

# DETECTION AND EVALUATION OF THE PRESENCE OF ENTEROCOCCUS IN THE FÚQUENE LAGOON

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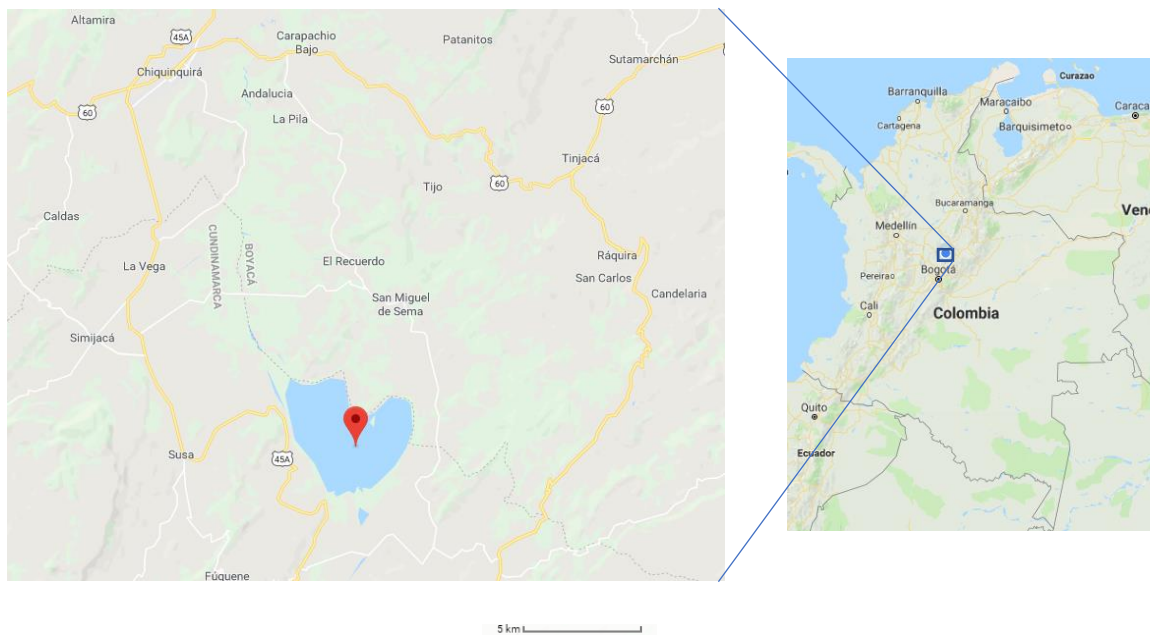
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## ABSTRACT

In this paper we present the results of the detection and evaluation of the presence of Enterococcus in the Fúquene Lagoon by means of the defined substrate technique. We also consider the environmental implications that come along with; contemplating the meaning that environmentally implies the presence of said pathogenic microorganisms and their impacts on the health of the populations involved in the water consumption of the lagoon.

## 1. INTRODUCTION

### 1.1 Lagoon of Fúquene



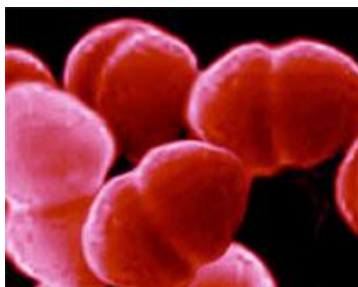
**Figure 1: Localization Lagoon of Fúquene**

**Source: Taken and adapted from Google Maps, 2018.**

The Fúquene Lagoon (located between Boyacá and Cundinamarca), takes up an area of 3,060 Ha; receives domestic and industrial wastewater discharge mainly from dairy, agricultural and grazing activities, from several municipalities that are around it. This discharge has affected the physicochemical and microbiological conditions of water, which in turn is being used for the supply of other rural and urban populations whose only affluent tributary is the Suárez River, which empties to the northwest of the lagoon. Additionally, it is the water supply for populations in the department of Santander, including the municipalities of Puente Nacional and Barbosa.

Due to the involvement of the lagoon by this discharge, an increase in Eutrophication has been found, generating considerable alterations in the landscape and navigability, as well as impacts in the biotic environment of the itself.

### 1.2. *Enterococcus* and its health impacts.



**Figure 2.** *Enterococcus*

Source: Taken from <http://apps1.semarnat.gob.mx/>

Pathogenic bacteria reach surface water bodies from human and animal faecal matter, by discharges of untreated or poorly treated wastewater, discharge from plants that process poultry and livestock meat; In rural areas, defecation in the open field is also a source of contamination of surface water.

The presence of pathogenic microorganisms in the water of the Fúquene Lagoon generates a great impact on health in the surrounding populations. The current indicators of faecal contamination in Colombia are faecal coliforms. Enterococcus are more resistant than faecal coliforms to adverse environmental conditions and additionally are very resistant to antibiotics; hence the interest to detect them and analyse their presence in the water of the Fúquene Lagoon.

Enterococcus bacteria are spherical, aerobic and facultatively anaerobic, and generally arranged in two cells or in chain form. Two species inhabit the intestines of the human being: *Enterococcus faecalis* and *Enterococcus faecium*. They have been classified as opportunistic pathogens and can cause various diseases of the urinary tract, endocarditis, bacteraemia and meningitis among others.

The annual incidence of nosocomial bacteraemia caused by Enterococcus is 1 or 2 cases per 1,000 hospitalized patients. It can be shown that, in Chiquinquirá, the incidence of communicable diseases, including water-borne diseases, has a high morbidity rate.

**Table 1: Mobility priorities assisted, Chiquinquirá**

	CAUSA DE MORBILIDAD PRIORIZADA	BOYACA 2012	CHIQUINQUIRA 2012
Morbilidad por grandes causas	Enfermedades no transmisibles	54,20	43,76
	Condiciones transmisibles y nutricionales	20,74	39,8
	Lesiones	6,78	31,69
	Condiciones mal clasificadas	16,71	20,03
	Condiciones materno perinatales	1,69	3,73
Eventos de alto costo	Prevalencia de enfermedad renal crónica en fase cinco con necesidad de terapia de restitución o reemplazo renal	53,75	0
	Tasa de incidencia de enfermedad renal crónica en fase cinco con necesidad de terapia de restitución o reemplazo renal por 100.000 afiliado	45,45	0

**Source: Ministry of Development and Social Welfare of Chiquinquirá**

According to SISRO, the third cause of morbidity in the municipality is communicable and nutritional conditions, with infectious and parasitic diseases occupying the second place of medical visits. In 2011, morbidity due to ADD in children under 1 year of age was presented in 487 cases and in children under 5 it occurred in 774 cases. In 2012, morbidity due to EDA in the general population was presented in 4910 cases, with the following specific distribution by vulnerable groups under 1 year: 324, under 5 years: 707, over 60 years: 249. In 2014, morbidity by EDA occurred in a total of 2,878, under 5 years: 663; older than 60 years: 305 reported cases. As can be seen, cases of ADD have gradually decreased, however, there are still cases in the general population and in vulnerable age groups.

<http://www.hospitalregionalchiquinquiragov.co/>

Urinary tract infections are the most common cause of these organisms, the rate of incidence of these infections increases drastically and they are the most common cause of bacteraemia.

In Colombia, Resolution 631 of 2015 from the Ministry of Environment and Sustainable Development, which establishes the parameters and the maximum permissible limit values for specific discharges of wastewater to surface water bodies, establishes the analysis and reporting of the values of the concentration in Probable Number (MPN / 100mL) of the Thermotolerant Coliforms, but has not contemplated the analysis of Enterococcus.

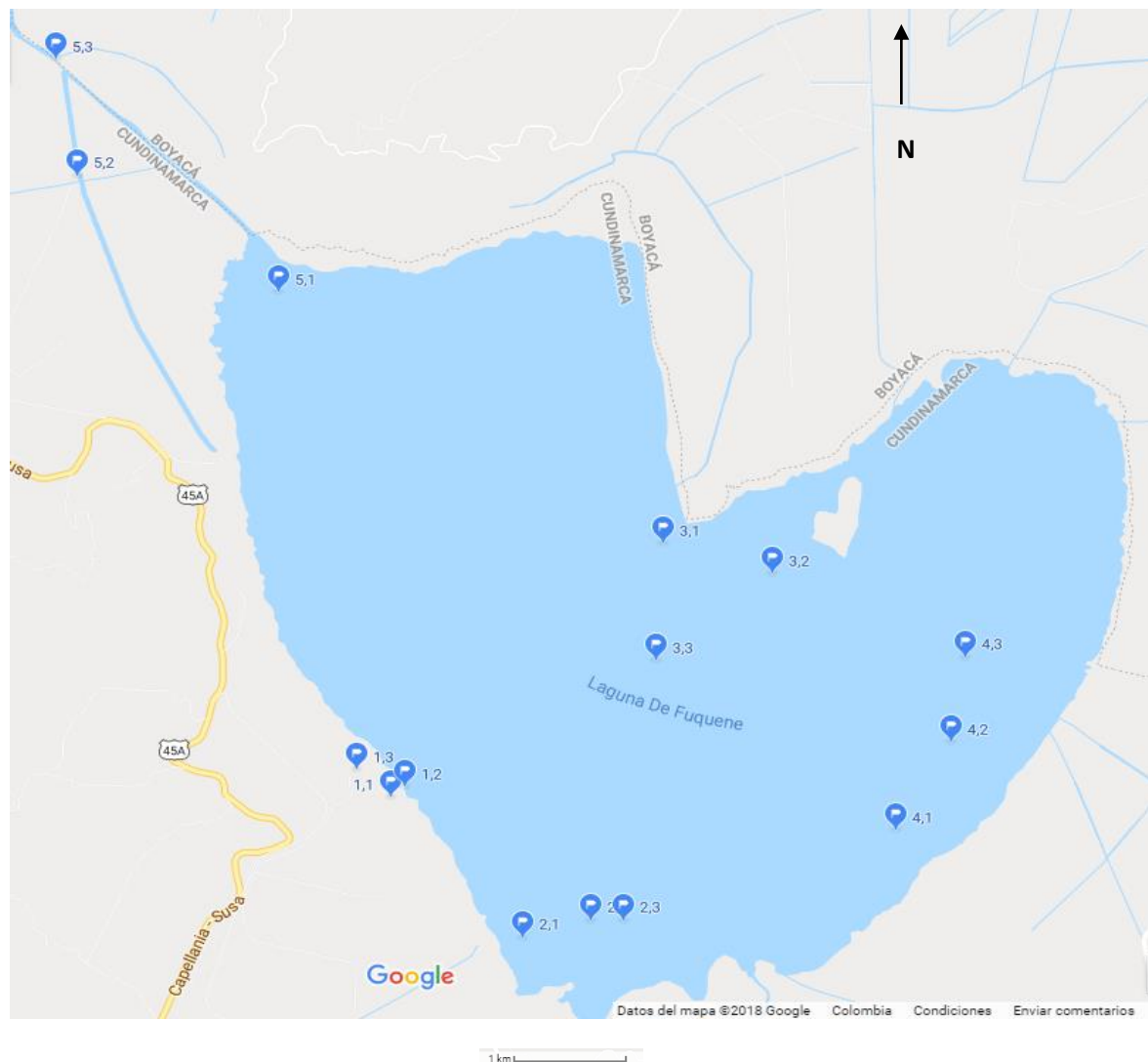
Resolution 1207 of 2014 from the Ministry of Environment and Sustainable Development of Colombia, which adopts provisions related to the use of treated wastewater, establishes for agricultural use a maximum of 100 MPN / 100 mL

In other countries such as Mexico and the United States, the detection of Enterococcus as indicators of faecal contamination in waters is regulated for surface waters, hence the importance of detecting them in the water of the Fúquene Lagoon.

## 2. METHODOLOGY

### 2.1 Sample

For the collection of the samples in the Fúquene Lagoon, the location of the tributaries was taken into account, such as the rural channels and the rivers that flow into it. Additionally, samples were taken in some points of the Suárez River which is a tributary, taking of the following locations:



**Figure 1: Location of sampling sites**

**Source: Taken and adapted from Google Maps 2018**



**Figure 2: Capture of superficial spot sample**

In total, 15 water samples taken at 5 different sites of the Fúquene Lagoon were collected; 3 samples were taken per zone according to the sampling protocols.

## **2.2 Processing the samples**

Once the samples were collected, they were processed in the Microbiology laboratory of the Escuela Colombiana de Ingeniería, for the analysis of the content of Enterococcus using the Defined Substrate technique (Enterolert) of IDEXX laboratories. Defined Substrate Technology® (defined substrate technology [DST®]).

After an incubation period of 24 hours at  $41 \pm 0,5^{\circ}\text{C}$ , the cells emitting a fluorescent light under the 6-watt ultraviolet lamp with a length of 365 nm are counted; those that emit a fluorescent light are positive for Enterococcus. Subsequently the most probable number is determined by means of the Table of M.P.N.



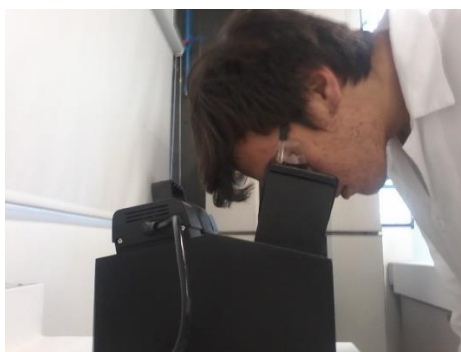
**Figure 5: Quantity-Tray. Sealer 2X.**



**Figure 6: Quantity-Tray with Sample and culture medium "ENTEROLERT"**



**Figure 7: Tray under ultraviolet light lamp 24 hours later. FLUORESCENCE: POSITIVE FOR ENTEROCOCCUS**



**Figure 8: Fluorescence display in trays**

**Source: Taken in the Microbiology Laboratory of the Colombian Engineering School.**

### 3. RESULTS AND DISCUSSION

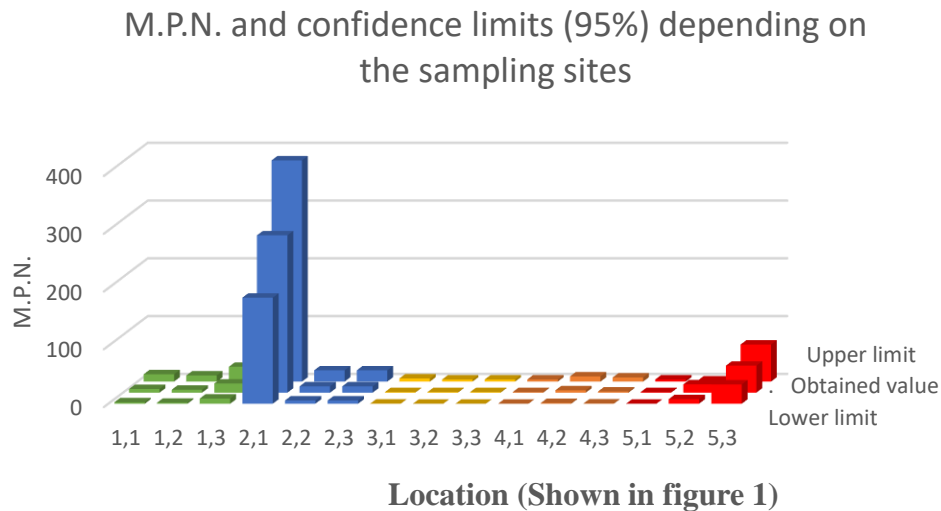
The results of each sample location are shown in the Table 2.

**Table 2: Promedio del Número más probable N.M.P. por zonas en la laguna**

ZONE	SAMPLE	$\frac{M. P. N.}{100 mL}$	CONFIABILITY (95%)		Average N.M.P.	Standard deviation of each zone
			Lower limit	Upper limit		
1	1,1	6,3	2,5	12,7	9,0667	4,7863
	1,2	5,1	1,7	10,6		
	1,3	15,8	8,8	25,7		
2	2,1	<b>272,3</b>	183,5	382,9	98,0333	123,2251
	2,2	10,9	5,6	19,5		
	2,3	10,9	5,6	19,5		
3	3,1	1	0,1	5,5	1	0
	3,2	1	0	3,7		
	3,3	1	0	3,7		
4	4,1	1	0	3,7	2,3667	1,2919
	4,2	4,1	1,2	9,1		
	4,3	2	0,3	7,1		
5	5,1	1	0	3,7	20,7333	19,1705
	5,2	14,5	7,8	2		
	5,3	<b>46,7</b>	33,3	64,2		

It can be observed that the concentration of Enterococcus is high on the shores of the lagoon, in the formation of the Suarez River (location 5.3) and in the southern zone, which is equivalent to zone 2. These results mean a high discharge of organic matter of faecal origin. By graphically comparing the results of each sample, it will have then (Figure 9):





**Figure 9: Concentration of Enterococcus (M.P.N/100ml) depending on the location (see Figure 3)**

The important concentration of Enterococcus can be seen in zone 2 (blue), where there is discharge of wastewater from the Municipality of Ubaté recognized by its dairy nationwide industry; There is a significant decrease in the content of Enterococcus in the most distant areas of the banks.

#### 4. CONCLUSIONS

- The presence of Enterococcus in the Fúquene Lagoon water indicates contamination of faecal origin, which confirms the discharge of wastewater into the lagoon.
- The high amount of Enterococcus in the lagoon, especially on the banks, implies a potential risk of diseases for the communities in the surrounding areas.
- The microbiological contamination in the water of the Lagoon of Fúquene is evident in the presence of Enterococcus. In spite of the figures provided by the Ministry of Health of Chiquinquirá regarding the high incidence of diseases, it cannot be guaranteed that these are caused by these microorganisms.
- The content of Enterococcus is lower in zones 3 and 4 corresponding to the central and western part of the lagoon, which allows us to conclude that the microbiological contamination is due to the discharge from rural channels in addition to the infiltration in the soil from the faecal matter of the cattle activity.
- The discharge of the rural channels provides important concentrations of contaminants which generate Eutrophication contributing to the environmental deterioration of the lagoon and therefore an impact on the health of the populations.

- Considering the environmental conditions of the lagoon, a continuous monitoring is recommended in order to understand the influence of these conditions in the presence of Enterococcus.
- The discharge of residual water from the Municipality of Ubaté does not meet the Enterococcus limit established by resolution 1207 of 2014, which is 100 MPN / 100 mL
- The Suárez River is the river that supplies the Municipality of Chiquinquirá and according to the high concentrations of Enterococcus found there, there is a potential risk of diseases that can affect the population due to inadequate water treatment processes before consumption.
- It is recommended to contemplate within the resolution 631 of 2015 from the Ministry of Environment and Sustainable Development which establishes the parameters and the maximum limit permissible in the specific discharge of wastewater to surface water bodies, the admissible limits of Enterococcus.



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