

Water quality assessment for balneability at Porto Real beach, Porto Nacional/TO

The environmental problems with each passing day has been gaining greater prominence in the news media of the whole world, but in a negative way. Water, an exhaustible natural resource, has been suffering enough through the misuse socioeconomic and environmental problems, pollution of resources water. With the population growth, the cities are receiving industrial facilities and this generates an increase of waste dumped, affecting the groundwater, and consequently affecting the quality of the water. With that, this study was carried out to evaluate the water conditions of beach Porto Real located in the river of Tocantins, in Porto Nacional/TO, for the purpose of bathing, accordance with the resolution CONAMA nº 274/00. The Coliliert method was used to obtain the values of faecal coliforms and the bacterium e-coli, the results showed low values, more than satisfactory, therefore, in the research period, Praia Porto Real waters presented satisfactory parameters in the bathing requirement.

Keywords: Environmental problems; Balneability; Water quality.

Avaliação da qualidade das águas para balneabilidade na praia Porto Real, Porto Nacional/TO

Os problemas ambientais a cada dia que se passa vêm ganhando maior destaque nos meios de notícias do mundo inteiro, porém de forma negativa. A água, um recurso natural esgotável, vem sofrendo bastante, por meio da má utilização, falta de consciência, problemas socioeconômicos e ambientais, poluição dos recursos hídricos, e etc. Com o crescimento populacional, as cidades passam a receber instalações industriais e isso gera um aumento de dejetos lançados, afetando o leito de rios e lagos, e conseqüentemente afetando a qualidade da água. Com isso, esse estudo foi realizado para avaliar as condições da água da Praia Porto Real, situada no Rio Tocantins em Porto Nacional/TO, para fins de balneabilidade, de acordo com a Resolução CONAMA 274/2000. Utilizou-se do método Coliliert para obtenção dos valores de coliformes fecais e da bactéria e-coli, os resultados apresentaram valores baixos, mais do que satisfatório, portanto no período de pesquisa as águas Praia Porto Real, apresentaram parâmetros satisfatórios no requisito balneabilidade.


Palavras-chave: Problemas ambientais; Balneabilidade; Qualidade das águas.


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INTRODUCTION

Our planet is affected by several environmental problems and issues, many of them caused by human action itself, these problems are currently being treated with significant importance, and satisfactory, but this treatment can not only, but must increase. The topic addressed here is water, a natural asset essential for the survival of all living beings on Earth. Water is a vital resource and is part of a set that ensures the existence of all living beings on the planet.

According to Lustosa (2018), water is an indispensable resource for life to exist because it has an indispensable role in maintaining vital functions of the organism, this natural asset besides promoting life has multiple functionality, it is used for food production, fishing, cooking food, power generation, navigation in order to transport people or goods and also for leisure among other activities.

Brazil is considered privileged when it comes to its natural resources, has a vast and rich biodiversity and a large amount of fresh water. Brazil is surrounded by beautiful scenery, which ends up being inviting to bathing and attracts tourists from all over the world. According to ANA (2019), Brazil has about 12% of all surface freshwater in the world, and some of the largest underground reservoirs. There are a lot of people who visit attractive places for bathing, recreational activities, and come into contact with water, this factor ends up raising concerns about the quality of these waters. Some of these waters are subject to analysis and verification of their quality, in order to prevent diseases.

Irregular activities, such as the discharge of effluents in inappropriate places, performed by residents of areas close to the waters used for recreation, significantly affect the quality of the water. In these places the degradation of natural resources such as water pollution, creates problems for both the stream/river and for the health of those who come into direct contact with these waters. Knowing this, we will address in this research project the bathing conditions of Beach Porto Real which is located on the Island Porto Real in Porto Nacional - TO.

For ANA (Agência Nacional das Águas - National Water Agency) bathing is the way to check if the water in a given location has the capacity to perform recreational activities in direct contact with it, this verification occurs through analysis of the water quality indicator parameters. Therefore, it is very important to highlight some problems that directly interfere with environmental degradation, facilitating access to the contamination of water resources, changing water quality and also people's health.

In accordance with Lustosa (2018), the evaluation and periodic monitoring of water quality for bathing purposes are extremely important, can help in reducing the impacts on the local economy, in raising the environmental quality of the river and in increasing sanitary security, well-being and health of the population, and tourists looking for leisure resorts practices. According to Lima et al. (2011), the amount of drinking water available is becoming an increasingly worrisome problem worldwide. This is due to several factors such as climate change, pollution of the environment, illogical and unsustainable consumption of this resource, and also the great population growth.

According to Hirata (2001), the problems involving water resources are directly linked to human

actions. The overexploitation of water bodies or misuse stands out, degrading and contaminating them. Inadequate use of water resources generates unusability for different media. Examples of inappropriate use are the dumping of domestic sewage, agricultural waste, industrial waste disposal and waste, often by the population itself and among other practices.

Therefore, the present work evaluated the water conditions of Porto Real Beach, located on the Tocantins River in Porto Nacional - TO, for bathing purposes, according to CONAMA Resolution 274/2000. Bearing in mind that the research site receives a large number of people, both locals and visitors, in search of leisure, performing aquatic recreational practices of primary contact, such as swimming, therefore it is necessary to study the bathing of the place from time to time, aiming to preserve the health of these people who seek to enjoy the place.

THEORETICAL REVIEW

Water in nature

ANA (National Water Agency) estimates that 97% of the existing water is present in the oceans, therefore salty and unsuitable for direct consumption and inadequate irrigation of the plantation, and 2.5% is found in glaciers and polar ice caps. Therefore, only the remaining 0.5% are fresh water in liquid form, of this small amount 97.9% are groundwater and only 1% of all fresh water, being found in the form of rivers, lakes.



Figure 1: Water distribution in the world. Source: ANA (2019)

According to Grassi (2001), water is a fundamentally important resource for the existence of life on the planet, it is a means of survival mainly for humanity, and this water that is used in food production, irrigation of plantations and as a universal solvent in cleaning and transportation of virtually all human-generated waste.

Water is a vital asset, it would be impossible to list all the uses of such an asset, however it is possible to visualize broad categories of water uses, namely: food and hygiene; industrial production; electricity generation; irrigation; navigation; fishing; leisure and sports. Due to the vital dependence of this resource,

rational use and conservation is important, so that the volume of water available on the planet meets the needs of the population.

Balneability

According to CETESB (2017), waters destined for the recreation of primary contact, that is, direct contact such as swimming, diving, water skiing, etc., whether fresh, brackish and saline waters, the possibility of being ingested by the bather is great. As for the activities of secondary or indirect contact such as navigation and fishing, the possibility of drinking water is very small, since it occurs accidentally. Bathing is the water quality for primary contact recreation purposes, based on the level of presence of faecal coliforms in the site. Aureliano (2000), states that bathing is a means of evaluation where there is an analysis of the sanitary conditions of waters destined for the recreation of direct and prolonged contact with water, in which there is a high possibility of the bather ingesting significant amounts of it.

Criteria For Balneability Assessment

According to CETESB (2017), the basic indicator parameter for the classification of the beaches according to their bathing capacity is the intensity of faecal coliforms present on the site, the presence of sewage on the beaches, such as: collection and disposal systems generated in the vicinity, tourist influx during periods of season, physiography of the beach, occurrence rainfall, among others, are factors that influence this parameter.

CONAMA Resolution No. 274, of November 29, 2000, defines, coliforms are bacteria, in the form of bacilli, in addition to being present in human and animal feces, they occur in soils, plants or other environmental matrices that have not been contaminated by fecal material, it also pre-establishes values of these indicators, so that it can be identified if the water quality is favorable or not to the bath.

Article two, paragraphs one and four of Resolution 247 of CONAMA (2000), defines the evaluation conditions in the proper and improper categories, the third article is about interdiction if the specifications required in the previously cited articles are not met:

§ 1 The waters considered as own may be subdivided into the following categories:

a) Excellent: when 80% or more than one set of samples

obtained in each of the previous five weeks, collected in the same place, there are a maximum of 250 fecal coliforms (thermotolerant) or 200 *Escherichia coli* or 25 enterococci per 100 milliliters;

b) Very Good: when 80% or more of a set of samples

obtained at home one of the previous five weeks, harvested at the same place, there are a maximum of 500 fecal coliforms (thermotolerant) or 400 *Escherichia coli* or 50 enterococci per 100 milliliters;

c) Satisfactory: when 80% or more of a set of samples

obtained in each of the previous five weeks, collected in the same place, there are a maximum of 1,000 fecal coliforms (thermotolerant) or 800 *Escherichia coli* or 100 enterococci per 100 milliliters.

§ 4 The waters will be considered IMPROPER when in the evaluated stretch, one of the

following occurrences is verified:

- a) Failure to meet the criteria established for own waters;
- b) The value obtained in the last sample is greater than 2,500 fecal coliforms (thermotolerant) or 2,000 *Escherichia coli* or 400 enterococci per 100 milliliters;
- c) High or abnormal incidence, in the region of collection, of water-borne diseases, indicated by the health authorities;
- d) Presence of solid or liquid waste or dumping, including sanitary sewage, oils, greases and other substances capable of posing health risks or making recreation unpleasant;
- e) pH < 6,0 ou pH > 9,0(fresh water), except for natural conditions;
- f) Flowering of algae or other organisms, until it is proven that they do not pose risks to human health;
- g) Other factors that temporarily or permanently contraindicate the exercise of primary contact recreation.

Table 1: shows the classification of water in relation to bathing according to Resolution 274/2000.

Category	Fecal Coliformes (NMP/100ml)*	Escherichia Coli (NMP/100ml)*
Excellent	< 250	< 200
Very good	< 500	< 400
Satisfactory	< 1000	< 800
Improper	Above 2500	Above 2000

* NMP: Most likely number per 100ml., In 80% or more of a set of samples obtained in each of the previous five weeks.

Source: CONAMA RESOLUTION No. 274 (2000).

Fecal Coliforms (Thermotolerant)

CONAMA resolution 274/2000 defines faecal coliforms as being Bacteria belonging to the group of total coliforms characterized by the presence of the β -galactose enzyme and the ability to ferment lactose with gas production in 24 hours at a temperature of 44-45 ° C in media containing bile salts or other surfactants with similar inhibitory properties. In addition to present in human and animal feces, they can also be found in soils, plants or any effluents containing organic matter.

In general, fecal coliforms are bacteria found in the intestines and feces of men and homothermal animals (animals maintain body temperature between 35 and 40°C), so the best term to adopt is thermotolerant coliforms. However, some bacteria belonging to this group may come from organic matter as stated in the CONAMA resolution.

A probable source of polluting load of faecal coliforms found in water is due to human occupation and land use, factors such as agricultural activity with its extensive animal activities (dairy, beef, swine, poultry and horses) in association with the non-treatment of waste generated, domestic effluents (TRAFICANTE, 2011). In the rainy season there is an increase in runoff and leaching in areas where human dwellings with pits are present, it is one of the main aspects responsible for the increase in the number of faecal coliforms in water bodies (SOUZA et al., 2008).

Escherichia Coli (E. COLI)

Escherichia coli, according to CONAMA resolution 274/2000, is a bacterium belonging to the Enterobacteriaceae family, characterized by the presence of β -galactosidase and β -glucuronidase enzymes. It

grows in a complex medium at 44-45 ° C, ferments lactose and mannitol with production of acid and gas and produces indole from the amino acid tryptophan. *Escherichia coli* is abundant in human and animal feces, having only been found in sewers, effluents, natural waters and soils that have received recent fecal contamination. According to that resolution, freshwater bathing conditions are assessed in categories, defined according to *Escherichia coli* levels.

For Barrell (2002), for bacteria to be considered ideal indicators of fecal pollution, they must be present in large numbers in human and animal feces; and also in wastewater, be detectable by simple methods, not be present in clean water. *Escherichia coli* from the coliform group, meets most of these criteria and its presence in water samples may indicate contamination by other intestinal pathogens. However, the absence of *E. coli* does not always mean that there are no other intestinal pathogens. *E. coli* is the only biotype in the Enterobacteriaceae family that can be considered exclusively of fecal origin. FIGURE 2 is a scheme for dividing faecally contaminated bacteria into groups.

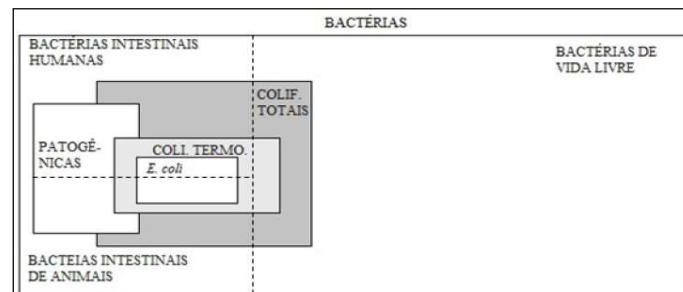


Figure 2: Schematic representation of bacteria and fecal contamination groups.

Water Diseases

Demographic growth and industrial development are causing land occupation quickly and intensively, and has significantly influenced the increase in pollution and water contamination. These factors end up compromising the existence of water resources for human consumption, recreation and various other activities, increasing the danger of the spread of water-borne diseases (SOUZA et al., 2005). Basic sanitation is directly related to water, as it has several essential nutrients to guarantee a healthy life. Waterborne diseases pose a great risk to human health. Therefore, it is relevant to establish policies for the protection and control of the environment, in which basic sanitation fits (HEMPRICH, 2015).

As stated by Pinheiro (2015), waterborne diseases are caused by the transmission of the infectious agent through water by ingestion (direct consumption of contaminated water or consumption of sanitized food with contaminated water) or by direct contact with the skin during the bath. The lack of basic sanitation in some regions can cause infectious diseases due to the contamination of water in rivers and lakes by the discharge of untreated sewage and by human and animal waste.

According to Berg et al. (2013), water courses contaminated by domestic sewage, when they come into contact with the waters of bathing areas, can put bathers exposed to various bacteria, viruses and protozoa. Therefore, the importance of assessing water health standards in bathing regions, since waters outside this standard, increase the possibility of acquiring diseases, leading, in some cases, to these diseases

can lead to death. Microorganisms are responsible for transmitting waterborne diseases to bathers, which are described in TABLE 1.

Table 1: Waterborne diseases.

Diseases	TRANSMISSION	SYMPTOMS
Cholera	Contaminated water, raw food and flies.	Diarrhea, feces similar to rice water, thirst, pain and coma.
Typhoid fever	Contaminated water, milk, dairy products, oysters, food and flies.	General infection, characterized by continuous fevers, pink spots, diarrhea.
Leptospirosis	Contaminated food, water or soil or excrement and urine from infected animals.	Fever, headaches, nausea, muscle pain, vomiting, thirst and prostration.
Amebiasis	Contaminated water, raw food, flies and cockroaches.	Abdominal discomfort, diarrhea, bleeding in the stool.
Ascariasis-Helminths	Food, contaminated water and sewage.	Stool worms, abdominal pain, skin rashes and nausea.
Schistosomiasis	Contaminated water	Diarrhea, dermatosis, cirrhosis of the liver, disorders of the spleen.
Hookworm	Water and raw food	Intestinal disorders, abdominal pain, vomiting, sleep disturbance.
Infectious Hepatitis (A and B)	Water, food, milk, direct contact.	Fever, nausea, headache, loss of appetite, possibly vomiting and fatigue.
Polio	Direct contact and through the sewer network.	Fever, headaches, malaise and paralysis.

Source: Cesa (2008).

The increase in runoff and leaching in areas where human dwellings with pits are present, in the rainy season, is one of the main aspects responsible for the increase in the number of faecal coliforms in water bodies (SOUZA et al., 2008).

MATERIALS AND METHODS

The location chosen for this research was the Porto Real beach, located on the Porto Real island, located on the Tocantins River. The municipality of Porto Nacional is located in the central region of the state of Tocantins, approximately 64 km from Palmas, the state capital, its territorial area is 4,449 km², it is the fifth largest municipality in the state. It is estimated that the city has a population of 53,010 inhabitants (IBGE, 2019). Porto Real Beach is located on the Tocantins River, and is located between the parallels 10 ° 41'44 "S and 48 ° 25'08" W, 224 m above sea level south of the municipality of Porto Nacional, as shows figure 3.

The conduct of this research was experimental, it verified the quality of the water that bathes Praia Porto Real, through tests and laboratory analyzes. It also makes it possible to carry out a descriptive analysis. The purpose of this research is to prove if the parameters and results obtained are satisfactory, that they can seek maximum water quality in the researched region, proving if the water that is providing leisure to bathers is in its proper conditions.

In this project, monitoring was carried out during the months of February and March, totaling a period of six weeks. The point was demarcated through the global positioning system (GPS navigation model GARMIN-60CSx), the definition of the sampling points was carried out following the parameters contained in NBR-9897, which goes directly to the planning of sampling of liquid effluents and receiving bodies.

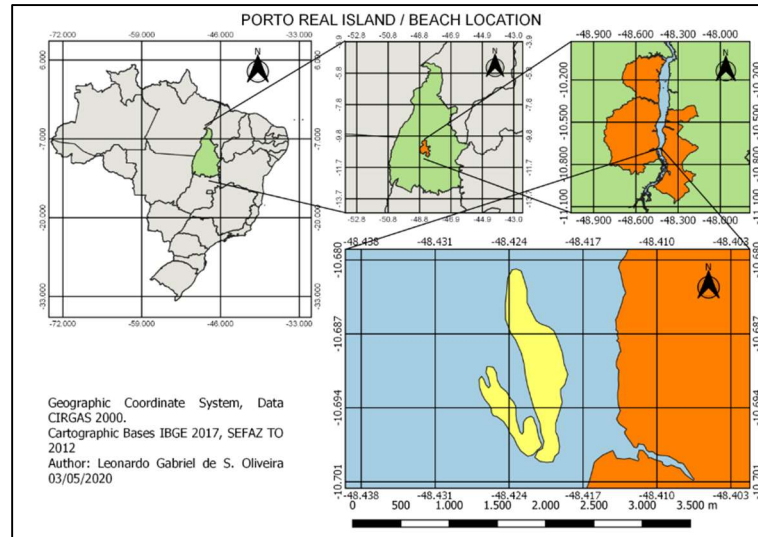


Figure 3: Porto Real Beach, Porto Nacional-TO.

The samples were collected weekly, using 100 ml sterilized glass containers, approximately 25 cm deep and 6 meters away from the margin. The points chosen for collection were selected according to the location where there is the highest concentration of people bathing on the beach, following Art. 5, single paragraph of Conama Resolution No. 274/2000. Figure 4 shows the model of the container that will be used in the collections.



Figure 4: Example of collector. **Source:** Netlab (2019).

In the collection of material for data analysis, disposable gloves and sterilized flasks were used, and the samples collected in the field were stored in a thermal box with ice to be transported to the IFTO chemistry laboratory. The collected samples were transported to the laboratory of the IFTO - Campus Porto Nacional, from then on microbiological analyzes were started on the E. Coli group, based on the collilert technique according to the methodology described by Standard Methods (APHA, 2005).

The Colilert method is widely used in this type of research. The culture medium (Colilert enzyme) is already in the right amount for the analysis of 100 mL of water; each enzyme will be added to the 100ml flask with the sample that will be collected and stirred until the granules are completely diluted. After that, the solution is incubated at 35°C in an oven for 24 hours. The parameters followed were determined by CONAMA resolution 274/2000, the bacterium E. coli is adopted as a microbiological indicator of bathing.

RESULTS AND DISCUSSION

The collection of samples for monitoring water quality in the region of Praia Porto Real occurred in

February and March of the year 2020. The incidence of rain in the research period was high, water showed high turbidity due to suspended solids from the agitation of the waters. The high rate of water turbidity can be caused by erosion of river banks in rainy periods, or by the bad use of the soil in which vegetation is prevented, a fact that may indicate a possible contamination of water.

At the end of the research period, four of the six samples presented fecal coliforms, and only three had the presence of E-coli with values below the minimum recommended by the CONAMA resolution 274/00, which defines that when in 80% or more than one set of samples obtained in each of the five weeks, a maximum of 200 *Escherichia coli* is found, the waters are considered proper and fall into the excellent category for bathing purposes. As shown in figure 5.

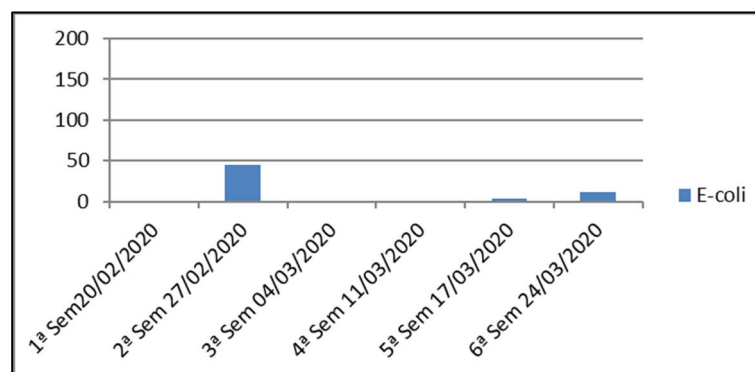


Figure 4: E-Coli concentration.

According to Morais et al. (2012), the runoff of water from rain can end up contaminating the water, by transporting waste and feces from homeothermic animals or by the presence of ditches and the absence of a sewage system nearby. However, the precipitation in the research period did not have a negative change in the results, aiming that the study site is on a small island, inhabited by a very small number of animals and only 2 families.

On 02/27/2020 there was no rain, but the sample had the highest level of E-Coli which was 45.2 (NMP/100ml), on 03/17/2020 there was no precipitation, the sample showed very low values of E-Coli, in the other days of collection there was rain, but in the rainy days only the sample of 03/24/2020 presented the biological indicator E-Coli, the other samples did not present the biological indicator.

CONCLUSIONS

According to the results of the analysis of samples collected during the research period, it can be concluded that at the point of study the waters of Porto Real beach located on the Tocantins River in the city of Porto Nacional, for bathing purposes, had an adequate result for use. Comparing the data of the results obtained in this study with that specified by the CONAMA resolution 274/2000, it is concluded that the water quality in the research site presents its own condition and is classified in the excellent subcategory, because in all samples the E. coli values presented were less than 200 CFU / 100 ml.

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