Quality of water for human consumption in public schools in Maceió, Alagoas
Qualidade da água para consumo humano em unidades de ensino da rede pública municipal de Maceió, Alagoas

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ABSTRACT

The study evaluated the microbiological quality of water for human consumption in teaching units of the municipal public network in Maceió, Alagoas, and verified the hygienic-sanitary conditions of their water tanks and piping systems. This is an observational and descriptive study, carried out in 20 educational units supplied by artesian wells. Water samples were collected from the artesian well and the unit's kitchen faucet. The water quality was evaluated by the test of total coliforms and E. coli, based on the presence/absence of Colilert substrate, and classified as “acceptable” or “unacceptable”. The hygienic-sanitary conditions of the pipes and tanks were evaluated based on a checklist. In 50% of the teaching units, the water quality was unacceptable. Regarding hygienic-sanitary conditions, 73.7% of the units complied with current legislation with regard to structure, hygiene and coating material. However, in 95.0%, the cleaning of the water tanks had not been carried out as recommended by federal legislation; consequently there was a lack of records of the procedures performed. These schools risk transmission of waterborne and foodborne diseases from the water that is used to prepare beverages and food for the schoolchildren. Therefore, it is important to adopt effective measures to control and monitor water quality in order to correct the situation found in these schools.

Keywords: Water quality control; Coliforms; Good distribution practices; School Feeding

RESUMO

O estudo avaliou a qualidade microbiológica da água para consumo humano em unidades de ensino da rede pública municipal de Maceió, Alagoas e verificar as condições higiênico-sanitárias dos encanamentos e reservatórios. Trata-se de um estudo observacional e descritivo, realizado em 20 unidades de ensino abastecidas por poço artesiano. Foram coletadas amostras de água do poço artesiano e da torneira da cozinha da unidade. A qualidade da água foi avaliada pelo teste de coliformes totais e E. coli, pela presença/ausência com substrato Colilert, e classificada em “aceitável” ou “inaceitável”. As condições higiênico-sanitárias dos encanamentos e reservatórios foram avaliadas a partir de um checklist. Observou-se que em 50% das unidades de ensino a qualidade da água foi inaceitável. Em relação às condições higiênico-sanitárias, 73,7% das unidades, estavam em conformidade com as legislações vigentes no que se refere à estrutura, higiene e material de revestimento. Entretanto, em 95,0%, não era realizada a higienização dos reservatórios conforme preconizada pela legislação, e consequente ausência dos registros dos procedimentos realizados. Estas escolas correm o risco de transmissão de doenças transmitidas pela água e pelos alimentos a partir da água que é utilizada para preparar bebidas e alimentos para os alunos. Portanto, é importante a adoção de medidas eficazes de controle e monitoramento da qualidade da água, a fim de corrigir a situação encontrada nessas escolas.

Palavras-chave: Controle de qualidade da água; Coliformes; Boas práticas de distribuição; Alimentação escolar.
INTRODUCTION

Sustainable access to drinking water is essential for maintaining life (KLAMT et al., 2021; MORAES et al., 2018). Population growth, industrial development, and disorderly land occupation have contributed to the scarcity of this resource and to the deterioration of water sources (CUNHA, BORGES, 2015).

Furthermore, the lack of basic sanitation or inadequate sanitation, common in developing countries such as Brazil, are factors associated with water contamination. Contaminated water has been reported to be among the ten leading causes of illness and death of 125,000 children under five years of age worldwide (TUNDISI, 2008).

According to UNICEF (2022), 785 million people in the world lack basic hygiene and efficient sanitation services; of these, 144 million consume untreated water. This scenario makes water a strong agent in the dissemination of pathogens, such as Escherichia coli, Vibrio cholerae, Salmonella typhi, and Shigella, causing various water-borne diseases, including cholera, typhoid, and paratyphoid fever, as well as gastroenteritis (LIN, GANESH, 2013; MORAES et al., 2018).

In Brazil, during the period from 2016 to 2019, 2504 outbreaks of diseases transmitted by contaminated water and food were reported. However, in only 894 of these was it possible to identify the type of contaminated food, with water accounting for 28.4% of the results (MINISTÉRIO DA SAÚDE, 2020).

Therefore, the distribution of water for human consumption in adequate quantity and quality has become a growing concern and subject of worldwide discussions, given that it is fundamental for public health, especially for children (LOPES et al., 2015). Brazilian public policies such as the National Policy on Nutritional Food Security (PNSAN) include the promotion of universal access to quality water in their guidelines (BRASIL, 2010).

Considering that school-aged children can spend five to eight hours a day in public teaching units, it is imperative that these spaces have favorable environmental conditions to ensure good health practices and quality of life for children. Consumption of contaminated water can occur through direct ingestion, washing hands and food preparation. Water can be contaminated at the point of origin or collection, during its distribution, and, mainly, in the water tanks of these establishments, due to neglect of periodic hygiene (SIQUEIRA et al., 2010; STOLF and MOLZ, 2017).

Thus, it is important to establish ways to verify compliance with the criteria for maintenance, registration, and cleaning of water reservoirs for establishments that handle food (BRASIL, 2004). Checklists can be used as a tool for monitoring and identifying
nonconformities, as a quick, low-cost, practical, and highly beneficial evaluation method (STEDEFFELDT et al., 2013). Additionally, microbiological monitoring of the water must be carried out to verify that the drinking water is meets requirements of current legislation (BRASIL, 2017).

Assuming that access to healthy and adequate food is a social right inherent to the dignity of the human person and that the school environment should operate as a space for training and exercising rights, it is essential that schools use quality clean water. This research sought to evaluate the microbiological quality of water used for human consumption in teaching units of the municipal public network in Maceió, Alagoas, and to verify the hygienic-sanitary conditions of the piping and water tanks.

METHODOLOGY

An observational and descriptive study was carried out, between February and May 2022, in schools and kindergartens of the municipal public system in the city of Maceió, Alagoas. This network has 142 teaching units. Of these, 121 units have drinking water supplied by the public network, and in 21 the supply comes from an artesian well. For this particular study, all teaching units whose water supply came from an artesian well were eligible, as there was no guarantee of the quality of that water. One teaching unit was not included in the study because, at the time of collection, the supply was being carried out by a third-party source.

Water samples from 20 teaching units were collected and analyzed. Samples were collected in sterile 100 ml bags containing 0.2 ml of 10% sodium thiosulfate solution to neutralize the action of residual chlorine. Water was collected from the unit's kitchen faucet and, additionally, when possible, directly from the artesian well. Before collecting the samples, the faucets had been previously cleaned with a 70% alcohol solution and then opened so that the water flowed for 2 to 3 minutes to eliminate impurities and water accumulated in the pipe. After collection, the samples were homogenized by inverting the collection bag, then placed in a styrofoam box with ice and transported to the Federal University of Alagoas. The time between collection and the beginning of the analysis did not exceed 24 hours, respecting a preselected analysis protocol (APHA, 2012).

The total coliform test was performed using the presence/absence (P/A) test with Colilert® substrate (Idexx, São Paulo, Brazil). The contents of a Colilert® blister were added to a 100 mL sample of water, slightly shaken, and incubated at 35 °C to 37 °C for 24 hours. After sample incubation time, the flasks were visually observed and those with a yellowish color were considered positive for total coliforms. The flasks positive for total coliforms were exposed to the
emission of ultraviolet light at a wavelength of 360nm, and those that showed fluorescence were considered positive for *E. coli* (APHA, 2012).

The interpretation of the results followed Consolidation Ordinance Nº. 5, of September 28, 2017, of the Brazilian Ministry of Health, which recommends the total absence of coliforms and *E. coli* in at least 100 mL of water (BRASIL, 2017). The microbiological quality of the collected water was then classified as “acceptable” or “unacceptable”.

To assess the hygienic-sanitary conditions of the plumbing and water tanks in the teaching units, a checklist was prepared based on legislation RDC 216/2004 (BRASIL, 2004) and Ordinance No. 326/97 (BRASIL, 1997). Issues related to the origin and treatment of water, conservation, registration, and procedures adopted for cleaning the water storage tanks were considered. Then, the data were analyzed and classified as compliant (C) and non-compliant (NC).

Categorical variables were presented through absolute and relative frequencies. The microbiological report of the water and the diagnosis of the hygienic-sanitary conditions of the plumbing and storage tanks of drinking water were issued. Based on the nonconformities found, a corrective action plan was prepared. All documents were handed over to the managers of the teaching units, for them to be aware of the results and take action on them.

**RESULTS**

28 water samples were analyzed, 19 of which were collected directly from the faucets in the kitchens of the teaching units and 9 from the artesian wells. Considering that, at the time of collection, in one teaching unit, the water from the kitchen tap came from a tanker truck, that sample was excluded. Due to the difficulty in accessing the wells, water was not collected at wells in 11 teaching units. Chart 1 describes the results of the microbiological analysis of the collected samples.

Among the samples collected directly from the kitchen taps (n=19), in 8 (42.1%), the water quality was unacceptable due to the presence of total coliforms. Of these, in 2 faucet samples (25.0%) there was still the presence of *E. coli*. In the samples from the wells (n=9), in 5 (55.5%) there was the presence of total coliforms, among which, 2 (40.0%) were positive for *E. coli*. Thus, of the 20 teaching units evaluated, in 10 (50.0%) the water quality was unacceptable.
Chart 1 – Microbiological quality of water in teaching units of the municipal public network in Maceió, Alagoas, 2022.

<table>
<thead>
<tr>
<th>Teaching unit</th>
<th>Teaching unit kitchen faucet</th>
<th>Pit artesian of the teaching unit</th>
<th>Quality standard water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>total credits</td>
<td>E coli</td>
<td>water quality</td>
</tr>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Presence</td>
<td>Presence</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>3</td>
<td>Absence</td>
<td>Absence</td>
<td>Acceptable</td>
</tr>
<tr>
<td>4</td>
<td>Presence</td>
<td>Absence</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>5</td>
<td>Presence</td>
<td>Absence</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>6</td>
<td>Presence</td>
<td>Absence</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>7</td>
<td>Presence</td>
<td>Absence</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>8</td>
<td>Presence</td>
<td>Absence</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>9</td>
<td>Absence</td>
<td>Absence</td>
<td>Acceptable</td>
</tr>
<tr>
<td>10</td>
<td>Absence</td>
<td>Absence</td>
<td>Acceptable</td>
</tr>
<tr>
<td>11</td>
<td>Absence</td>
<td>Absence</td>
<td>Acceptable</td>
</tr>
<tr>
<td>12</td>
<td>Presence</td>
<td>Presence</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>13</td>
<td>Absence</td>
<td>Absence</td>
<td>Acceptable</td>
</tr>
<tr>
<td>14</td>
<td>Absence</td>
<td>Absence</td>
<td>Acceptable</td>
</tr>
<tr>
<td>15</td>
<td>Absence</td>
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<tr>
<td>16</td>
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<td>Absence</td>
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<tr>
<td>17</td>
<td>Absence</td>
<td>Absence</td>
<td>Acceptable</td>
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<tr>
<td>18</td>
<td>Absence</td>
<td>Absence</td>
<td>Acceptable</td>
</tr>
<tr>
<td>19</td>
<td>Presence</td>
<td>Absence</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>20</td>
<td>Absence</td>
<td>Absence</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

Caption: C. totals: total coliforms. E. coli: Escherichia coli.

With regard to the hygienic-sanitary conditions of the units, of the n=19 (100%) evaluated water tanks, n=14 (73.7%) of them complied with current legislation, which determines the appropriate conditions for control of the potability of water for handling food within the recommended guidelines, that is, they were free of cracks, leaks,
infiltrations and peeling, presenting an adequate state of hygiene and conservation, in addition to being properly covered. Furthermore, in 80.0% (n=16), the tanks were built or lined with material that did not compromise the water quality. In most units n= 19 (95.0%), however, the tank cleaning was not carried out periodically, every 6 months, as recommended by RDC 216/2004 (BRASIL, 2004) and ordinance 326/97 (BRASIL, 1997), nor could they produce records that proved the performance of hygienization (Table 1).

Table 1. Sanitary hygienic conditions of pipes and water reservoirs in teaching units of the municipal public network in Maceió, Alagoas, 2022.

<table>
<thead>
<tr>
<th>Aspect rated</th>
<th>According to</th>
<th>No according to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>(%)</td>
</tr>
<tr>
<td>The potability of the water from the well is recorded semiannually through laboratory tests</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Well water chlorination and control records are available</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Water tanks are crack-free, with no leaks, infiltrations or peeling; they are in adequate state conservation and are duly covered*</td>
<td>14</td>
<td>73.7</td>
</tr>
<tr>
<td>Plumbing is in satisfactory state</td>
<td>16</td>
<td>80.0</td>
</tr>
<tr>
<td>The water tank is cleaned at maximum 6 month intervals</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td>There are records attesting to the hygiene of the water tank</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>The water tank is built or coated with material that does not compromise water quality</td>
<td>17</td>
<td>85.0</td>
</tr>
</tbody>
</table>

Caption: C- Conform, NC- no conform.

*In one teaching unit, this was not possible to be observed
DISCUSSION

In the present study, data analysis revealed a clear predominance of total coliforms as the main water contaminant in the schools visited, contrary to the provisions of Ordinance No. 05/2017 (BRASIL, 2017). Junior, et al. (2015) found similar results in a study carried out in 12 schools in the city of Rio Largo, Alagoas, where 58% of them (7 schools, 4 of which were public schools supplied by an artesian well) had water contamination by total coliforms.

This situation highlights the importance of paying attention to possible danger to students, as these data may indicate the presence of potentially pathogenic bacteria (DE PAIVA BARÇANTE, et al., 2014) in school water systems. Food, in general, can be contaminated by pathogenic bacteria and transmitted to humans as a result of precarious hygienic-sanitary conditions during processing and preparation (SIQUEIRA et al., 2010).

Foodborne Diseases (DTA) are characterized by a set of gastric disturbances, usually involving vomiting, diarrhea, fever, and abdominal pain. Bacteria, due to their diversity and pathogenesis, constitute, by far, the microbial group that is the most important and most closely associated with waterborne and later foodborne diseases. (VAN AMSON; HARACEMIV, CHAVES; MASSON, 2006).

Furthermore, our study reported the presence of Escherichia coli in two water samples that had total coliforms. In a study conducted by Faria, De Oliveira Paula, and Veiga (2013) in 21 municipal schools in Minas Gerais, one of the schools visited had the same enterobacteria in the water, indicating fecal contamination and insufficient sanitary conditions for children attending schools.

It is known that Escherichia coli is an enterobacterium that has high pathogenicity for humans, especially for children, who have relatively low immunity to this type of disease (FRANCO; LANDGRAF, 2006). Because of this, in addition to attesting to the unacceptability of water for human consumption, this pathogenic agent can cause diarrhea, fever, and colic, among other symptoms to those infected (MICHELINA et al., 2006).

It is important to point out that the schools in our study that had contaminated samples, for the most part, had tanks without lids or with lids made of material that did not protect the water from dirt/insects, in addition to the inadequate plumbing. According
to Rocha et al. (2010), this type of contamination can occur during the retraction of water in the public system. Most of the time, however, contamination is associated with poor hygiene conditions in the pipes and in the storage tank, which feeds the taps in these educational institutions.

Following this logic, the National Health Surveillance Agency recommends in RDC No. 216/04, that water tanks must be built and/or lined with materials that do not compromise the quality of the water, being free of cracks, leaks, infiltrations, and peeling, among other defects; they must have an adequate state of hygiene and conservation, and must be properly covered. In addition, the water tank must be sanitized, at least at six month intervals; and records of the operation must be kept, which was not happening in the units participating in the study (BRASIL, 2004).

Cardoso et al. (2010) conducted a study in public elementary schools in the city of Salvador (BA) using forms prepared based on Resolution nº 216/04, in a stratified sample of 235 schools. Regarding the water supply, the authors mention having found inadequacies, conditions also verified in the present work. In only 31.1% was there information regarding the monitoring of water quality and in only 8.1% was there a water potability record, a certificate issued by the responsible public body. Additionally, a little more than half of the schools (54.5%) reported only periodic cleaning.

This study constitutes a preliminary record of municipal public schools in the city of Maceió-AL that are supplied by an artesian well. It represents an important contribution to a needed debate on future interventions in the field of public and environmental health in these spaces. Towards this, it should be noted that access to drinking water is considered a fundamental right of the human person and is closely related to health promotion with a focus on healthy and sustainable environments. Access to good quality water is fundamental (FORTES, BARROCAS, KLIGERMAN, 2019).
CONCLUSION

The study reported on contamination by total coliforms and E.coli in the water used for food preparation in a most of the evaluated schools. The results indicate that the schools are not in concordance with the microbiological standards established by Brazilian legislation for human consumption. Thus, they risk transmission of waterborne and foodborne diseases from the water used to prepare beverages and food for the schoolchildren, and this risk is aggravated by involving a group that is more vulnerable to the action of microorganisms, the children.

In addition, most schools the cleaning of the tanks was not carried out periodically, nor did they have records of the most recent cleaning.

Therefore, these results point to the importance of adopting effective measures to control and monitor water quality in order to reverse the situation found in these schools.
REFERENCES


