Microbial Indicators of Coastal Water in Albania

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Abstract: - Beaches located in Durres and Himara are the most attractive sites in Albania. The purpose of this study is to assess the microbiological quality of seawater in these beaches that are frequented during the summer season. Seawater samples were tested mainly for *Eschericia coli* and fecal enterococci in accordance with European standards. Water samples (36) were collected in Currila and Plepa beach, located on the Adriatic Sea, and Jala beach located on the Ionian Sea. The monitoring of these sites was done during three years 2017- 2019 from June to September. Plepa beach has the highest concentaration of *Eschericia coli* 600-650 CFU/100ml, followed by Currila with 580-600 CFU/100ml. While Jala beach results in a smaller pollution 260-300 CFU/100ml. Although the presence of faecal enterococci, the most polluted beaches are Currila and Plepa with 220-320 CFU/100ml and 260-300 CFU/100ml respectively. While Jala beach results less colonies respectively 120-250 CFU/100ml. Based on these data, it is shown a high concentration of fecal indicators in these beaches, especially at the Adriatic Sea. According to the European standard, water is classified as “bed” status. Jala beach is classified as “good” status. The pollution increases during July and August. These results emphasize the necessity to monitor these sites periodically to prevent the risk of pollution that may come from different factors.

Key-Words: - bacteria indicator, enetrococci, seawater, Albania coastal, pollution.

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1 Introduction

The focus on bacteria as a public health monitoring tool is based on the relationship between the density of fecal indicator bacteria and the occurrences of illnesses among persons in water exposure. Data have also shown that fecal coliform, Escherichia coli and entorococci, are found in the environment in the absence of a known sewage source of contamination [1, 2, 3] and it is shown to multiply within warm tropical environments [4, 5, 6, 7, 8]. Concentrations of these microbes were measured in support of a pilot-scale epidemiologic study designed to evaluate relationships between microbial water quality and human health [9]. In general recreational waters contain a mixture of pathogenic and non-pathogenic microorganisms derived from sewage effluents, industrial processes, farming activities and wildlife, in addition to free-living pathogenic microorganisms [10]. Bacterial contamination is the primary source of microbiological water contamination usually responsible for waterborne diseases [11, 12]. Presence of pathogens in recreation water is direct dermal exposure resulting in health effects [13]. Faecal contamination of beach sand may be caused by animal excrements that indirectly can contaminate the seawater [14]. Some relevant studies can be found in [15] and [16]. Indicator bacteria are a good predictor of illness at beaches that have a point of pollution with human fecal indicator [12].

2 Problem Formulation

Albanian beaches in recent years are being visited by tourists from Russia, Poland, Italy, and several European countries. The Albanian coastline, especially the Ionian Sea, is very beautiful and rich in underwater and unexplored beaches. The quality of coastal water in Albania is especially analyzed by Public Health Institution or by individual studies. This study includes the Adriatic Sea and the Ionian Sea. We had monitored three-station beaches. The monitoring sites are Currila and Plepa beaches that are located in the Durrës city (Adriatic Sea), and the third is Jala beach that is located in Himara city (Ionian Sea) (Fig. 1, 2 and 3 respectively latitude and longitude 41.312209, 19.433678; 41.2864482, 19.507738; 40.118393, 19.701507). Our study covers the period from 2017 to 2019. These beaches are populated during June–September by Albanian and foreign tourist. The quality of seawater is very important for the tourists. The coastline in Currila beach is approximately 1,5 km long and there are many buildings, hotels and some private businesses near the shoreline. The beach is narrow and the shoreline sometimes is covered with seaweed and plastic waste. In this site wastewater including sewage was not treated, but collected in septic sewages. Plepa beach is longer than Currila. There are a lot of buildings in the coastline. In this area we noticed canal sewage discharged. Jala beach is approximately 1 km long. Based on the data; the beach has good water quality and good circulation. The shoreline is cleaner than the two other beaches. The population during the July and August is more than the capacity of the shoreline. The aim of our study is to assess the quality of seawater in these sites which focuses on the concentration of bacterial indicator according to European standards.

Figure 1 Currila beach monitoring, Satellite Google map

Figure 2 Plepa beach monitoring, Satellite Google map

Figure 3 Jala beach monitoring, Satellite Google map

3 Material and methods

Our study is based on the monitoring and classification of water beach for the presence of fecal indicator bacteria before, during and at the end of the touristic season according to the Directive 2006/7/EEC concerning the quality of bathing water. Sampling was carried from June to September during 2017-2019. The samples were collected at a distance 5 to 200 meters from the shoreline and 30-50 cm depth in order to avoid surface water contaminants. In each beach, there were taken three samples. The first at the distance of 5 meters from the shoreline, the second samples 100 meters, and the third samples were taken 200 meters from the shoreline. Samples were collect in June, July, August, and September for three years. The amount of samples is 0.5 litters. Sample bottles are sterilized in the autoclave for 20 minutes at a temperature of 120 ^{0}C. Transport and storage of samples before the testing was done with boxing freezer temperature 4-7 ^{0}C and analyzed on the same day. The frequency of testing samples is done once a month, in the middle of the month. Microbial analysis was tested for significant indicators, *Escherichia coli*, and *Intestinal enterococci* according to the Membrane Filtration Method (ISO 7899-2). To determine *Escherichia coli*, 100 ml of water was filtered through bacteriological filters 0.45 mµ and the filter placed in Petri dishes with C-EC agar that was incubated at a temperature of 37 ^{0}C (± 0.2 0C) for 24 hours. Intestinal *enterococci* were determined by usage the E. C. O.A. agar that was incubated at a temperature of 37 0C (± 0.2 ^{0}C) for 24 hours. All location beaches were evaluated using the Directive 2006/7/EC the management of bathing water quality.

4 Discussion

The bacteria indicators for these sites are presented in Table 1, 2 and 3 respectively. All the samples analysed (100%) were positive for bacteria indicators. At Currila beach *Escherichia coli* varies from 580 to 630 CFU/100ml. Intestinal enteroccoci colonies vary 220 to 320 CFU/100ml (Tab. 1). The highest concentrations for *E. coli* were detected at July and August 2019 whereas intestinal eneterococci are at August 2019.

Table 1 Indicators of bacteria in Currila

Years	Month	*Escherichia coli CFU/100ml*	*Intestinal enterococci CFU/100ml*
2017	June	580	220
	July	600	250
	August	600	260
	September	580	220
2018	June	600	250
	July	620	240
	August	610	280
	September	600	240
2019	June	600	220
	July	630	220
	August	630	320
	September	600	280

In table 2 are shown the colonies presented at Plepa beach which varies 600 to 650 CFU/100ml for *Escherichia coli* and 260 to 350 CFU/100ml for intestinal enterococci. The higher value for *E. coli* is at July and August 2017, 2018 and 2019. It is the same results for intestinal enterococci for this site. Higher concentration bacteria were detected at August 2019.

Table 2 Indicators of bacteria in Plepa bay

Years	Month	*Escherichia coli CFU/100ml*	*Intestinal enterococci CFU/100ml*
2017	June	600	260
	July	650	260
	August	650	290
	September	600	250
2018	June	600	270
	July	640	270
	August	650	300
	September	620	260
2019	June	620	260
	July	650	260
	August	650	350
	September	620	300

The indicators of bacteria at Jala beach are presented at table 3. Colonies of *Escherichia coli* vary 210 to 350 CFU/100ml, whereas intestinal eneterococci vary 120 to 250 CFU/100ml. The higher concentration for both *E. coli* and intestinal enterococci were at August 2019. When we compare the number of the colonies during the monitoring years, it results that the highest colony is observed during 2018 and 2019. While comparing the pollution at different months, we prove higher colonies during July and August.

Table 3 Indicators of bacteria in Jala

Years	Month	*Escherichia coli CFU/100ml*	*Intestinal enterococci CFU/100ml*
2017	June	210	120
	July	240	180
	August	255	210
	September	230	130
2018	June	250	170
	July	260	210
	August	270	220
	September	260	120
2019	June	280	180
	July	285	200
	August	350	250
	September	250	140

Average colonies for *Escherichia coli* for 3 collection sites are presented in Fig. 4. Higher colonies were detected at Plepa beach, 635 CFU/100ml, in Currila beach with 615 CFU/100ml, and at Jala beach 291CFU/100ml. The average value for *Escherichia coli* during 2017 in Jala beach is below 250 CFU/100ml (233 CFU/100ml) and the quality of water is excellent quality according to the EU standards. During 2018 and 2019 these colonies are above 250, (260 and 291 CFU/100ml respectively) and the water can be classified as good quality. The colonies of *Escherichia coli* sampling at Currila and Plepa beach were higher than Jala beach. At Plepa beach the average colonies varies from 590 during 2017 to 607 at 2018 and 615 at 2019. We observe the same results at Currila beach with average colonies that vary 625, 627 and 635 respectively 2017, 2018 and 2019 (Tab. 1, 2, 3 and Fig. 4). Based on statistical calculation the presence of *Escherichia coli* during all our study for Plepa and Currila beaches were above 500 CFU/100ml, but during July and August we noticed an increased colony. This water is classified as a "sufficient" quality according to the bathing Water Directive 2006/7/EC (Table 1, 2, 3 and Fig. 4).

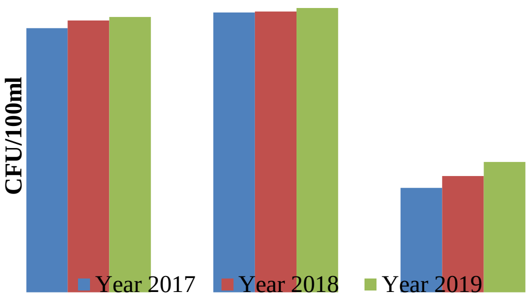

Figure 4 Average colonies of *Escherichia coli*

In Figure 5 we presented average colonies for intestinal enterococci. The average values for intestinal enterococci during (2017-2019) were above the 200 CFU/100ml at Currila and Plepa beaches. During 2017 the average colonies were 237 and 265 respectively at Currila and Plepa beach. During 2018 and 2019 we noticed an increased colony 257-260 at Currila and 275-292 at Plepa. The presences of intestinal enetrococci in these sites classified the water as "bad" status. At Jala beach we observed a fewer colonies that range 160, 180 and 192 CFU/100ml during 2017, 2018 and 2019. These results are compared with European standards and water is classified as “excellent” status. At Jala beach the higher concentration of bacteria is observed during the tourist season mainly July and August. Based on the reports of Public Health Institute of Albania, the increase of skin disease cases, is mainly in children during these months, are in accordance with our data.

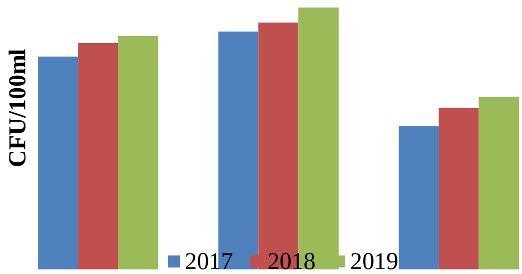

Figure 5 Average colonies of *Intestinal enterococci*

The high concentration of bacteria indicator in recreational waters may infect human and aquatic animals [17]. These pathogens suppose come from sewage discharge and might contribute to water pollution, particularly at Currila and Plepa beaches. In these sites there is some illegal sewage discharges from restaurants and private businesses at Currila beach, because there is not any sanitation treatment. While at Plepa beach the main pollution risk is the sewage canal that discharge without treatment. At Jala beach the concentration of bacterial indicator are less than two other sites. Water discharges are managed according to the standards. The increase of these bacteria may be affected by the over populated coastline and nonpoint source like storm water runoff or debris in to seawater.

5 Conclusion

Based on the microbiological indicator, we noticed that Currila and Plepa beaches had "bad" quality water. Jala beach is classified as "good" quality water for coastline water according to the European standards. Our study has the same aim with these studies [18, 19]. We think that illegal sewage discharges at Currila beach without treatment is a very important pollution factor. At Plepa beach the major pollution is a canal of sewage discharges that is not connected with a sewage system treatment. Regardless of some effort by local and general government in the infrastructure to maintain the beaches clean, the pollution in Currila and Plepa beaches continued. The main topic of our study was to confirm the level of pollution from these beaches, because of many people’s complaints about the water quality. We think an illegal or sewage discharges in the sea is a risk factor for pollution on the coastline waters. To protect the human health from potential factor associated with bathing waters, we should identify the origin of microbial contamination. It's very important to monitor these beaches and to see if status has changed or not.

References:

[1] M Carilo, E Estrada, TC Hazen, Survival and enumeration of the fecal indicators *Bifidbacterium* adolescents and *Escherichia coli* in a tropical rainforest watershed, *Applied and Environmental Microbiology*, Vol. 50, No.5, 1985, pp. 468-474..

[2] S C Rivera, T C Hazen, G A Toranzos, Isolation of fecal coliforms from pristine sites in a tropical rain forest, *Applied and Environmental Microbiology*, Vol. 54, No.2, 1988, pp. 513-517.

[3] RC Wright, The seasonality of bacterial quality of water in a tropical developing country Sierra Leone, *The Journal of Hygiene*, Vol. 96, No. 1, 1986, pp. 75-82.

[4] TR Desmarais, HM solo-Gabriele, CJ Palmer, Influence of soil on feacal indicators organisms in tidally influenced subtropical environment. *Applied Environmental and Microbiology*, Vol 68. No. 3, 2002, pp. 1165-1172.

[5] CM Hardina, RS Fujioka, Solil: The environmental source of *Escherichia c*oli and enterococci in Hawaii's stream, *Environmental Toxicology and Water Quality*, Vol. 6, No. 2, 1991, pp. 185-195.

[6] BM Roll, RS Fujioka, Source of faecal indicators bacteria in a brackish, tropical stream and their impact on recreational water quality, *Water Science and Technology*, Vol. 35, No. 11, 1997, pp. 179-186.

[7] Helena M Solo-Gabriele, Melinda A Wolfert, Timothy R Desmarais, Carlo J Palmer, Source of *Escherichia coli* in a coastal subtropical environmental, *Applied and Environmental Microbiology*, Vol. 66, No. 1, 2000, pp. 230-237.

[8] R C Wright, The survival patterns of selected fecal bacteria in tropical fresh waters, *Epidemiology & Infection*, Vol. 103, No. 3, 1989, pp. 603-611.

[9] Lora E Fleming, Gabriele H Solo, Saimir Elmir, Tomoyuki Shibata, Dominick Squicciarini Jr, Wendy Quirino, Margia Arguello, Gayl Van der Bogart, A pilot study of microbial contamination of subtropical recreation waters, *Fla J Environ Health*, Vol. 184, No. 29, 2004, pp. 1-9.

[10] WHO, *Guidelines for safe recreational water environments, volume 1 Coastal and fresh waters*, Geneva, 2003.

[11] Russel DA, Walling JP, Waterborne pathogens in urban watersheds. *J Water Health* Vol. 5, No.1, 2007, pp. 149–162.

[12] Byappanahalli MN, Nevers MB, Korajkic A, Staley ZR, Harwood VJ, Enterococci in the Environment, *Microbiol Mol Biol Rev* Vol. 76. No. 4, 2012, pp. 685–705.

[13] USEPA *Recreational water quality criteria_Draft. Report of Office of Water 820-D-11-002*, 2012.

[14] Halliday E, Gast RJ Bacteria in beach sands: an emerging challenge in protecting coastal water quality and bather health, *Environ Sci Technol* Vol. 45, No. 2, 2011, pp. 370–379.

[15] Ghritartha Goswami, Sudip Basack, Nikos Mastorakis, Abhishek Saikia, Baby Nilo, Nasir Ahmed, Coastal Ground Water Flow and Management: A State-of-the-Art Review, *International Journal of Mechanics*,Vol. 14, 2020, pp. 37-48.

[16] Sidra Ghayas, Junaid Sagheer Siddiquie, Suboohi Safdar, Asif Mansoor, Neural Network Implementations on the coastal water quality of Manora channel for the years 1996 to 2014, *International Journal of Circuits, Systems and Signal Processing*, Vol. 14, 2020, pp. 996-1004.

[17] A. Al-Gheethi, I. Norli, A. N. Efaq, J. D. Bala, and M. A. AlAmery, Solar Disinfection and lime treatment processes for reduction of pathogenic bacteria in sewage treated effluents and biosolids before reuse for agriculture in Yemen. *Water Reuse Des.* Vol. 5, No.3, 2015, pp. 419-429.

[18] National Environmental Agency, *Condition of Report in the environment*, Tirana, 2018.

[19] National Environmental Agency, *Condition of Report in the environment*, Tirana, 2019.