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Determining the Level of Bacteriological Pollution Level in Yağlıdere Stream, Giresun

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A B S T R A C T

The aim of this study is to investigate the levels of bacteriological water quality and pollution in Yağlıdere Stream, Giresun, Turkey. For this purpose, surface water and sediment samples were collected monthly, from five stations between June 2013 and May 2014. A bacteriological assessment of water and sediment samples with a 22 °C to 37 °C temperature range, including total coliform bacteria (*TC*), fecal coliform bacteria (*FC*), fecal streptococcus (*FS*), and *Escherichia coli* were done. Analysis was performed according to standard methods. Water quality and pollution level in Yağlıdere Stream were assessed in accordance with both Turkish legislation and international criteria. The *FC*, *FS* and *E. coli* count were detected higher than the reference value at multiple stations in almost every month of the year indicates. In conclusion, it can be said that the bacteriological pollution level of both the surface water and sediment structure of the stream pose a threat to the ecosystem balance.

Keywords: Yağlıdere Stream, bacteriological pollution, water quality

A R T I C L E I N F O

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Yağlıdere Çayı (Giresun)'nın Bakteriyolojik Kirlilik Düzeyinin Belirlenmesi

Öz: Bu çalışmanın amacı Yağlıdere Çayı'nın bakteriyolojik su kalitesi ve kirlilik düzeyinin araştırılmasıdır. Bu amaç için Haziran 2013 ve Mayıs 2014 tarihleri arasında 5 farklı istasyondan aylık olarak su ve sediment örnekleri toplanmıştır. Bakteriyolojik olarak su ve sediment örneklerinden: 22°C ve 37°C'deki toplam bakteri sayısı, su örneklerinden: toplam koliform bakteri sayısı (*TK*), fekal koliform bakteri sayısı (*FK*), fekal streptokok bakteri sayısı (*FS*) ve *Escherichia coli* sayısı tespit edilmiştir. Bütün bu analizler standart metotlara göre gerçekleştirilmiştir. Yağlıdere Çayı'nın bakteriyolojik su kalitesi ve kirlilik düzeyi ulusal ve uluslararası kriterlere göre değerlendirilmiştir. *FK, FS* ve *E. coli* sayısı, yılın hemen hemen her ayında birden fazla istasyonda referans değerlerden daha yüksek tespit edildi. Sonuç olarak Yağlıdere Çayı su ve sediment yapısındaki bakteriyolojik kirlenmenin ekosistemdeki dengeyi tehdit eder düzeyde olduğu söylenebilmektedir.

Anahtar kelimeler: Yağlıdere Çayı, bakteriyolojik kirlilik, su kalitesi

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Introduction

The quality of freshwater sources plays a very important role in the health of an ecosystem. Water quality refers to the physical, chemical, and biological properties of water that benefit its potential use. In order to determine its quality, water is usually analyzed according to these as well as bacteriological properties (Mutlu and Uncumusaoğlu 2016; Mutlu et al. 2016; Verep et al. 2017; Mutlu and Verep 2018). Deterioration in bacteriological life in an aquatic environment adversely affects other organisms, such as invertebrate animals and fish. Moreover, the bacteriological pollution from sewage can also lead to the harm and loss of valuable aquatic organisms, and may be responsible for the outbreak of water-born diseases (Sipahi et al. 2013; Akkan et al. 2015).

Pollutants entering certain freshwater sources (e.g. streams) harm the natural structure of those sources, which thus leads to water pollution. This situation unfavourably affects aquatic life and can even cause their extinction. Therefore, the state of pollution within our existing freshwater resources needs to be known and better understood. In recent years, a sizable number of studies have been carried out on bacteriological pollution levels in Turkish water resources (Yildirim and Vurmay 2017; Altuğ et al. 2017; Bulbul and Elipek 2017; Akkan 2017). These resources, hence, ought to be continuously monitored, with planning being made for the future, or else irreversible damage will occur. Furthermore, this situation can potentially lead to social, economic, and political problems. In turn, databanks that contain the pollution statistics obtained from local water quality studies need to be established. In due time, water policies should be established by using the data contained in such databanks. If not, the sustainable use of freshwater sources will be impossible to achieve.

The aim of this study is to investigate the bacteriological water quality level in Yağlıdere Stream, Giresun, Turkey, as well as to obtain rudimentary data for future planning for this freshwater resource, which discharges to the Black Sea.

Materials and Methods

Study Area and Sampling

Yağlıdere Stream is located in the Eastern Black Sea province of Giresun, Turkey. The Yağlıdere Stream is formed by the merging of Tohumluk Creek, which is originates in region of Kurteli, with Kılıçlar Creek, which originates from Erimez Mountain. The stream is 70 km in length, stretches along a narrow valley, and discharges into the Black Sea from the west of the district Espiye, Giresun. It has a water level of 415 hm^3 and a streamflow data of 96 m^3/sn.

The surface water and sediment samples were collected for bacteriological analysis from five stations between June 2013 and May 2014, on a monthly basis (Figure 1).

Figure 1. Study Area (adapted from Google Earth)

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 their total aerobic bacteria count and mesophilic aerobic bacteria counts. 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 used in order to determine the bacteria count in both the sediment (homogenate rate 1:9) and water samples.

All analyses were performed according to standard methodology (APHA 1992). The results of present study were assessed in accordance with both national and international criteria.

Results

The *TC* bacteria count in surface water samples in June was 460- >1100 *MPN*/100 mL, the *FC* bacteria count was >240 *MPN*/100 mL at all stations, and the *FS* bacteria count was 240- >240 *MPN*/100 mL. In addition, the change in the count of *E. coli* was determined to be between 80 and 240 *MPN*/100 mL. In July, the count of *TC* bacteria of water samples was determined to be between 11 and 290 *MPN*/100 mL, the *FC* bacteria count was 19- >240 *MPN*/100 mL, and the *FS* bacteria count was 23- >240 *MPN*/100 mL. *E. coli* counts varied between 80 and 120 *MPN*/100 mL. The *TC* bacteria count within the water samples in August was determined to be between 28 and 120 *MPN*/100 mL, the *FC* bacteria count 9- >240 *MPN*/100 mL, and the *FS* bacteria count was between

9 and 95 *MPN*/100 mL, whilst the *E. coli* count was between 18 and 120 *MPN*/100 mL. In September, the bacterial counts in water samples were determined for *TC* to be 29- >1100 *MPN*/100 mL, for *FC* at all stations to be >240 *MPN*/100 mL, for *FS* to be 23- >240 *MPN*/100 mL, and for *E. coli* to be between 72 and 200 *MPN*/100 mL, respectively. In October, the counter were determined for *TC* to be 75- >1100 *MPN*/100 mL, for *FC* to be between 0 and 240 *MPN*/100 mL, for *FS* to be 23- >240 *MPN*/100 mL, and for *E. coli* to be between 0 and 20 *MPN*/100 mL, respectively. In November, the count of *TC* bacteria was 16- >1100 *MPN*/100 mL, for *FC* it was between 9 and 240 *MPN*/100 mL, for *FS* bacteria it was 23- >240 *MPN*/100 mL, and for *E. coli* it was between 0 and 3 *MPN*/100 mL.

In the month of December, the count for *TC* was 1100- >1100 *MPN*/100 mL, for *FC* it was 240- >240 *MPN*/100 mL, for *FS* it was 23- >240 *MPN*/100 mL, and for *E. coli* it was between 18 and 47 *MPN*/100 mL. In January, counts were determined for *TC* to be 11- >1100 *MPN*/100 mL, for *FC* to be 23- >240 *MPN*/100 mL, for *FS* to be 23- >240 *MPN*/100 mL, and for *E. coli* to be between 0 and 120 *MPN*/100 mL, respectively. In February, counts for *TC* were between 28 and 210 *MPN*/100 mL, for *FC* were 240- >240 *MPN*/100 mL, for *FS* were 9- >240 *MPN*/100 mL, and for *E. coli* were between 0 and 3 *MPN*/100 mL, respectively.

For the months of March, April and May, counts for *TC* were 16- >1100 *MPN*/100 mL, between 15 and 210 *MPN*/100 mL, and between 16 and 1100 *MPN*/100 mL, for *FC* (at all stations) were 240 *MPN*/100 mL, >240 *MPN*/100 mL, and 240- >240 *MPN*/100 mL, for *FS* were between 0 and 240 *MPN*/100 mL, between 23 and 240 *MPN*/100 mL, and between 0 and 240 *MPN*/100 mL, and for *E. coli* were between 45 and 120 *MPN*/100 mL, between 24 and 240 *MPN*/100 mL, and between 48 and 180 *MPN*/100 mL, respectively. Results of bacteria counts in surface water samples were shown in Table 1.

Table 1. Results of bacteria counts in surface water samples

	Station	**Bacteria Count (*MPN*/100 mL)**					**Bacteria Count (*MPN*/100 mL)**			
		TC	**FC**	***E. coli***	**FS**		**TC**	**FC**	***E. coli***	**FS**
June	**1**	>1100	>240	80	240	**December**	1100	240	20	>240
	2	>1100	>240	240	240		>1100	>240	40	>240
	3	>1100	>240	120	>240		>1100	>240	20	>240
	4	460	>240	200	240		>1100	240	18	240
	5	1100	>240	240	>240		1100	>240	47	23
July	**1**	290	19	80	23	**January**	150	>240	0	240
	2	120	>240	96	>240		>1100	>240	120	>240
	3	20	>240	120	>240		>1100	>240	72	>240
	4	75	>240	80	240		11	23	69	95
	5	11	240	120	>240		15	0	0	23
August	**1**	43	9	80	95	**February**	28	19	2	>240
	2	75	240	18	95		1100	9	3	240
	3	28	>240	120	23		1100	0	0	23
	4	120	240	90	95		290	0	0	19
	5	120	240	120	9		210	0	0	9
September	**1**	>1100	>240	120	>240	**March**	16	>240	45	0
	2	>1100	>240	134	>240		>1100	>240	120	9
	3	>1100	>240	120	>240		290	>240	73	23
	4	29	>240	72	23		>1100	>240	72	240
	5	1100	>240	200	23		>1100	>240	108	9
October	**1**	1100	0	0	240	**April**	28	240	24	23
	2	>1100	240	20	>240		29	240	120	240
	3	>1100	23	3	>240		93	240	48	23
	4	75	0	0	23		15	240	240	240
	5	>1100	0	0	240		210	240	240	240
November	**1**	>1100	9	0	23	**May**	93	240	48	0
	2	16	240	3	240		1100	>240	105	240
	3	240	19	2	>240		120	>240	77	240
	4	>1100	19	0	>240		16	>240	140	23
	5	20	19	2	23		150	240	180	23

Throughout this study, the bacteria count among aquatic flora (between 22°C and 37°C) at $\log_{10}$ for water was found to be 4.2 (3.4-5.5) and 4.0 (2.5-4.8), and for sediment to be 9.2 (3-13.8) and 10.2 (5.1-14.2), respectively (Figures 2, 3, 4, and 5).

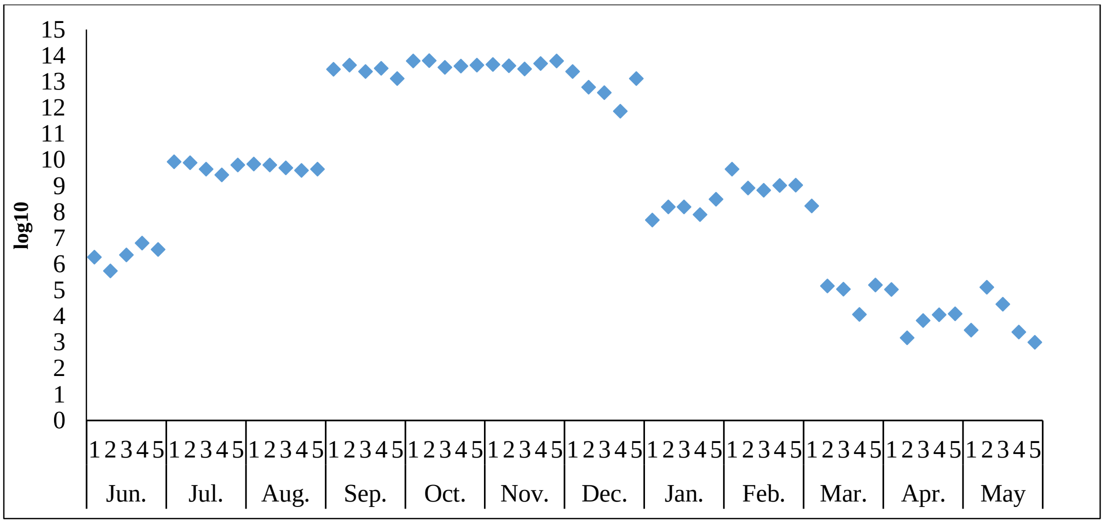

Figure 2. 22 ℃ Bacteria Count of Sediment

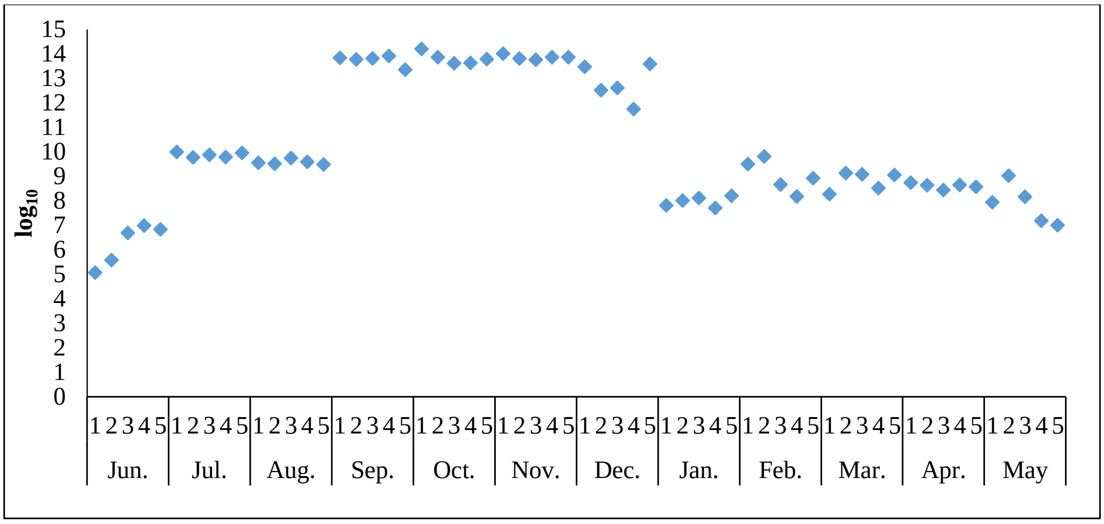

Figure 3. 37 ℃ Bacteria Count of Sediment

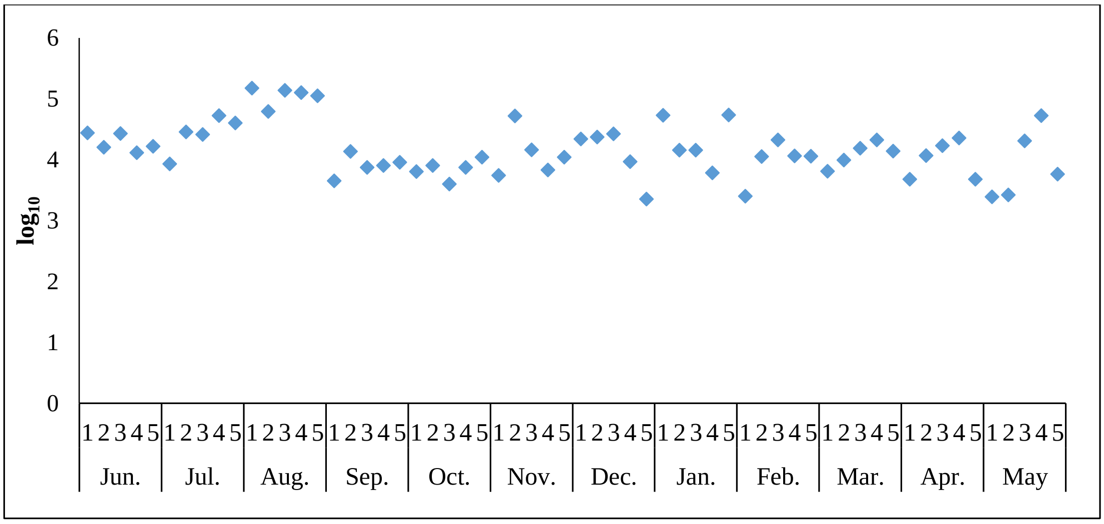

Figure 4. 22 ℃ Bacteria Count of water

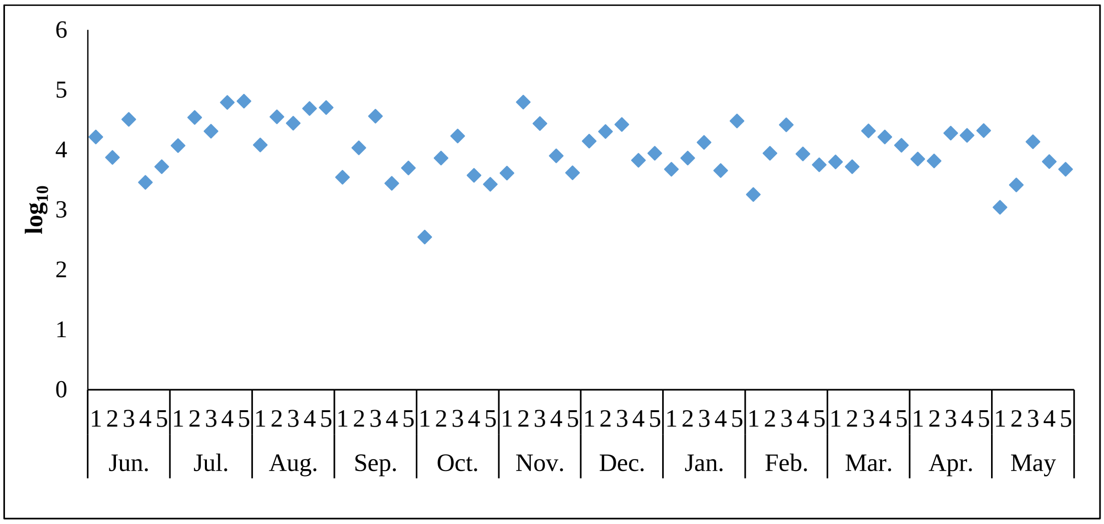

Figure 5. 37 °C Bacteria Count of Water

Kirecci et al. (2017) had reported that 79% of the bacteria found in samples taken from different water sources in the province of Kahramanmaraş were identified as being *E. coli* (89). Tunçsiper (2017), in one bacteriological study conducted at Kızılca Creek, had reported that water samples had heavily contaminated with bacteria (Class IV- TWPCR 2004 -), as well as had pointed out that the condition of the lake poses a grave threat to drinking water, recreation, fish production, animal production, and irrigation. Gemci et al. (2016) had reported that coliform bacteria were not detected in either the surface water of either Pınarbaşı, Karasu, or Ayvalı. Bulut et al. (2016) had reported there being bacteriological contamination at Eğirdir Lake, whereupon researchers had pointed out that *TC* bacteria count had increased in summer and autumn, as well as that *FC* bacteria was detected at certain stations. Gürün and Altuğ (2013) had reported there being an extensive amount of bacteriological pollution at Güllük Port and Sarıçay Stream, and had stated that the bacteria at all of the stations had reached almost 90% during the summer months.

In the present study, *TC*, *FC* and *FS* rates were determined to 45%, 71.66% and 56.66%, respectively, in the sixty surface water samples collected from Yağlıdere Stream, thus indicating bacteriological pollution. *E. coli* was also detected at high rates across almost all seasons. Across all seasons the *TC* count had reached upwards of 1100 MPN/100 mL and above. The only time this number fell was in the month of April. In addition, it was also found that the *FC* count was 240 MPN/100 mL at almost all stations, and months, except for February. The changing *FS* count has been determined to be in the range 0->240. The abnormal crossing of reference ranges of at least one station each month paints a bleak picture for Yağlıdere Stream, 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 water-borne disease outbreak. The values obtained from this study are extremely high according to EPA and WHO standards (Table 2).

Table 2. Bacteriological Water Quality 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

Conclusion

Consequently, the bacteriological water quality level is not suitable for aquatic life in the Yağlıdere Stream. The largest contribution of this pollution had been established as being domestic waste as well was the waste of animal slaughterhouses, both of which were uncontrolled. When we compare our results with the literature, we have found that this pollution level only increases in the summer. The fact that *FC*, *FS* and *E. coli* were detected at multiple stations in almost every month of the year indicates that the river has been heavily exposed to sewage-derived waste. What is more, when the number of bacteria in the water and sediment flora of the streamline is examined, we can see that the current human population in the unit area is also considerable, which is another indication that the organic load upon the stream is far too high. Therefore, if the local authorities do not take necessary measures, the outbreak of infectious water-borne diseases will unfortunately be inevitable.

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