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Physico-chemical and Bacterial Characteristics of Surface Water of Saricay Stream (Canakkale/Turkey)

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Abstract

Aim: The objective of this research is to determine physic-chemical and microbial quality of Saricay Stream.

Methods: Water samples were collected from five different sites of the Saricay Stream (Canakkale, Turkey) in the months of January 2011 – December 2011 for the analyzing of some physico-chemical and microbiological parameters of the stream.

Results: In the present investigation, the stream temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), biochemical oxygen demand (BOD_5), values were altered between 15.8± 6.39 -16.2± 6.74 ºC; 7.7 ± 0.50 - 7.9 ± 0.42; 5.0± 2.54 - 11.6± 5.43 mS/cm; 7.0±2.70 - 11.8± 0.75 mg/L, 7.14±2.13 - 13.72 ± 7.67 mg/L, respectively. Nevertheless it is seen that waters of Saricay Stream for total coliform and faecal coliform at the sites 1 - 5 belonged to class 3 and class 4, respectively.

Conclusion: Furthermore, the presence of *Aeromonas* sp., *Vibrio* sp., *Plesiomonas shigelloides* and enteric bacteria in the water samples warrants for proper measures to reduce the pollution at point sources and requires proper remediation strategies to combat contamination in the river water.

Key words: Saricay stream, Physico-chemical parameter, Bacteriological parameter, Water quality

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Introduction

Rivers and streams are valuable freshwater resources that provide important habitats for nature conservation, recreation, transportation and economic growth (1). Anthropogenic activities strongly influence the natural status of almost all aquatic ecosystems. The input of large amounts of nutrients, pollutants and urban wastewater discharges can alter the quality of the recipient lakes, streams, rivers and coastal marine ecosystems (2).

The quality of water is typically determined by monitoring microbial presence and physico-chemical parameters. These parameters could be affected by external and internal factors. There is an intricate relationship between the external and internal factors in aquatic environments. Meteorological events and pollution are a few of the external factors which affect physico-chemical parameters such as temperature; pH and DO of the water. These parameters have major influences on biochemical reactions that occur within the water. Sudden changes of these parameters may be indicative of changing conditions in the water. Internal factors, on the other hand, include events, which occur between and within bacterial and plankton populations in the water body (3). The most frequently used microbial indicators of water quality are total coliforms (TC), faecal coliforms (FC), faecal enterococci (FE), all considered indicators of recent fecal contamination (4). However the estimation of bacteriological quality of surface and underground waters based on classical sanitary indicators (TC, FC, FE) may not reflect their safety for the health of bathing people and/or using water for drinking or irrigation and household purposes. Numerous human diseases human consumption, recreation and other purposes such as agricultural use in the area of river and sewage inflow are associated with the presence of opportunistic pathogens from *Pseudomonas* sp., *Aeromonas* sp., *Staphylococcus* sp., *Vibrio* sp. and other microorganisms groups, being able to generate infections by contact with skin, mucous membrane, nasopharyngeal cavity, respiratory ducts, eyes, ears and urogenital passages (5).

Thus, this study attempt to investigate monthly changes in physico-chemical and bacteriological parameters of water in the Saricay stream and to assess some opportunistic pathogens on health of stream ecosystem influenced by anthropogenic activities.

Materials and Methods

Study area

The Saricay Stream is located in the southwest region of Marmara, latitude 39° 40' – 40° 45' N and longitude 25° 37' – 27° 45' E, in Canakkale, Turkey (Figure 1a). The study area is the most important lowland in the Marmara region. Its mean depth is 2 m and flow speed between 15 and 300 m^3/s. This water resource is used for agriculture as on irrigation water and drinking water for animals (6). Atikhisar dam which was building on Saricay Stream was used as drinking water.

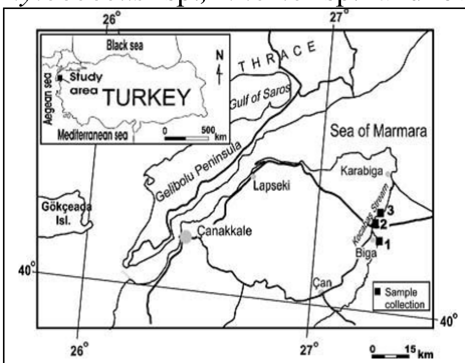

Figure 1a. Location of Saricay Stream in Turkey (6)

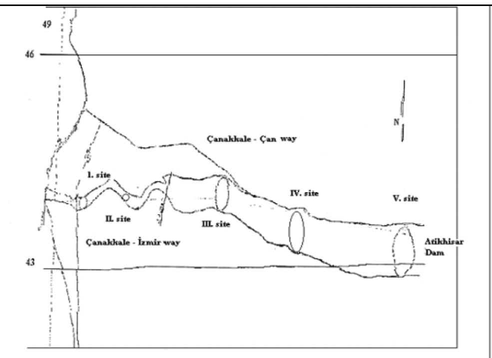

Figure 1b. Map of Saricay Stream indicating the Sampling Site (6)

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Water quality analysis

Sampling for water parameters were carried out in the five sites at monthly intervals between January and December 2011, covering dry and rainy seasons (Figure 1b). Standard methods (7) were used during collection, preservation and estimation of different parameters. Water temperature, pH, EC and DO were estimated at the spot with Hatch – Lange trademark ecological kit. Rests of the parameters (BOD5, TC, FC and FE) were determined in the laboratory within three hours of collection. The samples were immediately brought into laboratory to determine BOD_5 by using Winkler method (6). TC, FC and FE bacteria quality were determined by the most probable number (MPN) method (8). For the isolation of the motile *Aeromonas* spp., *Vibrio* spp., *Plesiomonas shigelloides,* alkaline peptonated water was used as enrichment medium and ampicillin Aeromonas Agar, Thiosulpate Citrate Bile Salts Sucrose Agar (TCBS) and Inositol Brilliant Bile Agar as a selective and differential culture medium, respectively. And other enteric bacteria were determined on MacKonkey and Eosin Methylene Blue (EMB) Agar (7). Complete identification of all bacteria was achieved by use of the tests in Bergey's Manual of Determinative Bacteriology (9).

Statistical Analysis

Mean and SE mean of microbiological and physicochemical analysis data were used to present monthly values from these parameters. Statistical parameters of physic-chemical and microbiological analyses data were used to present the values of these water quality characteristics. Pearson's correlation coefficient (r) was used to show correlation between the all parameters data using the MINI-TAB Statistical Software 13.20. The Student's t-test was used to determine the statistical significance. Probability was set at $p \leq 0.05$.

Results

Monthly physico-chemical and microbiological parameters from five sampling sites along the Saricay Stream were shown in Table 1 is a summary of arithmetic mean of all parameters. Table 2, a summary of correlation coefficients between various parameters are indicated in Saricay Stream. Bacterial isolates obtained from freshwater in this study were shown in Table 3.

When the physico-chemical parameters analyzed, it observed that temperature, pH, EC, DO, BOD_5 values were changed between 15.8± 6.39 -16.2± 6.74 ºC; 7.7 ± 0.50 - 7.9 ± 0.42; 5.0± 2.54 - 11.6± 5.43 mS/cm; 7.0±2.70 -11.8± 0.75 mg/L, 7.14±2.13-13.72 ± 7.67 mg/L, respectively (Table 1).

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Table 1 – Values of physicochemical and microbiological parameters (Mean ± SD) of Saricay Stream

Parameters	Site					
	I. site	II. site	III. site	IV. site	V. site	Average
T (°C)	16.0 ± 7.01 (I)	16.1±6.62 (I)	15.8± 6.39 (I)	16.1± 6.05 (I)	16.2± 6.74 (I)	16.04±6.56 (I)
pH	7.8±0.17 (I-II)	7.8 ±0.20 (I-II)	7.8± 0.21 (I-II)	7.7± 0.50 (I-II)	7.9± 0.42 (I-II)	7.8±0.3 (I-II)
EC	12.7±4.39 (I)	9.5±4.80 (I)	5.0± 2.54 (I)	9.8± 6.47 (I)	11.6± 5.43 (I)	9.72±4.72 (I)
DO	7.0±2.70 (I-II)	7.5±2.61 (I-II)	8.6± 1.76 (I-II)	9.1± 1.71 (III)	11.8± 0.75 (IV)	8.8±1.90 (I-II)
BOD_5	7.29±1.77 (II)	7.14±2.13 (II)	13.72±7.67 (III)	13.14±4.34 (III)	13.23±5.93 (III)	10.90±3.37 (III)
TC (MPN/100 mL)	19258.33± 31152.13 (I-II)	15683.33± 32164.71 (I-II)	27658.33 ± 40257.93 (III)	37541.67 ± 44649.57 (III)	23100 ± 41442.36 (III)	24648.33 ±37.933.34 (III)
FC (MPN/100 mL)	11016.67± 9911.961 (IV)	13208.33± 30579.42 (IV)	56475 ± 48031.56 (IV)	59900 ±52577.01 (IV)	43400 ± 50799.09 (IV)	36800 ±38379,80 (IV)
FE (MPN/100 mL)	12316,67± 31462.44	8850± 10162.81	8558.333 ± 7879.255	35358,33 ± 46820.67	14658,33 ± 32590.47	15948.33 ±25783,129

Faecal contamination indicator of Saricay stream – TC, FC, FE- were altered between 15683.33± 32164.71 - 37541.67 ± 44649.57 MPN/100 mL; 11016.67±9911.961 – 59900 ±52577.01 MPN/100 mL; 8558.333 ± 7879.255 – 35358.33 ± 46820.67 MPN/100 mL, respectively. According to WPCR, TC values of 1-2 stations in Class I-II; other stations in Class III and FC values of all stations were in Class IV (Table 1).

Yearly averages indicate a slight increasing trend at all the sites. While temperature with EC, DO, FE; pH-DO; DO-FC; TC-FC, FE; BOD_5 – EC, DO, FC showed significant positive correlation; EC showed negative correlation with FC; which is indicated by asterisk in Table 2.

Table 2 - Correlation coefficients between the parameters in the stream of Saricay

Parameters	Temperature	PH	EC	DO	BOD_5	TC	FC	FE
Temperature	1	0.320	0.624*	0.514*	-0.029	-0.113	-0.142	0.626*
pH		1	0.163	0.815*	0.205	-0.167	0.171	-0.292
EC			1	0.051	0.511*	-0.303	-0.549*	0.189
DO				1	0.644*	0.323	0.578*	0.233
BOD_5					1	0.403	0.713*	0.406
TC						1	0.880*	0.829*
FC							1	0.533*
FE								1

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Total 349 enteric bacteria isolates were identified from five sites of Saricay stream. Among enteric bacteria 87 strains of *Aeromonas* sp. were the most frequent isolates. These were followed by 72 strains of *E.coli* (%), 65 strains of *Vibrio* sp., 37 strains of *P.vulgaris*, 27 strains of *K.pneumoniae*, 25 strains of *Serratia* sp., 24 strains of *P. shigelloides* and 12 strains of *S. typhimurium* (Table 3).

Table 3. Isolated bacterial strains of Saricay Stream

Bacterial isolates	Station I N (%)	Station II	Station III	Station IV	Station V	Total frequency N=349
Vibrio sp.	10 (15.38)	12 (18.46)	14 (21.53)	24 (36.92)	5 (7.69)	65
Aeromonas sp.	20 (22.98)	15 (17.24)	15 (17.24)	25 (28.73)	12 (13.79)	87
P. shigelloides	3 (12.5)	5 (20.83)	7 (29.16)	8 (33.33)	1 (4.16)	24
E.coli	15 (20.83)	9 (12.5)	10 (13.88)	32 (44.44)	6 (8.33)	72
K.pneumoniae	3 (11.11)	3 (11.11)	5 (18.51)	13 (48.14)	3 (11.11)	27
Serratia sp.	4 (16.00)	4 (16.00)	3 (12.00)	9 (36.00)	5 (20.00)	25
P. vulgaris	4 (10.81)	3 (8.10)	2 (5.40)	20 (54.05)	8 (21.62)	37
S. typhimurium	2 (16.66)	2 (16.66)	2 (16.66)	4 (33.33)	2 (16.66)	12

Discussion

The aim of this study was to examine to determine physic-chemical and microbial quality of Saricay Stream. According to Turkish legislation (10) [Water Pollution Control Regulation (WPCR)] Official Gazette, water quality of inland waters is classified into four groups as: high quality waters (Class 1), moderate quality waters (Class 2), polluted waters (Class 3), and highly polluted waters (Class 4). Nevertheless based on results of comparison of data with WPCR, it is seen that waters of Saricay Stream at the sample sites belonged to Class I-II for parameter of temperature, pH, EC, DO, BOD_5, except DO values of 4 and 5 stations. In these stations DO values belong to Class III and IV, respectively (Table 1). When our physicochemical parameter findings compared with Hacioglu and Dulger (6), it seen that all parameters lower than their findings except DO. DO content is one of the most important factors in stream health. Its deficiency directly affects the ecosystem of a river due to bioaccumulation and bio magnifications. The oxygen content in water samples depends on a number of physical, chemical, biological and microbiological processes. DO values also show lateral spatial and seasonal changes depending on industrial, human and thermal activity (7). Low DO concentrations (< 3 mg/L) in fresh water aquatics systems indicate high pollution level of the waters and cause negative effects on life in this system (11). In our study DO concentrations were high, so that can be by high flow rate of stream.

Freshwaters polluted by faecal discharges from human and animals may transport a variety of human pathogenic microorganisms (virus, bacteria etc.). Because the detection of all waterborne faecal pathogens is very difficult, various indicators of faecal contamination are usually used to detect faecal pollution in natural waters (12). All stations were

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compared each other about faecal contamination, it seen that fourth stations has higher TC, FC and FE values. This is due to the station which remains in the residential area thought to be exposed to the highest anthropogenic pressure. Results which were found in the present investigation for TC and FC had shown similarity previous studies (6,13,14). Also, there is no data about FE in WPCR. But, it appears from our results that the impact of all these factors means together contribute to the hierarchy of abundance FE > TC > FC. The bacteriological quality of the Saricay stream posed an increased risk of infectious disease transmission to the communities that were dependent on the stream.

All isolated microorganisms in this research are potential pathogens causing a variety of diseases. *E.coli*, *Proteus* spp., *Serratia* spp. and *K. pneumoniae* causes diarrhea, urinary tract, bacteremia, wound infection, pneumonia, nosocomial infections and kidney infections etc. (15). *Aeromonas* sp., *P. shigelloides*, *Vibrio* sp. have also emerged as opportunistic pathogens responsible for gastroenteritis, skin and tissue infections, persistent dysentery and a variety of clinical syndromes in children, elderly people and compromised children, elderly people and patients (16,17). The presence of enteric bacterial pathogens in water sources may spell health hazards such as diarrheal diseases, which accounts for substantial degree of morbidity and mortality in adults and children (18). The obtained results have been compared with those from literature (1,5,17,18), and it can be observed a similarity with these, where the authors show high incidence of pathogenic and opportunistic bacteria isolated different water resources.

Water resources are useful or potentially useful to humans that include agricultural, industrial, household, recreational and environmental activities. Virtually all of these human uses require fresh water. 97.5% of water on the earth is salt water, leaving only 2.5% as fresh water of which over two thirds is frozen in glaciers and polar ice caps. Fresh water is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing. Water demand already exceeds supply in many parts of the world, and as world population continues to rise at an unprecedented rate, many more areas are expected to experience this imbalance in the near future. In present study, most of the physico-chemical average values were below the permissible limits for Official Gazette (10) standards for fresh water except BOD_5 (Table 1). But microbiological indicator bacteria (TC, FC, and FE) values and enteric bacteria rates of Saricay stream can be hazardous for public health and environmental risk factor. So, in next studies pollution sources must be taken under control and cleaned waste waters by purification plants. Also, periodic bacteriological monitoring of the stream system recommended. Because of pathogenic bacteria have an epidemiological behavior different from the traditional indicator bacteria; in addition to the faecal indicator bacteria it is important to detect pathogen bacteria, virus and other microorganisms.

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