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Research Article

Evaluation of the quality of wet and dry sand in Velipoja beach (Albania) through microbiological parameters

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Abstract

Microorganisms are natural inhabitants of beach sands. The levels of pathogenic microorganisms in beach sands can increase through direct deposition from human activities, wastewater discharges, and animals. In this study, the presence of pathogenic microorganisms and faecal pollution (*E. coli* and *E. faecalis*) was evaluated in the sandy beach of Velipoja, which was monitored during the period April - September 2024 (once a month) in 5 sampling stations with a total of 90 samples (dry sand, wet sand and seawater) were collected and analysed for microbiological parameters. All stations were evaluated using the beach sand classification under the Blue Flag program. *Escherichia coli* concentration during sampling period ranged from 0 to 52 CFU/g. The maximum value of *Escherichia coli* was registered in August. This high pollution is a consequence of a surface water discharge channel. *Enterococci faecalis* concentration during sampling period ranged from 2 to 80 CFU/g. The maximum value of 80 CFU/g was observed at station 4. Based on the results obtained, Velipoja beach does not represent any risk to human health.

Keywords: sandy beaches, pathogenic microorganisms, infectious disease, faecal pollution, marine ecosystems

1. Introduction

Beach sand can harbour a variety of microorganisms, including bacteria (*E. coli, enterococci*), viruses, fungi, and protozoa. According to international literature, many microorganisms that have been isolated from beach sand, may act as reservoirs or vectors of infection, as well as a source of water contamination (Whitman et al., 2014; Solo-Gabriele et al., 2016; Weiskerger et al., 2019). A number of species of

these microorganisms are potential pathogens and can easily come into contact with humans through sand (table 1). Pathogens such as Salmonella, Campylobacter and various protozoa can be present in contaminated beach sand. Factors influencing contamination are wastewater discharges, stormwater runoff, wildlife populations, septic tank effluent, or shedding by recreational water users, which can be carried into the sand by waves and tides (Whitman et al., 2014).

Velipoja is one of the largest beaches in the Albanian coast with spaces filled with black sand, lagoon and natural reserves. The Buna estuary has a surface area of approximately 90.7 km2, which is created by the deposits of Buna River. The lagoon of Viluni is located 2 km east of the beach of Velipoja, surrounded by wetlands. It communicates with the sea through a natural channel, in which the water changes direction very often. In the southeast of Velipoja, is situated Rrjolli, with a virgin beach with crystal water and black sand rich with iodine. However, one of the most problems in Albania is pollution on marine ecosystems carried out from urban development, uncontrolled constructions of buildings such as: hotels, beach bars, restaurants etc., which use septic tanks, due to the lack of sewage system and discharge them into the sea, becoming in this way a potential source of sea water pollution. The number of tourists visiting Velipoja beach has been increasing in recent years. The control of the environment was done to evaluate the quality of seawater and sand on Velipoja beach in different stations during season and to guarantee healthy ecosystems. Beach sand quality did not become a regulatory concern until 2010, with the Portuguese Blue Flag program, in collaboration with the National Institute of Health and the Portuguese Environment Agency (Sabino, R et al., 2011). The Blue Flag program of Portugal implemented sand monitoring as new awarding criteria for the 2022 bathing season. Therefore, many countries have considered that it is important to monitor the microbiological quality of sea water and beach sand continuously, especially in the tourist season.

Table 1 Microorganisms isolated from seawater and beach sand

	Microorganisms	**Origin**	**Disease**	**Main sources**
Bacteria	*Escherichia coli*	The enteric flora of humans and animals.	FIO	Humidity, temperature, UV rays and dissolved CO affect the life set of the microorganism.
	Enterococcus spp.	The enteric flora of humans and animals.	FIO	Isolated on beach sand.
	Staphylococcus spp.	The normal flora of humans and animals.	Skin infections	Isolated on beach sand.
	Pseudomonas aeruginosa	Microorganism of environments.	Ear, and skin infections	Isolated on seawater and beach sand.
	Salmonella spp. Shigella spp.	Originated from human faeces and animals.	Gastroenteritis	Isolated on beach sand.

Viruses	Enteroviruses	Gastrointestinal tract of humans and animals.	Gastroenteritis, fever, skin rash	Isolated on the Black Sea coast.
Parasites	*Toxocara spp.*	Dog faeces	Diarrhoea, abdominal pain	Isolated on beach sand.
	Candida spp. *Aspergillus spp.*	Skin and mucosae of animals.	Candidosis, allergy	Isolated on beach sand.

Beach sand or similar sediments may act as reservoirs or vectors of infection, as well as a source of water contamination (Mendes et al., 1998; Russel DA, 2007; Halliday E, 2005). Continuous epidemiological studies have shown that these pathogens (table 1) can cause many health problems to beachgoers, including gastrointestinal illnesses, respiratory problems, eye, nasal cavity, skin, and ear infections etc., in people who use these areas for their recreational activities (Bonilla *et al*., 2007; Pinto *et al*., 2012; Sabino *et al*., 2014). Generally, most of the recreational users of beaches, especially children are in contact with beach sand more than seawater (Elmanama. A et al., 2005). Microbial contamination in recreational waters is monitored through measures of FIOs, including 'generic' (non-pathogenic) *E. coli* and enterococci (EU, 2006). The enterococci are a group of bacterial species belonging to the genus *Enterococcus*. FIOs are seldom in themselves pathogenic, but since they are found in faeces of both human and animals, they are useful indicators for faecal contamination of water. According to many reported studies, the assessment of microbiological quality of beaches is based on the assessment of faecal pollution due to its adverse effect on recreational water users. Sampling for microorganisms in sand should therefore be considered for inclusion in regulatory programmes aimed at protecting recreational beach users from infectious disease (WHO, 2003). Many studies have reported the presence of Enterococcus spp., E. coli, Aeromonas spp., Staphylococcus spp., Pseudomonas spp., etc.., in either beach sand or sea water or in both samples which can cause infections in humans (Elmanama. A et al., 2005).

2. Material and Methods

During the period April-September 2024, 5 sampling points on the beach of Velipoja were monitored. A total of 90 samples (dry sand, wet sand and seawater) were collected (table 2). These beaches were regularly monitored and were selected due to the high number of bathers and poor microbiological water quality.

Table 2. Geographic coordinates of sample stations of Velipoja beach

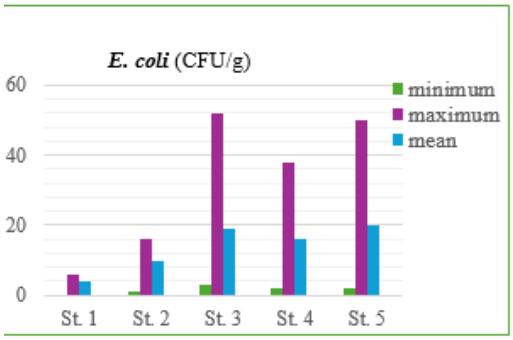
Code	Beaches	Geographic coordinates	
		Latitude	Longitude
St 1	Buna estuary	41°50′51′′N	19°22′41′′E
St 2	Ada beach	41°51′22′′N	19°24′38′′E
St 3	Center beach	41°51′38′′N	19°25′31′′E
St 4	Viluni lagoon	41°51′30′′N	19°26′37′′E
St 5	Rrjoll	41°51′15′′N	19°28′07′′E

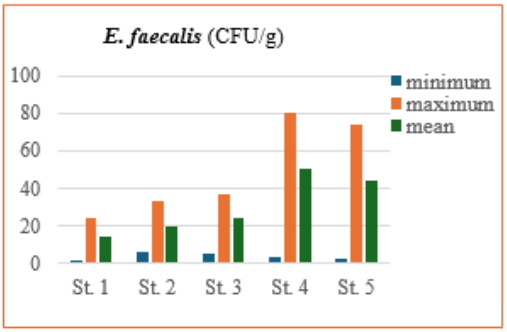
The sandy beach area is selected in the areas that are most used, in a distance of about 10 meters from the shore. Dry sand was collected in non-flooded areas and wet sand was collected in an intermediate zone between dry sand and seawater (the intertidal zone), in places where bathers could be found. Single plastic bags are used for sand samples. The amount of sand that was taken for analysing microbiological parameters is 50 g for each sample (dry and wet sand). Transport and storage of samples before the testing was done with boxing freezer temperature 4-7°C and analyzed within 24 hours so that there is no change in parameters (Figuers & Borrego, 2000). 10 g of sand is separated from the sample and then transferred to a beaker containing 100 ml of distilled water, stirring it for 30 seconds and allowing the precipitation of sand particles. Then 10 ml of the resultant supernatant was added to a sterile bottle containing 90 ml of distilled water and mixed for 2 minutes before filtering (Abdallah et al, 2005). Filtering of the sample was done with the filter membrane method, in cellulose, with pores with a diameter of 0.45 μ, and aseptic transfer to Petri dish with selective terrain. Two microbiological indicators were analyzed: *Escherichia coli* (terrain Endo agar) and *Enterococci faecalis* (terrain Slanetz Bartley) with Membrane Filtration Method. Plates are incubated at 37°C and 44 °C for 2-3 days. Colonies found are expressed in Colony Forming Units (CFU)/g of sand. Classification of beach sand was done under the Blue Flag program of Portugal (WHO, 2021).

- For enterococci, the guideline value of 60 CFU/g or MPN/g of sand is used as the compliance criterion for all sampling events.
- E. coli is used as an extra faecal indicator to connect with the European Bathing Water Directive parameter, using as compliance cut-off a reference value of 25 CFU/g (Sabino R. at al., 2011).

3. Results and discussion

Levels of pathogenic microorganisms in beach sands can increase through deposition from human activities, wastewater discharges, and animals**.** All locations were evaluated using the beach sand classification under the Blue Flag program. Summary data for *E. coli* in sand samples according to sampling stations is presented in fig.1. During the monitoring period, bacterial concentrations ranged from 0 to 52 CFU/g, where the highest value of indicator bacteria (52 CFU/g) was found in stations 3 and 5 in August (Fig. 1). *E. faecalis* concentration during sampling period ranged from 2 to 80 CFU/g (Fig. 2). The maximum value of 80 CFU/g was observed at station 4. But





referred the beach sand classification under the Blue Flag program. Stations 3, 4 and 5 result above the recommended value for *E. coli* during July – August (Figure 1) and for *E. faecalis* (Fig. 2).

Fig. 1 The values of *E. coli* in sandy beach **Fig. 2** The values of *E. faecalis* in sandy beach

Factors influencing contamination are wastewater discharges, wildlife populations and shedding by recreational water users, which can be carried into the sand by waves and tides. The data show that in general the number of coliform bacteria during investigation period of 2024, has a peak during July – August. This could be due to the high number of people visiting the beaches of this coastline during summer season.

4. Conclusion

Based on the results obtained, the concentration of *Escherichia coli* and *Enterococci faecalis* is in line with the norms and the sand of these beaches turns out to have a suitable quality for frequency. Velipoja beach does not represent any risk to human health. With the aim to protect human health, a continuous monitoring process of the coastline is important. After the obtained results, the following conclusions and recommendations can be listed:

- Clean the shore area if you see a solid waste;
- Use the showers on the beach to get sand off your skin and inside your ears, and shower thoroughly when you get home;
- If you have wounds, dress them properly with waterproof bandages before going to the beach and avoid exposure to water, because the wound may become infected;
- Do not rub your eyes if you have sand in them; rinse with clean water instead to avoid scratching;
- Do not take pets to the beach.

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