Migration Letters

Volume: 20, No: S1 (2023), pp. 1361-1367

ISSN: 1741-8984 (Print) ISSN: 1741-8992 (Online)

www.migrationletters.com

Pollution From Sewage Discharges And Their Potential Environmental Risks In Marine Waters In Colombiana

Alexander Pérez Cordero[1], Donicer E. Montes Vergara[2] ,Yelitza Aguas Mendoza[3]

Received: 20 -12- 2022
Accepted: 25- 03- 2023
Published: 22 -07- 2023

ABSTRACT

The objective of this study was to evaluate the physicochemical and microbiological quality of wastewater discharged into the ocean from the municipality of San Bernardo del Viento, department of Córdoba. Water samples were collected in five time periods distributed every 15 days. The parameters evaluated were: physicochemical parameters (pH, turbidity, total solids, BOD, COD and NO3) and microbiological parameters (concentration of Escherichia coli and total coliforms). The results show a high concentration of Escherichia coli (5.3 x 10^{-3} CFU/ 100 mL), total coliforms (5.9 x 10^{5} CFU/ 100 mL) and organic load represented in total solids (530 mg/L) and nitrates (12.91 mg N-NO_3/L), as well as high turbidity (27.5 UPS), BOD5 (410.5 mg O_2/L) and COD (267 mg O_2/L). The results of the parameters evaluated in the area under study show contamination values above the permitted values according to The results of the parameters evaluated in the area under study show contamination values above the permitted values according to Resolution 883 of 2018 complements the current regulations for the control of water pollution established in the Sole Regulatory Decree of the Environment and Sustainable Development Sector (Decree 1076 of 2015).

Key words. *Dumping, enterobacteria, pathogens, organic load, pollution.*

INTRODUCTION

For many years, the seas have been the great dumping ground for a large part of the waste and residues generated by domestic and industrial activities, a circumstance that has deteriorated their environmental quality, putting the health of aquatic ecosystems and humanity at risk (Landrigan et al. 2020). In developing countries, 80-90% of the wastewater generated is discharged without adequate treatment into natural water bodies (Allaoui et al. 2015).

In accordance with the recommendations made by the 2019 International Mission of the Wise, promoted through the National Government of the Republic of Colombia and managed by Colciencias, now the Ministry of Science, Technology and Innovation, it was proposed to

[1] Universidad de Sucre, Facultad de Ciencias Agropecuarias, Colombia, https://orcid.org/0000-0003-3989-1747
[2] Universidad de Sucre, Facultad de Ciencias Agropecuarias, Colombia, https://orcid.org/0000-0002-2860-0505
[3] Universidad de Sucre, Facultad de Ingeniería, Colombia, https://orcid.org/0000-0003-4880-4510

contribute, based on a detailed analysis of the context and potential of Colombia, to the design of policies, cross-cutting programmes and specific instruments that would enable the country's scientific, artistic, technological and intellectual potential to be used to generate greater conditions of equity and sustainable socio-economic development over the next twenty years. In particular, the Oceans and Hydrobiological Resources thematic focus aimed to transform the national vision of the scientific, educational and natural capital exploitation potential, with the purpose of achieving the well-being of the population, as a mechanism to put an end to poverty, as well as to protect and sustainably and sustainably inhabit the country (Franco eta al., 2020).

Likewise, Franco et al. (2020) point out that the diagnosis of marine-coastal, insular and continental ecosystems, their state of health and affectation by natural and anthropic sources, the situation of their biological resources, the circumstances in which they are managed, administered and controlled by public and private institutions, the public policies and regulations in force that regulate the various socio-economic activities, both marine and continental, and finally a vision of the future, should be updated to 2020.

According to Sánchez et al. (2002) and Perevochtchikova (2013). The environmental diagnosis of an ecosystem is the first phase that must be carried out to identify the conditions in which the area under study is found and a fundamental part of determining the degree of contamination and the measures to be taken for the implementation of decontamination strategies. The analysis must include, as a first stage, the evaluation of biological, physical and anthropogenic aspects, which allow for the estimation of the impacts derived from human activity and, secondly, the determination of society's lifestyles, in order to contribute to the development of efficient environmental management.
Among the factors of environmental degradation that are currently of great interest to governments and the scientific community is pollution and the environmental risks caused by wastewater discharges with a high content of pathogenic microorganisms and organic matter and toxic compounds (Sáenz-Arias et al., 2023).

This is why it is necessary to carry out a characterization and inventory diagnosis of environmental situations, identifying the first indicators that must be taken into account to determine the degree of affectation of an ecosystem due to the actions that have been developed in its environment and that can directly or indirectly cause impacts to the environment; it is also the starting point to analysis the evolution that may occur with the implementation of corrective actions.

Given the importance of marine water bodies for the environment and the surrounding community, a pre-diagnosis of the physico-chemical and microbiological parameters of the water discharged by the Sinú river on the beaches of the municipality of San Bernardo del Viento, Córdoba, Colombia, was proposed as a strategy.

MATERIALS AND METHODS

Study Area. The Gulf of Morrosquillo is located in northwestern Colombia, extending from San Bernardo Point (09°42'4.746 "N; 75°42'6.146 "W) in the department of Sucre, to Cispatá Bay (09°24'19.068 "N; 75°50'8.982 "W) in the department of Córdoba. The gulf is part of a mosaic of continental, coastal, insular and marine ecosystems located within the world's intertropical belt, with a coastline extension of approximately 142 km in a southwest-northeast direction from Boca de Corea (Sinú River) to Punta San Bernardo. In total the area reaches 2429 km2 of which an area of approximately 390 km2 corresponds to the continental part and 2039 km2 to the maritime part (Quintana and Cañón, 2010).

Isolation of enteropathogenic bacteria. The proposed technique for the isolation of enteropathogenic bacteria was performed using the protocol proposed by Olivas et al, (2011) and adjusted by Pérez et al, (2023), Thus: which consisted of the following: The filtration equipment consisted of a reusable sterile filter holder, in which a sterile bacteriological filter with a porous membrane of 47 mm diameter and 0.45 µm pore with sterile grid was mounted. Then 100 mL of water sample was filtered, the membrane was separated from the filter holder and placed in an MI medium plate (DIFCO), grid side up, marking the box. Serial dilutions of 1:100, 1:1000, 1:10 000, 1:100 000 and 1:1 000 000 were made following the same filtering and seeding methodology for each dilution. All plates were incubated at 37 °C for 24 hours. At that time, all Petri dishes were removed from the incubator and read. All blue colonies, corresponding to E. coli, were counted and the results recorded. White colonies, corresponding to total coliforms, were also counted on each filter. Only counts of less than 200 colonies were recorded as total coliforms (TC) and E. coli (EC). Calculations were performed to obtain the total number of organisms in the dilutions.

Physico-chemical parameters to be evaluated. The parameters to be evaluated were: pH, turbidity, total solids, BOD, COD and NO_3. The analyses to be taken for the samples by surface collection of 1 litre each, in triplicate. will be submitted for laboratory analysis. The methodologies were those proposed in the respective certified laboratory for the analysis of analytical techniques for the determination of physicochemical parameters and pollutants in natural waters.

RESULTS AND DISCUSSION

Figure 1 shows the results obtained for the presence of Escherichia coli bacteria and total coliforms discharged through wastewater from the Sinú River into the ocean waters, located in the municipality of San Bernardo del Viento Caribbean Sea. Five samplings were carried out with an interval of 15 days to determine the dynamics of the presence of enteropathogenic E. coli bacteria and total coliforms present in the body of sea water located in the municipality of San Bernardo del Viento Caribbean Sea. The results show a range of presence of E. coli from day zero of 3,020 x 10^3 CFU/ 100 mL and by day 60 a number of 5,3 x 10^3 CFU/ 100 mL was found. For total coliforms it was 4.9 x 10^5 CFU/ 100 mL (day zero) and 5.93 x 10^5 CFU/ 100 mL for day 60.

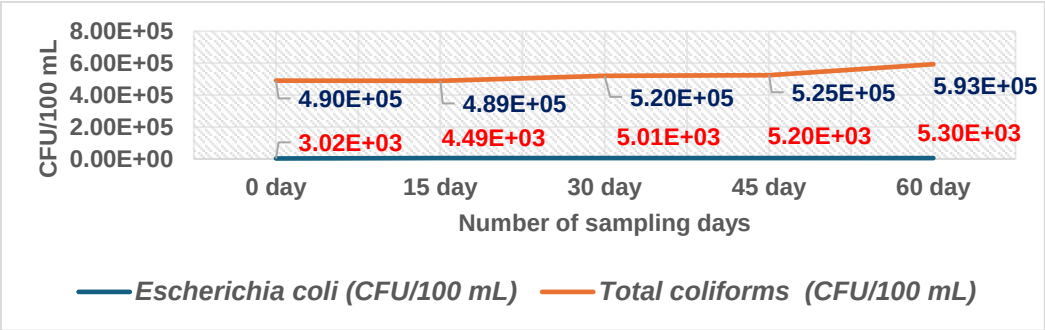

Figure 1. Concentration of pathogens (Escherichia coli and total coliforms) discharged through wastewater in the water body of the municipality of San Bernardo del Viento, Caribbean Sea, Colombia.

According to the environmental diagnosis of the Gulf of Morrosquillo, carried out by Barreto et al, 1999 and discussed by Quintana and Cañón, (2010), indicate that the potentially polluting activities in this ecosystem at marine level are: continental discharges (rivers and streams); operation According to the Marine Environmental Quality Network (RedCAM, 2008), it has been established that the contribution of faecal coliforms contributed to the Gulf by the Sinú

river, are found in 16.77% respectively of the total discharge to the Caribbean Sea, which is attributed to domestic wastewater discharges along the coastline. Regarding the water quality of the entire Gulf (RedCAM, 2008) determined that the most critical sanitary quality in the waters of the Gulf of Morrosquillo is found in the stations Playa Francés, Playa Tolú, Hotel Playa Mar, Playa en Tolú, Hotel Montecarlo in Coveñas, Puerto Viejo in Coveñas, Punta Piedras in Coveñas, Coquerita Isla Palma (San Bernando), Punta Rincón and Playa Berrugas. The results of these determinations show concentrations for total coliforms under the membrane filtration technique ranging from 5.5 x 10^3 CFU/100 mL to 50 colony forming units.

With regard to the studies carried out on the concentrations of microorganisms associated with wastewater discharges recorded in coastal waters worldwide (Sáenz-Arias, et al., 2023), the following countries are listed as follows: Croatia: Sewage (AR), Faecal coliforms 8.3x108 CFU/100 mL; United States: Estuarine water, E. coli 2-1340 CFU/100 mL; France: Urban wastewater, E. coli 14.0±8.3±8.3×106 NMP/100 mL, E. coli 34-65 470 CFU/100 mL; India: AR untreated, Thermotolerant coliforms 10^5-10^8 NMP/100 mL, Thermotolerant coliforms 104-105 NMP/100 mL; Turkey: AR untreated Faecal coliforms 4.9 x 10^5 CFU/100 mL and UK: Seawater: E. coli 3.20 x 10^3 CFU/100 mL. The results shown infer that seawater contaminated with Escherichia coli through sewage discharge corresponds to Croatia, France and the UK.

Table 1 shows the relationship between the parameters pH, turbidity, total solids, biochemical oxygen demand, chemical oxygen demand, nitrates and concentration of E. coli and total coliforms. The results indicate that there was an increase in the physicochemical parameters from day zero to day 60, with the highest number of these parameters occurring up to day 60. It is also observed that the microbiological parameters E. coli and total coliforms concentrations increase as the physicochemical parameters increase.

Table 1. Concentrations of physico-chemical and microbiological indicators of pollution associated with wastewater discharges recorded in coastal waters in the department of Córdoba, Colombia.

Parameters	0 day	15 day	30 day	45 day	60 day
pH	4,09	4,8	4,85	4,85	4,07
Turbidity (UPS)	25,6	25,7	25,9	26,3	27,5
Total Solids (mg/L)	449	449	501	520	530
DBO_5 (mg O_2/L)	259,9	260,2	263	265	267
DQO (mg O_2/L)	396,3	397,3	398,2	410,1	410,5
Nitrates (mg N-NO_3/L)	12.8	12,85	12,86	12,9	12,91
Escherichia coli (CFU/100 mL)	3,02E+03	4,49E+03	5,01E+03	5,20E+03	5,30E+03
Total coliforms (CFU/100 mL)	4,90E+05	4,89E+05	5,20E+05	5,25E+05	5,93E+05

The concentration of total coliforms and Escherichia coli groups is associated with the variables of turbidity, total solids, pH, salinity, BOD_5, COD and nitrates, so it can be inferred that their presence is associated with these physical-chemical parameters when there are deficiencies in water replacement, these parameters being determinant in their rate of duplication.

Garay (2001), on the problem of marine pollution and its marked influence on the "health" of coastal ecosystems, is closely related to the growing increase in the number of people living in coastal areas, and also to the increase in domestic, agricultural and industrial activities which, due to poor management and inadequate control of solid and liquid waste, affect the marine environment with significant ecological, socio-economic and health implications.

In accordance with the description by Quintana and Cañón, (2010), in relation to the reference that bacteria bioindicators of faecal contamination adhere to sediments and that the net accumulation of sedimentation. Members of E. coli and total coliforms are inhabitants of the intestinal tract of humans and warm-blooded animals. They are facultative aerobic, gram-negative and ferment lactose at 44°C. They have no specific nutritional requirements and can grow from a wide variety of carbon and energy sources. It has the ability to adapt to marine environments and to survive at the sediment level due to the high content of organic matter present in sediments.
According to Sáenz-Arias et al. (2023), "Microbiological contamination and organic load in coastal waters of Colombia constitutes a knowledge and environmental challenge that must be addressed by improving scientific research and basic sanitation, including the use of new technologies to reduce the load of pollutants in aquatic ecosystems. In addition, environmental awareness should be generated in the community in general, and in environmental management and public health entities to achieve a commitment that promotes the implementation of control and mitigation measures, and their maintenance over time, from the sources of these two types of pollution.

Likewise, they express that preliminary diagnosis are actions that become more relevant if we take into account that the risks for aquatic fauna, aquaculture and fisheries, and public health increase greatly when synergic actions occur between both types of pollutants: microbial pathogens and organic load in coastal ecosystems. In this context, scientific research is essential to generate knowledge on the dynamics of these types of pollution and their ecological, social and economic risks, giving priority to the study of the presence of pathogens, and the transfer of virulence and drug resistance genes (Sáenz-Arias et al., 2023).

CONCLUSIÓN

According to Sáenz-Arias et al. (2023), the discharge of wastewater into coastal marine ecosystems pollutes and affects water quality, introducing pathogenic organisms that can cause disease and therefore represent a risk to environmental and public health. In Colombia, coastal waters are affected by wastewater discharges, deteriorating the sanitary quality of water in different coastal municipalities, with Santa Marta in the Caribbean and Tumaco in the Pacific being the most affected in 2021. However, the present study, carried out in marine waters of the municipality of San Bernardo del Viento, department of Córdoba, reports a high presence of the enteropathogenic bacterium Escherichia coli ($3.02 \pm 5.3 \times 10^3$ CFU/100 mL), total coliforms of $4,92 \pm 5.9 \pm 5.9 \times 10^5$ CFU/ 100 mL), organic load represented in total solids 449 ± 530 mg/L and nitrates of 12.8 ± 12.91 mg N-NO3/L), in addition to high turbidity of 396.6 ± 25.6 ± 27.5 UPS), BOD_5 of 259.9 ± 267 mg O2/L) and COD of 396.6 ± 410.5 mg O_2/L.

The results of the parameters evaluated in the area under study show contamination values above the permitted values according to Resolution 883 of 2018 complements the current regulations for the control of water pollution established in the Sole Regulatory Decree of the Environment and Sustainable Development Sector (Decree 1076 of 2015); its issuance, in development of the mandates of the National Development Plan and the strategies of the National Environmental Policy for the Sustainable Development of Oceanic Spaces and Coastal and Insular Areas, as well as the National Policy for the Integrated Management of Water Resources.

ACKNOWLEDGEMENTS

The authors would like to thank the microbiological research laboratory of the University of Sucre-Colombia.

DECLARATIONS

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Conflict of interest
The authors declare that they have no competing interests.

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