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Levels of Bio-Indicator Bacteria Transported To The Black Sea By The Riva Stream, Istanbul, Turkey

Research Article

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Abstract

In this study the levels of indicator bacteria and variable environmental conditions were investigated in the Riva Stream and transition zone of the Black Sea, Istanbul, Turkey. The surface water samples were taken from ten stations chosen regarding point-sources of pollution of the Riva Stream in the summer and winter season between the period June 2010 and August 2011. The membrane filtration technique was used to determine levels of total coliform and fecal coliform bacteria. Variable environmental parameters and water clarity were recorded in-situ. The results showed that obtained levels of indicator bacteria in all samples higher than the limit values for defined by national directive. A positive relationship between the indicator bacteria and temperature was recorded. The finding also showed that the Riva Stream under the influences of bacteriological pollution due to the fact that the fecal sources with respect to anthropogenic activities. Consequently, the Riva Stream contribute as a point-sourced bacterial pollutant factor to the villages located to the shores of the Riva Stream as well as the coast of the Turkish Black Sea and the beach located just west of Riva village. The pollution sources should be reduced and precautions must be taken for prevent potential problems related to ecosystem and human health. In this study, the first data related to the bacteriological load of the Riva Stream was obtained. However, there is a need long term monitoring studies to evaluate the effects of environmental variations and human impacts on the bio indicator bacteria in this areas.

Keywords : Bio-indicator bacteria; Riva Stream; Fecal Coliform; Total Coliform

Introduction

Despite of the presence of fecal coliforms in water may not be directly harmful; water contaminated with fecal coliforms may contain pathogenic bacteria and may be hazardous to human health. Fecal contamination carries an important role as a widespread hazard for public health [1]. As a result, indicator bacteria have traditionally been used for routine examination of surface water quality since the early 1970s, Water quality researchers relied almost exclusively on indicator bacteria including the coliform group, fecal streptococci, Escherichia coli (E. coli) and enterococci [2,3]. Due to the coastal zones are usually under intense anthropogenic pollution, microorganisms are accepted as the major factors for pollution. Domestic waste-water discharges are threats of the coastal environments worldwide considerably [4]. Coastal waters are under pressures of sewage waste-water discharge and disposal practices that may cause high nutrient levels, hazardous chemicals and pathogens causing diseases [5, 6,7]. Pathogens transmitted by human feces and the sewage systems polluted by human and animal pathogens as the main source of bacterial pollution. Total and fecal coliforms as well as fecal streptococci are traditionally used as universal microbiological indicators of water quality [8].

The Sea of Marmara is an inner sea, located between Asia and Europe continents. Istanbul Strait (Bosphorus) and Çanakkale Strait (Dardanelles) are gateways to the Aegean Sea and the Black Sea. Accordingly, it is important for fisheries industry, marine transportation and also ecosystem health [9].

The Riva Stream is approximately about 33 km and it flows through Riva village, Istanbul. The Riva Stream, one of the largest streams of Istanbul region, is located in exit of the Sea of Marmara-Istanbul between the Black Sea. Ömerli Dam was established on the Riva Stream in 1972 by DSI (General Directorate of State Hydraulic Works) to provide drinking water for the city as the biggest drinkable water reservoir (23.5 km2 area, 62 m maximum

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depth) of the northern part of the Marmara region, Turkey [10, 11].

The Riva basin is under the influences of settlements, recreational, domestic, agricultural and industrial activities. Previous studies, conducted in the Riva Stream related to the eutrophication and fisheries of the region, implied the occurrence of some pollutant inputs in the region [12,10,11,13]. However, there is no data related to indicator bacteria or bacterial pollution load of the Riva Stream transported to the Black Sea.

In this study, the presence of indicator organisms of bacterial pollution (total coliform, fecal coliforms) and its relationship with primary hydrographic parameters were investigated for the first time with an aim to detect transported indicator bacteria levels via the Riva Stream to the Black Sea, Turkey.

Material and Methods

The water samples taken under aseptic conditions from surface (0-30 cm) on 10 different stations in the different time periods between June 2010 and August 2011were transported daily to the Aquatic Microbial Ecology Laboratory of Faculty of Fisheries of Istanbul University.

The primary hydrographic parameters; salinity, temperature, pH and dissolved oxygen concentration were measured in-situ by using a portable Hach Lange Multiparameter (HQ 40D). Water clarity/underwater visibility was measured by using Secchi disk. Membrane filtration technique was used for bacteriological analyses. The water samples were filtered through a 0.45 µm membrane filter with a metal vacuum filtering set (Millipore, Germany) and then the membrane filter was placed on m-Endo, m-FC for total coliform and fecal coliform bacteria. The plates were incubated for 48 h (at 37±0.1°C and 44.5±0.1°C) and then the colonies on the plates were evaluated [14].

Blue colonies which grew on m-FC medium were evaluated to be fecal coliform suspicious; pink-red colonies with yellow-green metallic shininess which grew on m-Endo medium were evaluated as coliform suspicious. The correction tests were done for the suspicious colonies. Cytochrome oxidase test (API Strep, BioMerieux) was applied to coliform suspicious colonies and oxidase negative colonies were counted to be coliform. Cytochrome oxidase and indole (HIMEDIA) tests were applied to fecal coliform suspicious colonies, and oxidase negative and indole positive colonies were counted to be fecal coliform bacteria. The results were expressed to be the colony formed unit in 100 ml; (CFU/100 mL) [15,14].

Location of Riva Stream and the sampling stations were shown in Figure 1. The photographs taken from the sampling areas of the Riva Stream were displayed in Figure 2

Figure 1. Location of Riva Stream and the sampling stations.

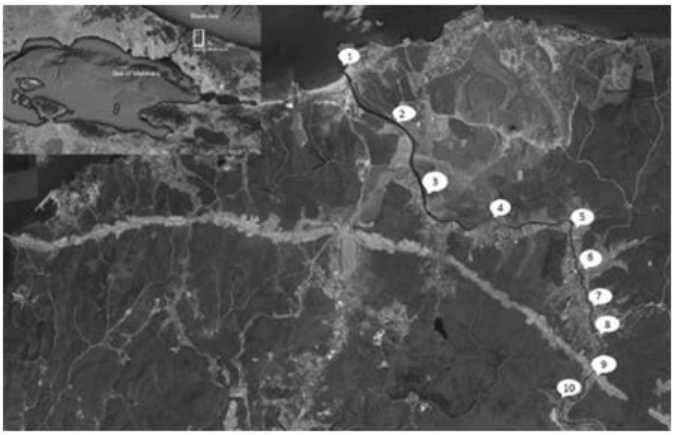

Figure 2. The photographs taken from the sampling areas of the Riva Stream.

Results

The physicochemical parameters of the sampling areas; dissolved oxygen, temperature, salinity, pH and also Secchi disc depth were shown on Table 1.

The minimum and maximum degrees Celsius values for temperature were 8.8–25.8, ‰ values for salinity were 5-86-0.24, pH values of the sampling stations were recorded to be 7.61-6.88, the milligrams per liter values for dissolved oxygen were 6.86-0.22. While the lowest meter values for Secchi disc were measured to be 0, the highest Secchi disc values was 1 meter.

The levels of total coliform detected in the surface water samples during the study period were shown in Figure 3.

While the samples taken all stations were displayed higher coliform bacteria counts than the national limit values during the study period, the highest counts of the total coliform bacteria were detected in June 2010.

The levels of fecal coliform detected in the surface water samples during the study period were shown in Figure 4.

The levels of fecal coliform were detected higher than advised national limit values. The counts of the fecal coliform were recorded minimum $2.4x10^5$ CFU/100 ml and maximum $5.6x10^5$ CFU/100 during the study period.

Discussion

In this study, levels of bacteria and the variable environmental parameters detected offer us data related to trophic status of the Riva Stream. The Secchi disk measurements used to indirectly estimate light penetrates through the water column of Riva Stream were found to conform to class IV (hypereutrophic) limit during the study period. The dissolved oxygen parameter is used to determine possible industrial based pollution. The water quality classes of Riva Stream in terms of dissolved oxygen values were detected as corresponding to class III and IV.

In this study detected bacteria levels in the surface water samples taken from the Riva Stream were also evaluated regarding usage style of the stream as a natural resource. The Riva Stream has importance because the upper course of it feeds Ömerli Dam, which provides more than forty percent of Istanbul's drinking water. In addition, the Riva Stream popular for recreational activities.

The area where Riva Stream flows into the sea is the popular beach of the Black Sea located just west of Riva village, Istanbul. The villages, farms, agricultural areas and touristic restaurants also have taken place on either side of the stream. In this study, detected bacterial pollution transported from the Riva Stream to the Black Sea and either side of the stream, in contrast to widely held recreational activities of the region, were evaluated as a potential risk for the region.

Figure 3. The levels of the total coliform bacteria detected in the surface water samples during the study period.

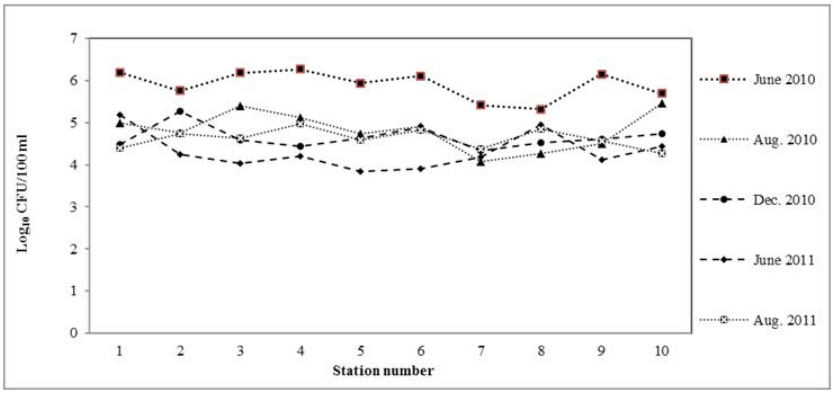

Figure 4. The levels of fecal coliform bacteria detected in the surface water samples during the study period.

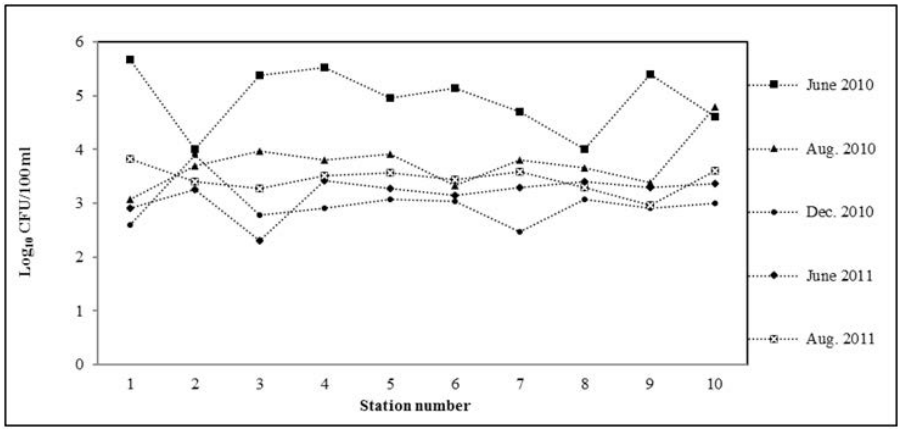

Table 1. Physicochemical parameters and Secchi disk depths on Riva Stream.

Stations	Months	Temp (°C)	Salinity (‰)	pH	O_2 (mg/l)	SD (m)
Station 1	Jun-10	19.9	5.15	7.55	6.86	1
	Aug. 2010	24.4	6.2	7.52	5.11	0.5
	Dec. 2010	12.2	2.45	7.49	5.36	1
	Jun-11	20.4	4.49	7.48	6.05	1
	Aug. 2011	25.1	5.86	7.53	5.27	0.5
Station 2	Jun-10	20.6	1.04	7.61	1.66	0.5
	Aug. 2010	25.3	2.02	7.5	2.6	1
	Dec. 2010	11	1.01	6.88	4.09	1
	Jun-11	20.7	1.02	7.4	3.86	0.5
	Aug. 2011	25.5	1.98	7.45	2.7	0.5
Station 3	Jun-10	20.6	0.96	7.56	0.77	0.05
	Aug. 2010	25	1.5	7.55	1.4	0.5
	Dec. 2010	10.9	0.82	7.19	4.2	0.75
	Jun-11	20.3	1.02	7.31	1.1	0.5
	Aug. 2011	25.2	1.33	7.40	1.2	0.5
Station 4	Jun-10	19.7	0.77	7.56	2.2	1
	Aug. 2010	25	1.2	7.55	2.96	0.5
	Dec. 2010	8.8	0.28	7.5	4.35	0.75
	Jun-11	19.5	0.85	7.51	2.65	1
	Aug. 2011	25.8	1.1	7.53	2.31	0.5
Station 5	Jun-10	20.4	0.74	7.53	0.77	0.1
	Aug. 2010	25.1	1.05	7.55	1.3	0.5
	Dec. 2010	11.3	0.74	7.33	3.2	0.5
	Jun-11	19.9	0.89	7.5	0.99	0.5
	Aug. 2011	25.4	0.81	7.46	1.5	0.5
Station 6	Jun-10	19.6	0.6	7.56	3.25	0.1
	Aug. 2010	24.5	0.95	7.54	0.97	0.5
	Dec. 2010	11.1	0.46	7.32	4.47	0.5
	Jun-11	19.3	0.72	7.49	2.5	0.25
	Aug. 2011	26	0.69	7.41	1.34	0.5
Station 7	Jun-10	20.6	0.65	7.5	0.9	1
	Aug. 2010	24.4	0.84	7.52	0.52	0.5
	Dec. 2010	11	0.55	7.34	3.17	0.5
	Jun-11	20.4	0.68	7.48	1.15	1
	Aug. 2011	25.2	0.56	7.39	0.75	0.75
Station 8	Jun-10	20.7	0.42	7.49	0.93	1
	Aug. 2010	24	0.59	7.54	0.27	0.5
	Dec. 2010	11.0	0.29	7.34	3.66	0.5
	Jun-11	20.4	0.41	7.52	1.69	1
	Aug. 2011	24.5	0.38	7.39	0.54	0.5
Station 9	Jun-10	20.5	0.4	7.52	0.22	0.5
	Aug. 2010	25.2	0.45	7.53	0.49	0
	Dec. 2010	12.1	0.24	7.39	4.17	0.5
	Jun-11	24.8	0.3	7.57	0.86	0.5
	Aug. 2011	25.5	0.31	7.55	0.71	0.5
Station 10	Jun-10	19.9	0.27	7.52	0.61	0.5
	Aug. 2010	24.8	0.3	7.57	0.86	0.5
	Dec. 2010	11.4	0.24	7.40	4.21	0.5
	Jun-11	20.2	0.33	7.41	0.89	0.5
	Aug. 2011	24.9	0.29	7.46	0.75	0.5

Conclusion

In this study indicator bacteria counts were found higher than standard values in the all study area. Because of indicator bacteria may show the presence of pathogenic bacteria this area must be examined more carefully in order to understand bacterial pollution levels in all aspects on study area. Beside increasing human population, anthropogenic pollution, domestic and industrial wastes, fishing and shipping activities and also untreated discharge of sewage water from the coastal towns and farms are the main responsible pollutant factors of coastal waters on this area. Increasing human activities around the region such as populated areas, connection roads of the third bridge of Istanbul also contribute to the lower course of the stream. This may lead to economic loss and serious human health hazards due to interactions between Ömerli Dam-Reservoir, Riva Stream and coastal ecosystems in future. However, the data related to bacterial pollution in the Riva Stream has not previously been reported. In this preliminary study, the findings showed that there was no decrease in the level of bacteria in all stations throughout the sampling period. This situation in turn showed that bacterial pollution from terrestrial were continual. Pollution factors should be reduced and precautions methods must be arranged as soon as possible. There is a need for work to be done to promote the entirety of the ecosystem, sustainable use of sources, and control of pollution sources to protect human and ecosystem health.

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