

Seasonal Variations in Microbial Quality of Recreational Beaches of Vlora Bay, Albania

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Abstract: A total of 5 sampling points along Vlora Bay beaches (Radhimë, Plazhi i Ri, Akademia e Marinës, Plazhi i Vjetër, Kabinat, Nartë) were selected and monitored during the summer and the autumn of 2014. Seawater samples were evaluated for faecal coliforms (FC) and faecal streptococci (FS). Statistical analysis of the results demonstrated higher concentrations of faecal coliforms and faecal streptococci during summer. Akademia e Marinës beach had the highest incidence of faecal indicators (FC and FS), respectively 100% of samples, followed by Plazhi i Ri (62.5% and 75%), while at Radhimë, Plazhi i Vjetër, Kabinat and Nartë there was not any faecal contamination. Climate changes have led to the extended beach season until autumn. The high concentrations of faecal indicators during summer and autumn in some of monitored beaches indicate that monitoring should be performed during the whole season, in order to protect bathers health.

Keywords: *faecal contamination, seawater, faecal indicators, monitoring.*

Introduction

Beaches, especially near urban areas are often subject to pollution due to sewage and industrial discharges, combined sewer overflows and urban runoff. Therefore, pollution abatement is a key part of coastal zone management aimed at minimising both health risks to bathers and ecological impacts, WHO(1999). Recreational beaches along Vlora Bay are a busy tourist destination during summer season. When their waters are contaminated with human or animal wastes, their use for recreation may pose a health hazard for the users. Epidemiological studies have shown a number of adverse health outcomes (including gastrointestinal and respiratory infections) to be associated with faecally polluted recreational water, WHO (2003). The disease incidence is dependent on several factors: the extent of water pollution, time and type of exposure, the immune status of users and other factors, Bartram & Rees (2000). The series of randomized epidemiological investigations, conducted in the United Kingdom, provide such data for gastroenteritis Kay et al.(1994), acute febrile respiratory illness (AFRI) and ear ailments associated with marine bathing Fleisher et al.(1996). Thus, it is essential that these areas are periodically evaluated in regard to their level of microbial contamination.

Material and Methods

Sample Collection

A total of forty seawater samples were collected from five beaches in Vlora Bay: Radhimë, Plazhi i Ri, Shkolla e Marinës, Plazhi i Vjetër, Kabinat, Plazhi i Nartës (Tablo 1). Sampling was performed according to the World Health Organization criteria for recreational water quality. Sample collection lasted from June 2014 to November 2014. 25 samples were collected in summer and 15 samples in autumn. Sterile bottles were used to collect water samples at chest level (1 m). The lid of the bottle was removed without touching the mouth of the bottle. The bottle was turned upside down at 20 cm below the surface. Then the bottle was turned upward, and when the bottle was approximately 2/3 filled, it was lifted above the surface and the lid was placed back, WHO(1995). A membrane filter technique was used for the detection and identification of faecal coliforms and faecal streptococci according to the standard method for water and waste water, APHA (1999).

Results and Discussion

All locations were evaluated using the European Community (EU) standards for faecal coliforms and faecal streptococci. The average temperature of water during summer around 10:00 am was 24 °C and

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the average pH was 8.3, while in autumn the average temperature of water was 20 °C and the average pH was 8.

Table 1. Sampling location

Site	City/Address	Recognized spot	GPS locations	
			N	E
1	Radhimë	Royal Hotel	40°22'44''	19°28'50.149''
2	Vlorë	Plazhi i Ri	40°26'15.747''	19°29'41.599''
3	Vlorë	Akademia e Marinës	40°26'44.144''	19°29'49.631''
4	Vlorë	Plazhi i Vjetër, Kabinat	40°27'57.061''	19°27'43.936''
5	Nartë	Karafili Resort	40°29'31.132''	19°25'48.431''

Faecal coliforms

Median concentrations of faecal coliforms for the 5 collection sites, are presented in Fig.1. During summer season bacterial concentration varied from 40 to 1500 cfu/100 ml, while in autumn season bacterial concentration varied from 3 to 1220 cfu/100ml. In summer 32% of samples surpassed the standards (ISO-9308-1), whereas in autumn this limit was surpassed by 33.3 % of samples from these beaches. Higher levels of faecal coliforms were detected in summer except site 2, where higher levels of bacteria were detected in autumn. Analysis of the variance (ANOVA) (Tab. 2) for the two factors analysed (Site and Season) revealed that Site had a significant effect on faecal coliforms concentrations at 95% confidence level ($p < 0.05$). Season and the interaction site and season had no significant effect at this level. According to Bonferroni's test, bacterial concentrations showed significant differences between some beaches (Site 2 and all four other sites; Site 3 and all other collection sites).

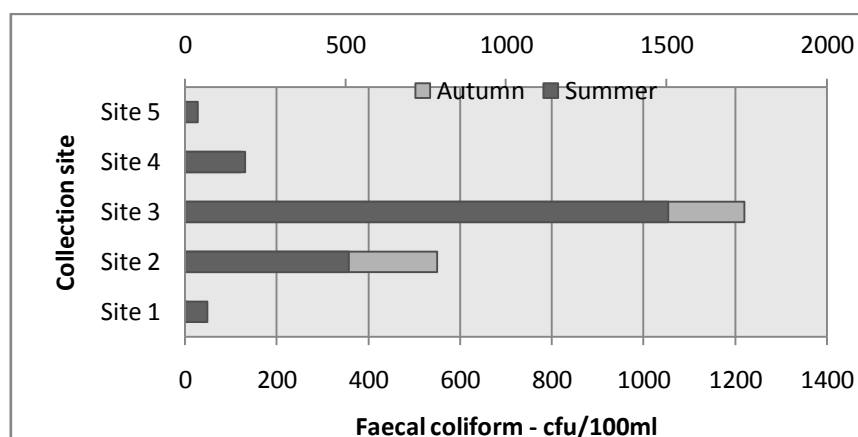


Figure 1. Median concentrations (Hazen's formula) of faecal coliform at each collection site during summer and autumn

Table 2. ANOVA for faecal coliform concentrations at five collection sites, in summer and autumn

Source	F-ratio	p-value
Main effects		
A: Site	57.777	0.000
B: Season	2.549	0.121
Interactions ab	0.672	0.616

Faecalstreptococci

Median concentrations of faecalstreptococci for the 5 collection sites are presented in Figure 2. During summer season bacterial concentration varied from 25 to 1250 cfu/100 ml, while in autumn season bacterial concentration varied from 3 to 1020 cfu/100ml. In summer 36% of samples surpassed the standards (ISO-7899-2), whereas in autumn this limit was surpassed by 33.3 % of samples from these beaches. Higher levels of faecalstreptococci were detected in summer except site 4, where higher levels of bacteria were detected in autumn. ANOVA revealed that Site had a significant effect on faecal

streptococcus concentrations ($p < 0.05$). Season and the interaction site and season were not significant at this level. According to Bonferroni's test average values were statistically higher at site 3.

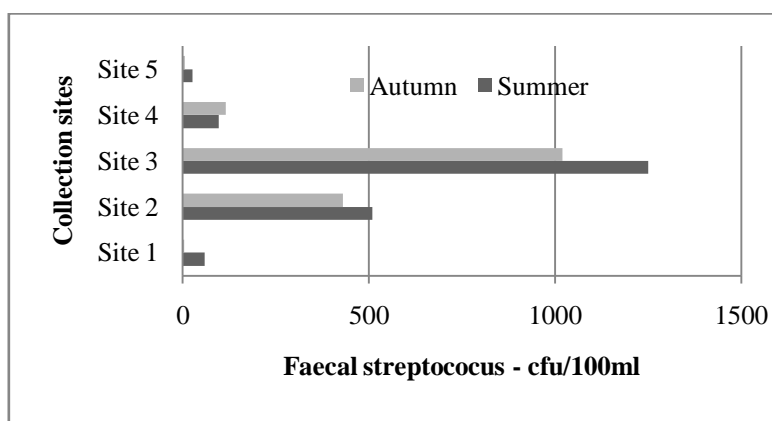


Figure 2. Median concentrations (Hazen's formula) of faecal streptococcus at each collection site during summer and autumn.

Table 3. ANOVA for faecal streptococcus concentrations at five collection sites, in summer and autumn

Source	F-ratio	p-value
Main effects		
A: Site	27.052	0.000
B: Season	0.006	0.938
Interactions ab	0.174	0.174

According to Prieto *et al.* (2001) the risk of health problems associated with swimming is related to the microbiological quality of the water. The most commonly encountered illnesses in swimmers were of upper respiratory tract, skin, and gastrointestinal disease. A cause-effect relationship between faecal pollution and gastrointestinal symptoms is well established and the symptom rates were found to be higher in children (Prüss, 1998).

Table 4. Summary results of faecal coliforms and faecal streptococci (cfu/100ml).

Location		% failure when compared to EU standards	Min	Max	Median	Interquartile range	90 th percentile
Site 1	FC	0	3	200	26.5	162.2	165.5
	FS	0	2	160	16.5	132.5	134.8
Site 2	FC	62.5	28	760	530	708.9	751
	FS	75	30	635	470	580.7	612.5
Site 3	FC	100	863	1858	1340	885.5	1792.6
	FS	100	400	1890	1135	1262.6	1776
Site 4	FC	0	44	210	174	158.8	204
	FS	0	10	160	72	134.1	148
Site 5	FC	0	2	50	20	46.2	48.5
	FS	0	3	35	16	30.8	34.4

Table 4 summarizes the results of failure percentages when compared to EU standards, minimum, maximum, median values, the interquartile range and 90th percentile (Hazen's formula) of indicator densities at each collection site. In this study, higher levels of indicator bacteria, faecal coliforms and faecal streptococci were detected mainly during summer (Figure 1 and 2). According to Institute of Public Health (2011), the main cause of pollution is untreated sewage discharge from point and nonpoint sources. Another pollution factor is bathers itself, especially during summer season when the number of visitors is much higher than in autumn. When faecal coliforms and faecal streptococci results were compared to the EU standards, a higher compliance failure percentage was associated

with faecal streptococci rather than of faecal coliforms. One explanation for the higher rate of enterococci standard failures is that enterococci survive longer in the marine environment than TC or FC, (Hanes & Fragala, 1967). Based on the results (Table. 4) the highest compliance failure percentage and concentration of faecal coliforms and faecal streptococci were found at site 3 (100% and 100%; 1792.6 and 1776 respectively). These results indicate that this area is highly polluted and beyond any evident parameter and tremendous source of infections. This was followed by site 2 (62.5% and 75%; 751 and 612.5) which also has a poor quality, while site 1, 4 and 5 were in compliance with the Guidelines and suitable for recreation. Our study was consistent with studies made by Institute of Public Health during 2010 and 2013 (IPH, 2011; Ministry of Environment, 2013), with the exception of site 4, which unlike the classification of 2010 and 2013 was within standards.

Conclusions

The aim of this study was to evaluate the levels of pollution from these beaches during summer and autumn, in order to protect human health. From 5 monitoring sites 40% of them (2 sites) had a poor quality, while 60% (3 sites) were suitable for recreation. Higher levels of indicator bacteria were detected mainly during summer. Variation in water quality may occur in response to events (such as rainfall) with predictable outcomes, or the deterioration may be constrained to certain areas or subareas of a single recreational water environment (WHO, 2003). Routine monitoring should be undertaken to determine if a beach's classification status changes over time. Also, advising local residents and tourist not to bathe in the impacted zone of the intermittent discharge for a given period is an important precautionary measure (WHO, 1999).

References

- American Public Health Association (APHA), (1999). Standard Methods for the Examination of Water and Wastewater, 20th.Ed. American Public Health Association, Washington DC.
- Bartram J, Rees G, (2000). Monitoring Bathing Water, E & FN SPON.
- Fleisher JM, Kay D, Salmon RL, Jones F, Wyer MD, Godfree AF, (1996). Marine waters contaminated with domestic sewage: nonenteric illnesses associated with bather exposure in the United Kingdom. *Am.J. Public Health*, 86(9): 1228-1234. <http://www.ncbi.nlm.nih.gov>.
- Hanes N, Fragala C, (1967). Effect of seawater concentration on the survival of indicator bacteria. *J Water Pollut Control Fed* 39, 76.
- Institute of Public Health, (2011). Microbiological monitoring of water quality of coastal recreational beaches of Velipoje, Shengjin, Durres, Kavaje, Vlore, Dhermi, Himare, BorshdheSarande in 2010. Final report, pp 20-22.
- ISO, (2000). Water quality - Detection and enumeration of intestinal enterococci, - Part 2: Membrane filtration method. Geneva, International Organisation for Standardization (ISO 7899-2).
- ISO, (2003). Water quality - Detection and enumeration of coliform organisms, thermotolerant coliform organisms and presumptive *Escherichia coli*- Part 1: Membrane filtration method. Geneva, International Organisation for Standardization (ISO 9308-1).
- Kay D, Fleisher JM, Salmon RL, Wyer MD, Godfree AF, Zelenauch-Jacquotte Z, Shore R, (1994). Predicting likelihood of gastroenteritis from sea bathing; results from randomized exposure. *Lancet*, 344(8927): 905-909. *J Epidemiology Community Health* 2001, 55:442-447 <http://dx.doi: 10.1136/jech.55.6.442>
- Ministry of Environment, (2013). Environmental monitoring. Water quality, pp 67-68. <http://www.mjedisi.gov.al>.
- Prieto M D, Lopez B, Juanes J A, Revilla J A, Llorca J, Delgado-Rodríguez M, (2001). Recreation in coastal waters: health risks associated with bathing in sea water. *J Epidemiol Community Health* 2001; 55:442-447.
- Prüss A, (1998). A review of epidemiological studies from exposure to recreational waters. *Int. J. Epidemiol.*, 27, 1-9. <http://ije.oxfordjournals.org>.
- WHO, (1995). Manual for Recreational water and Beach Quality Monitoring and Assessment. Draft. WHO, regional Office for Europe, European Centre for Environ. and Health.
- WHO, (1999). *Health-based monitoring of recreational waters: the feasibility of a new approach (the "Annapolis Protocol")*. Geneva, World Health Organization (<http://www.who.int/water>)

[sanitation_health/Recreational_waters/Annapolis.pdf](#)). (Protection of the Human Environment, Water, Sanitation and Health Series, WHO/SDE/WSH/99.1).
WHO, (2003). Draft Guidelines for Safe Recreational Water Environment. Volume 1: Coastal and fresh water. World Health Organization, Geneva. http://www.who.int/water_sanitation_health/bathing/srwg1.pdf.