the apparatus according to the existing brand. Direct reading gives results in the Nephelometric Turbidity Unit (NTU).

Chlorine values were determined using the Del Lab colorimeter. The water sample was placed to well mark No 01. The powder reagent was added with a small clean paddle and dried. Bowl # 01 introduced into the right hole of the comparator and Bowl # 02 with distilled water in the left hole, rotating the colorimetric disc compared to the color of the reacted sample with the contained disc colors. The reading expressed in milligrams per liter of chlorine.

The method used for fluorine analysis was performed by the reaction of spends, based on the combination of the fluoride ion and an intense red zirconium pigment complexed by the HACH DR 2500 spectrophotometer. The results expressed in ppm (mg L^{-1}).

Bacteriological analysis: The search for fecal and TC performed using the Colilert technique[5].

Statistical analysis: The results were analyzed statistically by analysis of variance (ANOVA) and the Tukey test was applied at a value $p<0.05$.

RESULTS

Among the samples taken from the school easel before the reservoir, 13 (65%) are non-standard pH (6.5-9.5) established by current legislation, in only 12 (60%) samples taken after the reservoir. All samples with pH below 6.0 were non-standard. Since the rest of the samples are within the established value (Fig. 1a).

It was found 2 (10%) samples below the established value for chlorine by the legislation in force among those collected before the reservoir. However, for samples taken after the reservoir 100% of cases were within the recommended by legislation. The mean value found for samples taken before the reservoir was 0.65 mg L^{-1}, within the value established by the Brazilian Ministry of Health (BMH) and the mean value for samples collected after the reservoir was 0.16 mg L^{-1}, below the recommended by the BMH (Fig. 1b). The average turbidity value found for samples taken before the reservoir was 0.3 NTU, the same as for samples taken after the reservoir (Fig. 1c).

Samples 14 (70%) obtained from the non-standard fluorine total for samples taken before the reservoir, while 18 (95%) samples were non-standard samples for those collected after the reservoir (Fig. 1d). For the determination of the fluorine value, an average of 0.46 mg L^{-1} before the reservoir and 0.3 after the reservoir obtained, all outside the standard established by the legislation, minimum of 0.6 mg L^{-1} and maximum of 0.8 mg L^{-1} (Fig. 1d).

From samples taken after reservoir 2 (10%) were positive for TC. The same occurred with 6 (32%) samples among those collected after the reservoir. All samples were negative for FC (*Escherichia coli*) (Fig. 2). Current legislation generally dictates the absence of TC and FC as the standard for microbiological quality for drinking water.

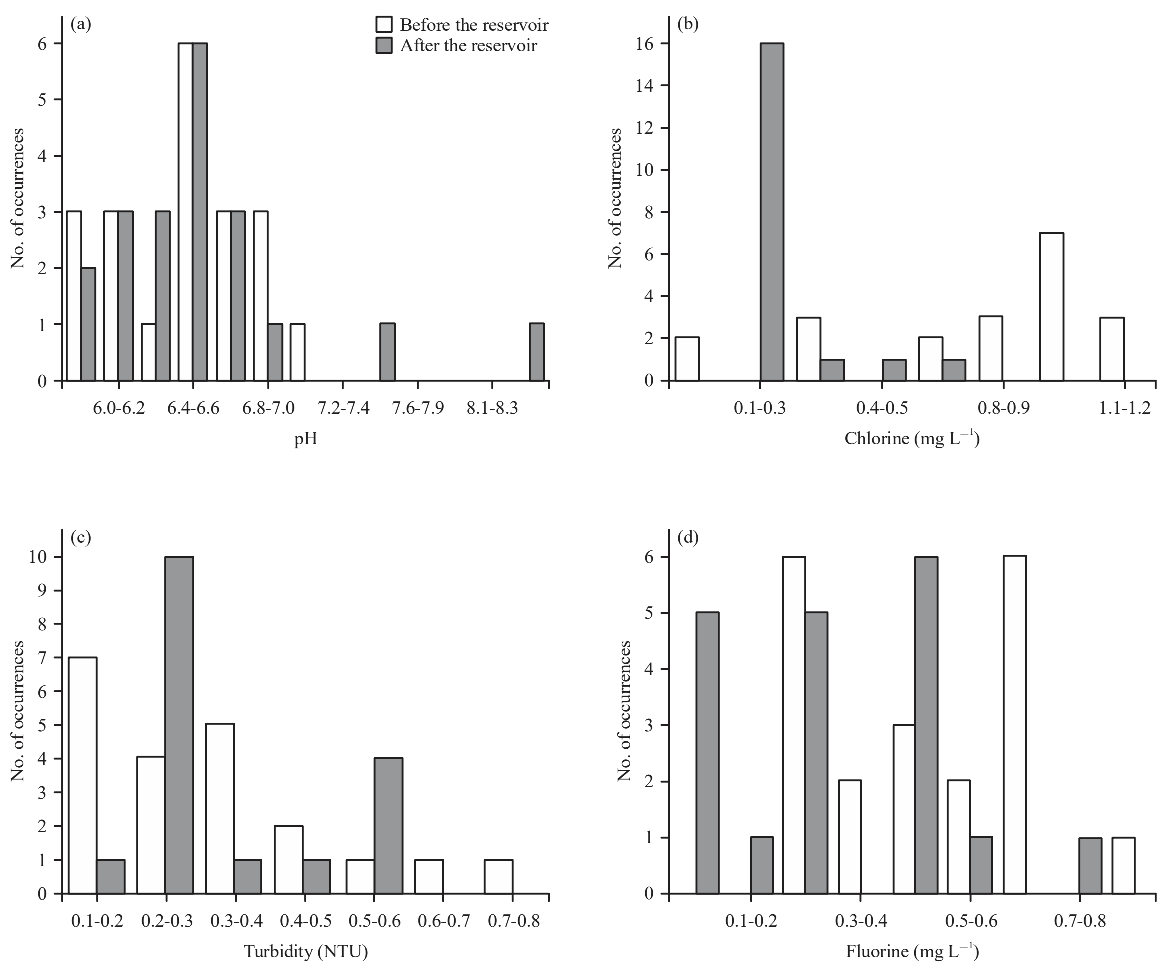

Fig. 1(a-d): Physicochemical analysis of water, (a) pH, (b) Chlorine, (c) Turbidity and (d) Fluorine

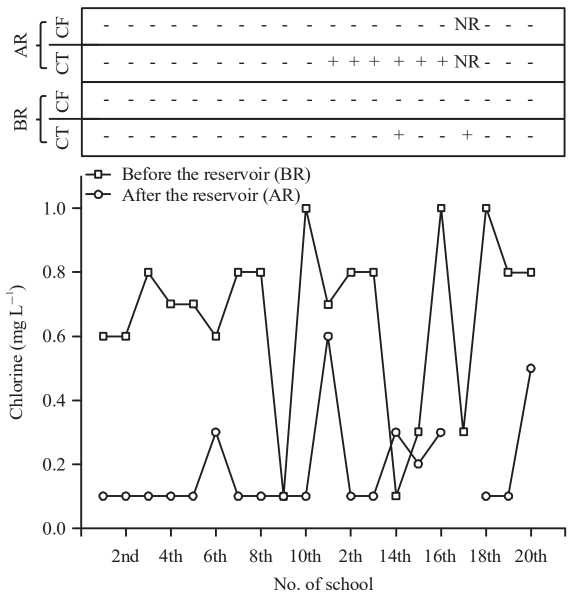

Fig. 2: Relationship of chlorine interference with the presence of fecal (CF) and total (CT) coliforms before and after the water tank in each school studied

AR: After reservoir, BF: Before reservoir, CT: Coliforms totals, CF: Coliforms fecals. In the upper part is shown if the studied samples presented CT and CF, +: Detected, -: Undetected, NR: No registered

DISCUSSION

Among the studied parameters, pH is an essential factor in determining potability based on values between[6] 6.5 and 9.5. It is advisable to use water with a pH around 8.3 to avoid deposits of rust and other harmful oxides in water tanks. For the samples taken before the reservoirs, none had a pH value around 8.3 so that over time the pipes may oxidize. Consumption of acidic pH water may irritate the gastric mucosa as well as corrosion in residential pipes and water supply systems[7].

Current legislation states that free residual chlorine must be between a minimum of 0.2 and a maximum of 2 mg L^{-1} for domestic use[8]. The increase in cases for samples taken after the reservoir is since these water tanks may be uncapped or dirty with organic matter accumulation, reducing the amount of chlorine[9] and the presence of pathogenic microorganisms may occur. The absolute and relative frequency of periodic cleanings by social class presented all cases found (10%) of periodic non-cleanings reported in public (state) schools.

Turbidity is an essential factor in ensuring the microbiological quality of water[10]. For both pre-reservoir and post-reservoir samples, the MPV for turbidity not achieved.

The presence of TC indicates the possible presence of pathogenic microorganisms, although FC[11]. It can be explained that some samples are out of quality due to the periodic lack of cleaning of the water tanks, although schools reported that they were cleaning and positivity for TC since they were uncapped or improperly capped contributing to the reduction in the concentration of residual chlorine present. However, aside from diarrhea, some strains of *E. coli* can cause severe complications in children such as hemolytic uremic syndrome which destroys blood cells leading to kidney failure.

CONCLUSION

It observed the influence of the water's reservoirs of schools on the alteration of chlorine concentration among the samples collected after them, resulting in the higher positivity for bacteria (TC).

SIGNIFICANCE STATEMENT

This study found that the water reservoir can interfere with the health of the population that consumes it due to the described data that alter its quality parameters. This study will help researchers discover critical areas of human drinking water contamination. Thus, a new theory about interference hypotheses of optimal standards of human consumption quality can be achieved by using these water reservoirs.

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