WATER QUALITY OF THE MEIA PONTE RIVER IN THE CATCHMENT REGION FOR PUBLIC SUPPLY

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ABSTRACT

Purpose: This research aimed to evaluate the physical-chemical and microbiological quality of water in a certain region of the Meia Ponte river basin, through monitoring water quality parameters, and also to verify the interference of the rainy season in water treatment.

Methods: Physicochemical and microbiological analyzes were carried out, evaluating the following parameters: pH, turbidity, color, temperature, total coliforms and Escherichia coli. The location chosen to carry out the collections was the water collection point for public supply from the Meia Ponte River.

Results and conclusion: The physicochemical results obtained in this work were in accordance with CONAMA Resolution 357/2005 of the Ministry of the Environment; as for the microbiological results, which are based on CONAMA 374/2000, only the verified values for Escherichia coli are in accordance with the resolution.

Research implications: The conservation of water sources is extremely important to ensure that the quality and quantity of treated water are in satisfactory condition to meet the population's demand. The quality of the water will depend on the activities that are carried out around the river basin.

Originality/value: Verification of the interference of seasonality typical of the region, in the quality of water for public supply.

Keywords: Supply Source, Conservation, Physical Chemistry, Coliforms.

QUALIDADE DA ÁGUA DO RIO MEIA PONTE EM REGIÃO DE CAPTAÇÃO PARA ABASTECIMENTO PÚBLICO

RESUMO

Finalidade: Esta pesquisa teve como objetivo avaliar a qualidade físico-química e microbiológica da água em uma determinada região da bacia hidrográfica do rio Meia Ponte, através do monitoramento dos parâmetros de qualidade da água, e também verificar a interferência da estação chuvosa no tratamento de água.

Métodos: Foram realizadas análises físico-químicas e microbiológicas, avaliando os seguintes parâmetros: pH, turbidez, cor, temperatura, coliformes totais e Escherichia coli. O local escolhido para realizar as coletas foi a captação de água para abastecimento público do rio Meia Ponte.

Resultados e discussão: Os resultados físico-químicos obtidos neste trabalho se encontraram de acordo com a Resolução CONAMA 357/2005 do Ministério do Meio Ambiente; já os resultados microbiológicos, que se baseiam na CONAMA 374/2000, apenas os valores verificados de Escherichia coli estão de acordo com a resolução.

Implicações da pesquisa: A conservação dos mananciais é de extrema importância para garantir que a qualidade e a quantidade da água tratada estejam em condições satisfatórias para atender a demanda da população. A qualidade da água dependerá das atividades que são realizadas em torno da bacia hidrográfica.

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1 INTRODUCTION

Water consumption is indispensable for life, but it can be a means of transmitting diseases if it is contaminated with etiological agents, which can be viruses, protozoa, bacteria, fungi, and other microorganisms. For many years various diseases have spread in this way (LIBANiUM, 2008).

Water is used for various purposes, such as shipping, fishing, power generation, domestic, industrial and agricultural supply. According to the National Agency for Water and Basic Sanitation (ANA, 2018), about 97.5% of the world's water is unfit for human consumption, with only 2.5% being suitable for consumption, most of this percentage is difficult to access, with only 1% being found in surface water sources and Brazil holds about 12% of all the world's fresh water, in ponds, rivers, streams, streams and aquifers.

Water is essential to life on the planet, to the conservation of ecosystems (Bicudo, Tundis & Scheuenstuhl, 2010) and to socio-economic development, and so it is a strategic asset (Carvalho, Lacerda, Carvalho, Lopes & Andrade, 2020) apud Daronco et al. (2023).

Knowing the importance of this good, the conservation of the water sources is of extreme importance, to ensure that the quality and quantity are in satisfactory conditions to meet the demand of the population. The quality of the water will depend on the activities that are carried out around the basin. The activities that are carried out define the classification of bodies of water and it is in accordance with Resolution CONAMA 357/2005 that the conditions and standards of effluents are established for bodies of water (SPERLING, 2005).

Legislation dealing with the limits of raw water parameters is mainly two: CONAMA 357 (2005) which concerns the physico-chemical parameters and CONAMA 274 (2000) for the bacteriological parameters.

Water turbidity occurs due to the presence of suspended particles, which reduce their transparency, and is measured by scattering the light they cause. The apparent color is also linked with the presence of suspended particles, which is measured by spectrophotometry. Another parameter in which suspended particles influence the result is in apparent color (DI BERNADO, L., PAZ, L. P. S., 2008).

In order to analyze whether the parameters are within the permitted standards, the data obtained should be compared with the maximum permitted values (MWV) according to the current legislation. In respect of the physico-chemical parameters, the legislation that governs is CONAMA 357/2005, where it classifies the types of water between 5 classes, special class and classes 1 to 4, where it determines the destination of the water.

Microbiological analyzes are of fundamental importance in determining water potability, because waters with contaminating microorganisms present a risk to the community because of their potential to transmit diseases. The presence of total coliforms may suggest fecal contamination of water, but only the presence of Escherichia coli is directly related to this type of contamination.
In view of the pathogenic potential of these micro-organisms, the water must be free from bacteria indicating fecal contamination. In order to determine whether raw water is within the established standards, the legislation governing biological parameters is CONAMA 274/2000 (SPERLING, 2005).

The present study aimed to evaluate the physical-chemical and microbiological quality of water in a given region of the river basin of the Meia Ponte river, through the monitoring of water quality parameters, and also to verify the interference of the rainy season in the water treatment.

2 MILESTONE

Brazil has great availability of water resources, but due to uncontrolled urbanization and extensive deforestation for agriculture and livestock, many of these resources are in poor quality, making it unfeasible to economically treat this water and damaging the entire aquatic ecosystem.

This poor quality and poor management of water resources is a serious problem, which due to climate change and to the large population growth of some Brazilian cities, have begun to face problems with water scarcity, like the water crisis in São Paulo. Therefore, it is well known that basic sanitation combined with the preservation of water sources is of great importance for the existence of quality water for all (Di BERNARDO, L.; DANTAS, A. Di B., 2017).

Sanitation covers four strands: water supply, sewage, urban drainage and collection and proper disposal of solid waste. Since failure to comply with one of these affects the development of the other. The quality of the water from the surface water sources, used to capture water, is deteriorating due to the deficiency of the urban drainage system, which ends up taking the water from the surface runoff to inside the water sources, water this one, which contains various solid and pollutant residues, due to the problems in the collection and disposition of the solid residues, which aggravates the quality of the water sources.

Surface waters in streams, rivers and lakes and groundwater are characterized by instability and mobility in a constant and dynamic cycle called the hydrological cycle. This dynamic can be compared to a large flow in which one of the sources is the springs of water, defined as natural outcrops of water, forming a watercourse (JUNG et al., 2023).

Effluent discharges, even if allowed and if they follow the standards set in CONAMA Resolution 430 (2011), alter the quality of the water, since the inspection by the environmental agencies cannot meet the existing demand.

The most important place in the whole water supply system is the source of abstraction, because it will determine the quantity and quality of water that arrives at the water treatment plant (ETA), and the location of this source determines its susceptibility to pollution and contamination (DI BERNADO, L., PAZ, L. P. S., 2008).

The treatment of water aims to remove pathogenic microorganisms, which are causers of diseases, and the aesthetic inconveniences, which are the physical characteristics that can lead to the rejection of the water distributed by the population (LIBANIUM, 2016). Therefore, it seeks to offer a drinking water, which is that which obeys the standards established by Ordinance 005, Ministry of Health (2017).

The Meia Ponte River is one of the main sources of water supply for the State of Goiás, and it is very important that the quality of water is maintained throughout its water course, complying with the established law. In the Meia Ponte River basin there is use of water for supply, power generation, irrigation, fish farming and removal and dilution of sewage (SANEAGO, 2011).
The Meia Ponte river runs 415 km to its mouth, draining 37 municipalities of the state of Goiás. It has its sources in the municipalities of Itauçu and Taquaral de Goiás, and its mouth in the Paranáiba river, in the municipality of Cachoeira Dourada that is bordered by the state of Minas Gerais. In the Meia Ponte river, the negative effect of urban occupation and anthropic activity is evident, generating diffuse and punctual polluting contributions to the water sources that supply the city, compromising the quality of its waters (VASCONCELLOS et al., 2002).

The Meia Ponte River basin is classified under CONAMA 357 (2005) as class 2, in which the waters may be used for human consumption, after conventional treatment, for the protection of aquatic communities, for primary contact recreation, for irrigation, for fishing, for aquaculture and for treatment, for public supply. It has been observed that in the basin there are animals, industries, waste, illegal sewage, urban expansion, agro-toxins, vegetables, crops, pivots, corrals, pasture, fish farms, dams, pig farms and chickens that are causing pollution and degradation of the source (SANEAGO, 2020).

3 METHODOLOGY

3.1 Characterization and Location of the Study Area

According to Veiga et al. (2013) the climate of the region where the Meia Ponte river basin is located is tropical humid, has two well-defined seasons: drought, which occurs between April and September; and rainy, which occurs between October and March.

The Meia Ponte river basin, with a drainage area of 1,631.65 km², is located in an area of high population density, with 2,813.36 inhabitants per square kilometer, due to the metropolitan region of Goiânia. The last demographic census put the sum of 1,802,210 inhabitants in the towns that are inserted into the basin.

These cities are: Brazabrantes, Damolândia, New Venice, Santo Antônio de Goiás, which are fully inserted into the basin; Caturai, Goiânia, Goianira, Inhumas, Itauçu, Nerópolis and Ouro Verde de Goiás that have the highest percentage of territories inserted into the basin, about 95.5%, and Anápolis, Campo Limpo de Goiás, Petrolina, Santa Rosa de Goiás, and Taquaral de Goiás that sum the territories have less than 5% of these inserted into the basin (IBGE, 201010; SGEI, 2000; SGEI, 2 017).

The assessment of water quality in the region of the Meia Ponte river basin was carried out near the point of abstraction for supply of the city of Goiânia, in the Meia Ponte river, located at the coordinates 16°34'10.9"S and 49°19'44.5"W, as illustrated in Figure 1.
3.2 Sampling

Sampling of raw water occurred at three points, shown in Figure 2, P1 upstream of the dam, P2 and P3 downstream of the dam, one on the right bank, and the other on the left bank of the river. The first place before the capture and the others after the capture of the Meia Ponte river, following the standards of sampling of the Environmental Company of the State of São Paulo - CETESB (2011).

The parameters analyzed were divided into physicochemical and bacteriological, such as: temperature, turbidity, color, pH, total coliforms and *Escherichia coli*. The analyzes were
carried out at the Sanitation laboratory and at the Biology laboratory of the School of Civil and Environmental Engineering of the Federal University of Goiás (EECA-UFG).

Two collections were made. Water sampling was carried out in the rainy month of December 2019. The samples were collected in 1 liter plastic bottles and 300 ml glass bottles.

The technique used to preserve the samples was a thermal box with refrigeration (ice). A blank sample, used for transport and for the flask, was used in all the samples to check for contamination in the flasks autoclaving and influence on the transport of the samples.

3.3 Analyzes of Physico-chemical and Microbiological Parameters

The parameters and methods of the analyzes carried out in the water quality monitoring of the Meia Ponte river, were following methodology described in the Standard Methods for the Examination of Water and Wastewater (2012), and are presented in table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Method/Reference</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-</td>
<td>4500B</td>
<td>pHmeter PG2000</td>
</tr>
<tr>
<td>Turbidity</td>
<td>uT</td>
<td>2130B</td>
<td>2100P Turbidimeter</td>
</tr>
<tr>
<td>Color</td>
<td>uC</td>
<td>2120C</td>
<td>Polycontrol spectrophotometer</td>
</tr>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>2550B</td>
<td>Chemical thermometer</td>
</tr>
<tr>
<td>Total coliforms</td>
<td>PWN/100 ml</td>
<td>9221F</td>
<td>Incubator, Quanti-tray IDEX kit</td>
</tr>
<tr>
<td>E. coli</td>
<td>PWN/100 ml</td>
<td>9221F</td>
<td>Incubator, Quanti-tray IDEX kit</td>
</tr>
</tbody>
</table>

Source: APHA (2012)

3.4 Preparation of the Mapping Basis

In this stage, the preparation of the maps was carried out, using the Geographic Information System (GIS) program, QGis. The map was made using data from the State Geoinformation System of Goiás (SGEI) and the Brazilian Foundation for Sustainable Development (FBDS), from which the following data were extracted: hydrography, municipal limit of Goiás, limit of the hydrographic basin of public supply and capture of public supply. The sampled points were obtained through the use of GPS.

4 RESULTS AND DISCUSSION

The following parameters obtained considerably different values in comparison with other studies previously carried out in the evaluated region: turbidity, apparent color and temperature. In the study by Carvalho and Siqueira (2011), where the object of study was the water quality of the Meia Ponte river in the urban perimeter of the municipality of Goiânia, Goiás, where 6 sampling points were chosen, the research was developed between the years 2004 to 2008, the average value of turbidity was 41.63, a value almost twice less than that found in the Meia Ponte river catchment. The average apparent color between the years 2004 and 2008 was 271.62 and 675.50 in the rainy period of the present study. There was a temperature variation of almost 2.5°C between the studies.

The mean values obtained from total coliforms of 18,781.2 MPN/100 ml were 18 times higher than permitted by legislation, and Escherichia coli of 81.0 MPN/100 ml. Thus, only the values presented for Escherichia coli are in line with CONAMA 274/2000. Thus, according to the applicable legislation, the passage under study is considered inappropriate.

The mean pH found in the study by Carvalho and Siqueira (2011), was 7.44, resulting from the years 2004 to 2008, in this period the maximum value found in the urban perimeter of Goiânia was 7.99, and the average value found in this study in the uptake of the Meia Ponte
river was 8.49, and the highest value obtained was 9.06 at collection point 01. The results of the analyzes performed are presented in Table 2.

It is possible to associate the differences in values found in the two studies due to the periods that the collections were carried out, four of the five collections carried out by Carvalho and Siqueira (2011) were carried out in the month of May, period considered drought, and only one collection was carried out in a period considered rainy.

Table 2. Results obtained from the parameters assessed in the rainy period

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Point 1</th>
<th>Point 2</th>
<th>Point 3</th>
<th>Legislation (VMP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium</td>
<td>Standard Deviation</td>
<td>Medium</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>pH</td>
<td>8.68</td>
<td>0.38</td>
<td>8.43</td>
<td>0.13</td>
</tr>
<tr>
<td>Turbidity (Ut)</td>
<td>103.50</td>
<td>32.50</td>
<td>73.00</td>
<td>0.0</td>
</tr>
<tr>
<td>Apparent color (uC)</td>
<td>1120.00</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>24.80</td>
<td>0.0</td>
<td>25.3</td>
<td>0.20</td>
</tr>
<tr>
<td>Total coliforms (NMP/100 ml)</td>
<td>16,465</td>
<td>15,374</td>
<td>14,882</td>
<td>14,342</td>
</tr>
<tr>
<td>Escherichia coli (NMP/100ml)</td>
<td>90.72</td>
<td>30.28</td>
<td>107.69</td>
<td>24.32</td>
</tr>
</tbody>
</table>

* There is no legislation determining the maximum permitted values (MWV) for these parameters in raw water.

Source: Authors (2020)

It can be noticed that the parameter of turbidity has the largest standard deviation found, 32.50 uT, following by the pH, 0.38 and the temperature 0.20°C.

The average values verified in the physicochemical analyzes carried out are in accordance with the standards established by CONAMA 357/2005, which provides for the classification of bodies of water and environmental guidelines for their framing.

However, the values found from the microbiological parameters sampling are not all in conformity according to CONAMA 274/2000, which defines criteria for sealing in the national territory, which has two categories improper and proper, the latter being subdivided into three sub-items: excellent, very good and satisfactory. The maximum values allowed by this resolution under satisfactory conditions are 1000 NMP/100 ml for total coliforms and 800 NMP/100 ml for E. coli.

Also according to CONAMA 274/2000, the waters will be considered unfit when in the assessed water segment, the criteria established for the proper waters are not met, the value obtained in the last sampling is higher than 2,500 coliforms total per 100 ml or 2,000 E. coli per 100 ml, and pH less than 6.0 or greater than 9.0, except for natural conditions.

5 CONCLUSIONS

The study made it possible to evaluate the quality of the water at the point of capture of the Meia Ponte river in Goiânia, using an analysis of the parameters of pH, turbidity, color, temperature, total coliforms and E. coli and to verify the interference of the rainy season in the quality of the water.

It can be observed that the bacteriological analyzes are not in accordance with CONAMA 274/2000, for these analyzes carried out. However, the physico-chemical parameters are in line with the current legislation, Conama 357/2005. Although not all of the parameters were in conformity with the regulations in force, after conventional treatment, and
with compliance with the standards of potability, this water can be regarded as suitable for supplying the public.

Collections carried out in the rainy month may show characteristics different from those carried out in dry months, knowing this, it is suggested to carry out more collections at the study point, at different times of the year, for the verification of the interference of seasonality in the quality of the water.

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