ACTA ABP BIOCHIMICA POLONICA

Vol. 62, No 4/2015
659–661
http://dx.doi.org/10.18388/abp.2015_1087

Regular paper

Pollution of recreational beaches of Vlora Bay (Albania) assessed by microbiological tests*

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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 period of January 2014 to August 2014. Seawater samples were evaluated for faecal coliforms (FC) and faecal streptococci (FS). Akademia e Marinës beach had the highest incidence of faecal indicators (FC and FS), 100% of samples respectively, followed by Plazhi i Ri (27.3% and 45.5%), mainly during summer. Whereas, Plazhi i Vjetër, Kabinat, Radhima and Narta beaches were in compliance with the Guidelines. High concentration of faecal indicators, at some of these beaches, especially during summer, emphasizes the necessity of periodical monitoring of these areas in order to prevent a health risk for bathers.

Key words: Vlora Bay beaches, seawater, faecal indicators

Received: 30 July, 2015; revised: 26 October, 2015; accepted: 28 October, 2015; available on-line: 24 November, 2015

INTRODUCTION

Recreational waters generally 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. These sources can include pathogenic organisms that cause gastrointestinal infections, upper respiratory tract, ears, eyes, nasal cavity and skin infections, WHO (2003). Epidemiological studies have shown that swimmers in sewage-polluted seawater experience diseases that range from self-limiting gastrointestinal disturbances to severe and life-threatening infections, Pond (2005). 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 and coworkers (1994), acute febrile respiratory illness (AFRI), and ear aliments associated with marine bathing, Fleisher and coworkers (1996). A few epidemiological studies have been conducted in waters impacted by nonhuman sources of faecal contamination. These studies collectively suggest that waterbodies with substantial animal inputs may potentially result in human health risks that vary based upon the relative proportion of the human and nonhuman faecal input, and the nature of the nonhuman source of infective agent(s), US EPA (2012). For this reason, it is essential that these areas are periodically evaluated in regard to their level of microbial contamination.

MATERIALS AND METHODS

Sixty five samples of water were collected from five beaches in Vlora Bay: Radhimë, Plazhi i Ri, Shkolla e Marinës, Plazhi i Vjetër, Kabinat, Plazhi i Nartës (Table 1). Sampling was performed according to the World Health Organization criteria for recreational water quality. Sample collection lasted from January 2014 to August 2014. Sterile bottles were used to collect water samples at a 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 coliform and faecal streptococci, according to the standard method for water and waste water, APHA (1999).

RESULTS

All locations were evaluated using the European Community (EU) standards for faecal coliforms and faecal streptococci. Median concentrations of faecal coliforms for the 5 collection sites are presented in Fig. 1. Higher levels of bacteria were detected in summer, varying from 40 to 1 500 cfu/100 ml. Faecal coliform concentrations were in compliance with the guideline value (ISO-9308-1) during winter and spring, except for site 3, whereas in the summer this limit was surpassed by 42% of samples from these beaches. Analysis of variance (ANOVA) of these data revealed that the two factors analysed (Site and Season) had a significant effect on faecal coliform concentrations at 95% confidence level ($p<0.05$), the F statistic for site was 140.408 and p-value <0.001; the F statistic for season was 16.712, p-value <0.001. The interaction site and season was also significant at this level, F-ratio= 4.078, p=0.001. According to the Bonferroni's test, average values were statistically higher in the summer than in the spring and winter. Bacterial concentra-

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*The results were presented at the 6th International Weigl Conference on Microbiology, Gdańsk, Poland (8–10 July, 2015).

Abbreviations: WHO, World Health Organization; US EPA, United States Environmental Protection Agency; ISO, The International Organization for Standardization; F, Fisher's value

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″

tions differed significantly between Site 2 and (Site 1 and 5); also Site 3 was significantly different from the other four collection sites.

Median concentrations of faecal streptococcus for the 5 collection sites are presented in Fig. 2. Higher levels of bacteria were detected in the summer, varying from 25 to 1250 cfu/100 ml. Faecal streptococcus concentrations were in compliance with the guideline value (ISO-7899-2) during winter and spring, except for site 3, whereas in the summer this limit was surpassed by 48% of samples from these beaches. ANOVA revealed that Site and Season had a significant effect on faecal streptococcus concentrations ($p < 0.05$), the F statistic for site was 61.152, $p < 0.001$; F-ratio for season was 6.086, $p = 0.004$. The interaction site and season was not significant at this level ($p > 0.05$). According to the Bonferroni's test, average values were statistically higher in the summer than in the winter, and also higher at Site 2 and Site 3.

DISCUSSION

Waterborne gastroenteritis outbreaks in swimmers occur more often in the summer, when the number of tourists at beach resort areas is higher, and consequently there is an increase of sewage discharge to the seawater, Sato et al. (2005). Also, rainfall events can increase this pollution to higher levels. A cause-effect relationship between faecal pollution and these outbreaks is well established and the symptom rates were found to be higher in children, Prüss (1998). In this study, higher levels of indicator bacteria were detected mainly during summer (Figs. 1 and 2). 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 2), it was observed that the beach at site 3 had the highest compliance failure percentage and concentration of faecal coliforms and faecal streptococci (100% and 100%; 1680 and 1500 respectively). These results indicate that this area is highly polluted and has a poor quality, WHO (2003). In this area there is a large number of wastewater outfalls, discharged without prior treatment, which may be the main polluting factor. This was followed by site 2 (27.3% and 45.5%; 650 and 540), which also contains a large number of wastewater outfalls, rating this site as not suitable for recreation; while site 1, 4 and 5 were in compliance with the Guidelines.

Our study was consistent with studies carried out by the 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. Furthermore, comparing to previous studies IPH (2011), it was observed that the index organism densities at Narta and Radhima beach, which are classified as excellent quality, has slightly increased. We suppose that rainfalls were the main cause of this increase and also, it was found that site 1 and 4 are exposed to short-term pollution. The aim of this study was to evaluate the levels of pollution from these beaches, in order to protect human health. Key elements in protecting human health from potential risks associated with recreational or bathing waters are the identification of pollution sources, assessing their impact on the target area and undertaking remedial action to reduce their public heath significance. Routine monitoring should be undertaken to determine if a beach's classification status changes over time. Also, advising local residents and tourists not to bathe in the impacted zone of the intermittent discharge for a given period, is an important precautionary measure, WHO (1999).

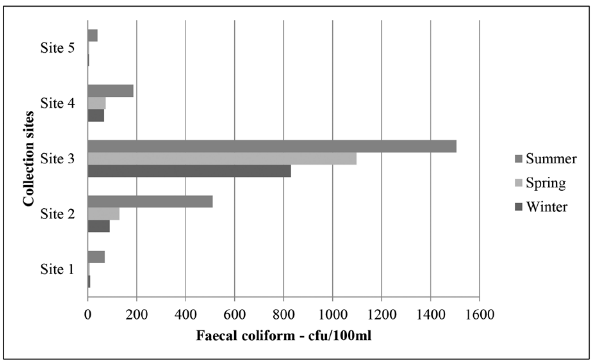

Figure 1. Median concentrations (Hazen's formula) of faecal coliforms at each collection site during winter, spring and summer. Twenty samples were analysed each, during winter and spring, while in summer twenty five samples were collected from these sites.

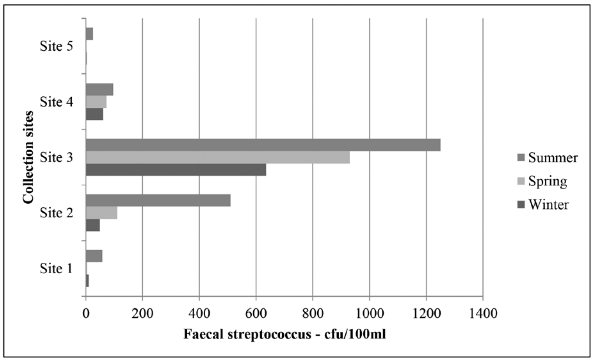

Figure 2. Median concentrations (Hazen's formula) of faecal streptococcus at each collection site during winter, spring and summer.
Twenty samples were analysed each, during winter and spring, while in summer twenty five samples were collected from these sites.

Table 2. Summary results of faecal coliforms and faecal streptococci (cfu/100ml), number of samples, failure percentages when compared to EU standards, minimum, maximum, interquartile range, median values and 90th percentile (Hazen's formula) of indicator densities at each collection site.

Location		Nr. of samples	% failure when compared to EU standards	Min	Max	Median	Interquartile range	90th percentile
Site 1	FC	13	0	2	200	15	103.6	108
	FS	13	0	1	160	10	92	93
Site 2	FC	13	0	55	760	180	590.2	650
	FS	13	0	30	635	170	504.4	540
Site 3	FC	13	100	740	1858	1080	892.8	1680
	FS	13	100	400	1510	850	980	1500
Site 4	FC	13	27.3	25	250	90	183	220
	FS	13	45.5	26	200	80	137	170
Site 5	FC	13	0	2	50	6	43.2	46
	FS	13	0	1	35	4	31.2	33

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