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ARAŞTIRMA MAKALESİ **RESEARCH PAPER**

Determining the Bacteriological Pollution Level of Gelevera Creek, Giresun [*]

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Abstract: The aim of this study is to investigate the bacteriological pollution level of Gelevera Creek (Giresun). For this purpose, a total of 48 water samples was collected from 4 different stations between April 2017-March 2018 and bacteriological parameters were analyzed using the standard methods. Bacteriologically, total count of bacteria at 37°C from water and sediment samples, and count of total coliform bacteria (TC), fecal coliform bacteria (FC), fecal streptococci (FS), *E. coli* from surface water samples were determined. The percentages for TC, FC and FS presence in surface water samples were 100%, 100%, 93.75% respectively. In addition, *E. coli* were determined in collected samples for almost all seasons. The levels of total coliform, fecal coliform and fecal streptococci exceeded the values recommended by World Health Organization (WHO) and values that are set according to Turkish standards. This issue is likely to cause serious and irreparable damage to the streamline. As a result, it was determined that surface water samples collected from Gelevera Creek are bacteriological polluted. Hence in this study, regular monitoring and assessment by using appropriate methods to reduce the bacterial load in the Gelevera Creek Basin are recommended.

Keywords: Gelevera creek, bacteriological pollution, water quality, *E. coli*.

Gelevera Deresi (Giresun)'nin Bakteriyolojik Kirlilik Düzeyinin Belirlenmesi

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Öz: Bu çalışmada Gelevera Deresi (Giresun)'nin bakteriyolojik kirlilik düzeyinin belirlenmesini amaçlamaktadır. Bu amaç için 4 farklı istasyondan toplam 48 su numunesi örneği Nisan 2017-Mart 2018 tarihleri arasında toplanmış ve bakteriyolojik değişkenler standart metotlar kullanılarak analiz edilmiştir. Bakteriyolojik olarak su ve sediment örneklerinden 37°C'deki toplam bakteri sayısı; yüzey suyu örneklerinden toplam koliform bakteri sayısı (TK), fekal koliform bakteri sayısı (FK), fekal streptokok bakteri sayısı (FS) ve *E. coli* sayısı belirlenmiştir. Yüzey suyu numunelerinde TK, FK ve FS bulunma yüzdeleri sırasıyla %100, %100, %93,75'tir. Ayrıca, hemen hemen her mevsim için, toplanan örneklerde *E. coli* tespit edilmiştir. Toplam koliform, fekal koliform ve fekal streptokok bakteri seviyeleri, Dünya Sağlık Örgütü (DSÖ) tarafından önerilen değerleri ve Türk standartlarına göre belirlenen değerleri aşmaktadır. Bu durumun akarsu hattında ciddi ve onarılamaz hasara neden olması muhtemeldir. Sonuç olarak Gelevera Deresi yüzey suyu örneklerinin bakteriyolojik açıdan kirli olduğu belirlenmiştir. Dolayısıyla bu çalışmada Gelevera Deresi havzasındaki bakteriyel yükü azaltmak için uygun yöntemler kullanılarak düzenli izleme ve değerlendirme yapılması önerilmektedir.

Anahtar kelimeler: Gelevera deresi, bakteriyolojik kirlilik, su kalitesi, *E. coli*.

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INTRODUCTION

Epidemics necessitate the protection of usable water resources. Aquatic ecosystems are one of the most sensitive systems in terms of epidemics derived from bacteria and viruses that cause serious problems. Deterioration in bacteriological life in an aquatic environment adversely affects other living things that are highly organized and structured (Kalkan & Altuğ, 2020). Therefore, bacteriological studies that carried out in these areas which have limited use are of great importance. In Turkey, there are many studies carried out for water quality of aquatic resources (Verep et al., 2019; Uncumusaoğlu & Mutlu, 2017; Tokatlı et al., 2017; Mutlu et al., 2018; Uncumusaoğlu & Mutlu, 2019; Güher & Öterler, 2020; Gümüş & Akköz, 2020; Balcıoglu, 2020). However, bacteriological studies are quite limited (Yalım et al., 2020; Altuğ et al., 2020; Akduman et al., 2020; Sönmez & Sivri, 2020). Therefore, regular monitoring programs should ensure continuity in such studies, and information from a common database should be shared instantly.

This study deals with the present situation of bacteriological water quality in Gelevera Creek flowing into the Black Sea. Further, the data obtained as a result of this study will provide basic information about future planning for this freshwater resource.

MATERIAL AND METHODS

Study Area and Sampling: Gelevera Creek is located in Espiye of the Giresun province in Turkey. Similarly, it is also called as Özlüce Creek. It begins from the Balaban Mountains (Gümüşhane) and it is fed by many water supplies, especially Karadona Creek, Karaovacık Creek and Çukur Creek. The stream is 80 km in length. It lies along a narrow valley and flows into the Black Sea from Espiye the east of Giresun.

The surface water samples and sediment samples were collected from four stations (Figure 1) between April 2017 and March 2018 on a monthly basis for bacteriological analysis.

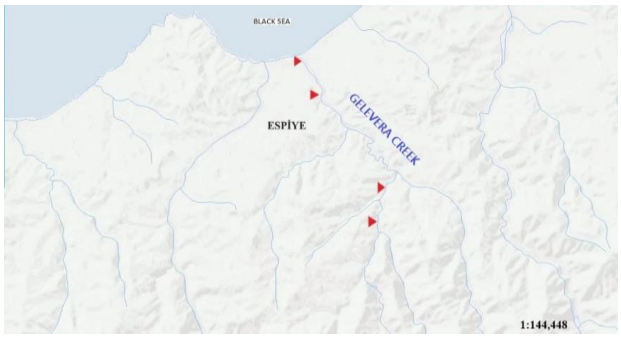

Figure 1. Study Area (Çolaker, 2019)

The surface water samples were then analyzed for total coliform (*TC*), fecal coliform (*FC*), fecal streptococcus (*FS*), and *E. coli*. The sediment samples were also analyzed for total count of aerobic bacteria and total count of mesophilic aerobic bacteria. The most-probable-number (*MPN*) method was used for the *TC, FC*, and *FS* count in order to determine the bacteriological quality. In addition, the standard plate count method was used in order to determine the bacteria count in both the sediment samples (homogenate rate 1:9) and water samples. Analyses were performed according to standard methodology (APHA, 1992).

RESULTS AND DISCUSSION

For surface water samples collected in summer, the count of *TC* bacteria was 240- >1100 *MPN*/100 mL, the count of *FC* bacteria was 240->240 *MPN*/100 mL, and the count of *FS* bacteria was 23-240> *MPN*/100 mL. The count of *E. coli* was determined to be between 15 cfu/100 mL and 203 cfu/100 mL. Total viable bacteria count at 37°C ranged from $2.9x10^3$ to $5.5 x10^5$ cfu/mL (Table 1).

For surface water samples collected in fall, the count of *TC* bacteria was determined to be between 240->1100 *MPN*/100 mL, the count of *FC* bacteria was 19->240 *MPN*/100 mL, and the count of *FS* bacteria was 0-240> *MPN*/100 mL. The count of *E. coli* varied between 0 cfu/100 mL and 125 cfu/100 mL. Total viable bacteria count at 37°C ranged from 8 $x10^2$ to 1.5 $x10^4$ cfu/mL (Table 1).

For surface water samples collected in winter, the count of *TC* bacteria was determined to be between 23 - >1100 *MPN*/100 mL, the count of *FC* bacteria 9-240 *MPN*/100 mL, and the count of *FS* bacteria was between 23-240> *MPN*/100 mL. The count of *E. coli* was between 0 - 20 cfu/100 mL. Total viable bacteria count at 37°C ranged from $1x10^2$ to 1.3 $x10^3$ cfu/mL (Table 1).

For surface water samples collected in spring, the bacterial counts in water samples were determined for *TC* to be 90-1100 *MPN*/100 mL, for *FC* to be 95->240 *MPN*/100 mL, for *FS* to be 0-240 *MPN*/100 mL, and for *E. coli* to be between 10 - 50 cfu/100 mL, respectively. Also, 37°C, total viable bacteria count ranged from 2.4 $x10^2$ to 6.6 $x10^3$ cfu/mL (Table 1).

Total viable bacteria counts in sediment samples at 37°C were $32.5x10^3$ – $4.5x10^5$ cfu/100 mL in summer; $1.3x10^4$ - $59x10^4$ cfu/100 mL in fall, $9x10^1$ – $2.3x10^4$ cfu/100 mL in winter, and $3.7x10^4$ – $59.8x10^4$ cfu/100 mL in spring.

Table 1. Results of bacteria counts in surface water samples.

	Station	Bacteria Count (*MPN*/100 mL)					Bacteria Count (*MPN*/100 mL)			
		TC	FC	EC	FS		TC	FC	EC	FS
June	1	240	240	15	240	December	93	9	0	23
	2	460	>240	17	240		240	19	6	23
	3	460	>240	37	>240		240	23	3	23
	4	>1100	>240	37	240		240	240	20	23
July	1	1100	240	103	23	January	23	9	0	240
	2	>1100	>240	23	23		240	23	0	>240
	3	1100	>240	37	23		240	23	0	23
	4	>1100	>240	135	23		>1100	240	20	240
August	1	>1100	>240	97	>240	February	23	9	0	23
	2	>1100	>240	173	>240		23	23	0	240
	3	>1100	>240	153	240		23	95	0	23
	4	>1100	>240	203	240		240	95	0	23
September	1	460	240	7	0	March	90	95	10	23
	2	460	>240	58	23		460	240	10	23
	3	460	>240	70	240		1100	>240	20	23
	4	>1100	>240	125	240		1100	>240	25	23
October	1	240	19	3	240	April	240	95	15	23
	2	1100	95	51	23		460	240	15	0
	3	460	240	20	>240		240	>240	25	95
	4	1100	>240	125	23		1100	>240	30	0
November	1	240	23	0	23	May	240	240	20	240
	2	460	95	75	23		460	>240	30	240
	3	460	240	10	23		460	>240	35	23
	4	460	>240	120	23		1100	>240	50	23

Eraslan Akkan et al. (2017) reported there was bacterial contamination at Harşit Stream and pointed out that bacteriological pollution had increased in summer and autumn, as well as that EC was detected at all sample stations. Aydın (2017) reported that percentages of TC, FC, EC and FS in the sixty surface water samples collected from Boğacık Creek were 98.33%, 91.67%, 83.33% and 96.67% respectively. In a similar study conducted in Yağlıdere Creek, the quality variables were detected as 45% for TC, as 71.66% for FC and 56.66% for FS (Akkan et al., 2019). In addition, the researchers pointed out that *E. coli* was present in the samples collected at any time of the year and the bacteriological flora was damaged. In this study, the percentages for TC, FC and FS presence in 48 surface water samples collected from Gelevera Creek were 100%, 100% and 93.75%, respectively. *E. coli* was detected at high rates for almost all seasons at most sampling stations.

The abnormal crossing of reference ranges of at least one station each month paints a bleak picture for Gelevera Creek which is used for a variety of purposes such as drinking and irrigation. In particular, the density in the fecal origin bacterial population is much higher than the reference ranges, thus inviting a waterborne disease outbreak. The values obtained from this study are extremely high according to EPA and WHO standards (Table 2).

It was determined that the changes in the count of bacteria collected from the surface water samples at 37°C were between $2.9x10^3$ and $5.5x10^5$ kob/mL in summer; between $8 x10^2$ and $1.5 x10^4$ kob/mL in fall; between $1x10^2$ and $1.3 x10^3$ kob/mL in winter; between $2.4 x10^2$ and $6.6 x10^3$ kob/mL in spring. The changes in the count of bacteria collected from the sediment samples were determined to be between $32.5x10^3$ and $4.5x10^5$ kob/mL in summer; between $1.3x10^4$ and $59x10^4$ kob/mL in fall; between $9x10^1$ and $2.3x10^4$ kob/mL in winter; between $3.7x10^4$ and $59.8x10^4$ in spring. When the stations were examined, it has been reported that the largest to smallest order seasonally for count of bacteria at 37°C was summer, spring, fall, winter.

Table 2. Bacteriological Water Quality Parameters (Akkan et al., 2019).

Parameters	RCWIHC, 2013	TS266	EPA, 2009	WHO, 2017
E. coli	0/250 mL	0/250 mL	0	0
FS	0/250 mL	0/250 mL	0	
TC	0/250 mL		0	0
FC			0	0
22 °C	20/mL*	100/mL*		
37 °C	5/mL*	20/mL*		

* max. value

According to findings of this study, it has been determined that pollution in surface water samples collected from Gelevera Creek was higher in sampling points corresponding to the district center and discharging area to the Black Sea. In addition, it has been observed that the stream load also carries additional pollutants to the area which coincides with the boundaries of Espiye district. When the results were analyzed, it was found that bacteriological pollution was higher in summer and spring than in fall and winter.

When the literature and the results of this study were compared, it has been consolidated that as in many studies conducted throughout the country and global, bacteriological pollution in which sewage and domestic solid waste play a major role increases in warm seasons. Similarly, it has been consolidated that with the comparision of the studies conducted in Giresun and this study, additional organic load is discharging to the ecosystem of the Black Sea, and that this carries a high risk for the ecosystem. As a common point of these studies; it also has been found that in settlement centers affect the bacteriological pollution in streamlines directly.

CONCLUSIONS

In conclusion, it was determined that Gelevera Creek was bacteriologically contaminated. Detection of this condition in almost every month of the year and in most stations is a serious danger. Major reasons of this pollution are determined to be domestic waste and the waste of animal slaughterhouses, both of which are uncontrolled. It has been observed that the stream bed is exposed to domestic waste excessively and some industrial waste. Further, it was noted that uncontrolled destruction for anthropogenic reasons was carried out along the streamline.

It can be observed that current human population per unit area should be considered as an effect when the count of bacteria in streamline's water and sediment flora is examined. This is also another indication that the organic load upon the stream is excessive. Therefore, an outbreak of infectious waterborne diseases will unfortunately be inevitable if necessary, precautions are not taken by the local authorities.

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