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The levels of indicator bacteria transported to the Black Sea by the Sakarya River (Karasu Region)

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Abstract

In this study, the counts of indicator bacteria were investigated with the aim of detecting the level of bacteria were carried via the Sakarya River into the Black Sea. The analyses were carried out in the samples of the surface water which were taken from depths between 0-30 cm and 1-3 meters in the Karasu region of the Sakarya River and at the discharge point to Black Sea during the period between March 2008 to January 2009. The samples were analyzed using m-FC NKS and m-Endo NKS by means of membrane filtration technique. The highest total and fecal coliform values were found ($28x10^{12}$ CFU/100 ml and $14x10^{12}$ CFU/100 ml, respectively) in the samples that were taken from the 3rd station. The study results showed that indicator bacteria levels were over the national and international limits for this region and that this situation contributed to the rise of bacterial pollution of the Black Sea.

Key Words: Sakarya River, Karasu Region, Indicator bacteria, Black Sea

Introduction

Bacteria are microorganisms that play important roles in the food chain and bio-geochemical cycles in natural aquatic ecosystems. World Health Organization (WHO) reported that the abundance of pathogenic bacteria in aquatic environments is largely affected by fecal pollution from point discharges such as sewage effluents, industrial effluents animal feeding operations and non-point sources such as from agricultural activity and inadequately functioning purification systems (Anon 2005).

Fecal material is transferred directly from the sewage discharge and the watershed surface into rivers, lakes and streams, and then onto the coastal environment (Shuval 2003).

Providing quality and safety of natural aquatic environments has great importance terms of human health as well as economical and ecological points. Depending on the anthropological factors bacteria that achieve an optimum growth rate at a temperature of 37°C may be present in aquatic environments. This situation can interpreted as the indicator of the external source of contamination in natural environments (Rheinheimer 1985).

The Sakarya River is under the influences due to the fact that chemical and biological pollution with respect to heavily inland, over population and industrial activities. Furthermore, domestic wastes, abattoirs and agricultural activities are the other pollution sources of the region. Domestic waste is the greatest contributor with (45%) from amongst all other pollution sources of the Sakarya basin. Sakarya River is also under pressure of pollution from the Porsuk River and Ankara Stream (Atıcı 1997). The Organization for Security and Cooperation of Europe (OSCE) described the Porsuk River as "*a river that any living thing cannot live on except for the harmful bacteria and viruses, it is full of waste deposits and it is one of the most dangerous Rivers in terms of pollution and health*" (Akanıl Bingöl *et al.* 2007).

There are several studies related to water quality and the sources of pollution of the Sakarya River (Atıcı 1997; Işık *et al.* 2006; Anon., 2006; Küçük 2008). However, there is no bacteriological data related to the bacteriological load in this region.

In this preliminary study the existing bacterial pollution state of Karasu region of the Sakarya River, and the level of indicator bacteria which were transported via the Sakarya River to the Black Sea, was investigated for the first time.

Materials and Methods

The study was carried out seasonally between March 2008 and January 2009. The stations were chosen from Karasu region of the Sakarya River (Station 3, Station 4 and Station 5), estuary (Station 2) and the Black Sea (Station 1) (Figure 1).

The coordinates of sampling stations are shown in Table 1.

The water samples were taken from 0-30 cm surface and from various depths ranging from 1 to 5 meters. Water samples were filtered through a 0.45 µm membrane filter with a metal vacuum filtering set (Millipore, Germany) and then the membran 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 the colonies on the plates were evaluated (APHA 1998; EPA 2006).

Table 1. The coordinates of sampling stations.

Stations	Coordinates
Station 1	41° 08' 19" N 30° 39' 10" E
Station 2	41° 07' 31" N 30° 38' 54" E
Station 3	41° 05' 40" N 30° 38' 47" E
Station 4	41° 05' 00" N 30° 38' 49" E
Station 5	41° 04' 33" N 30° 38' 49" E

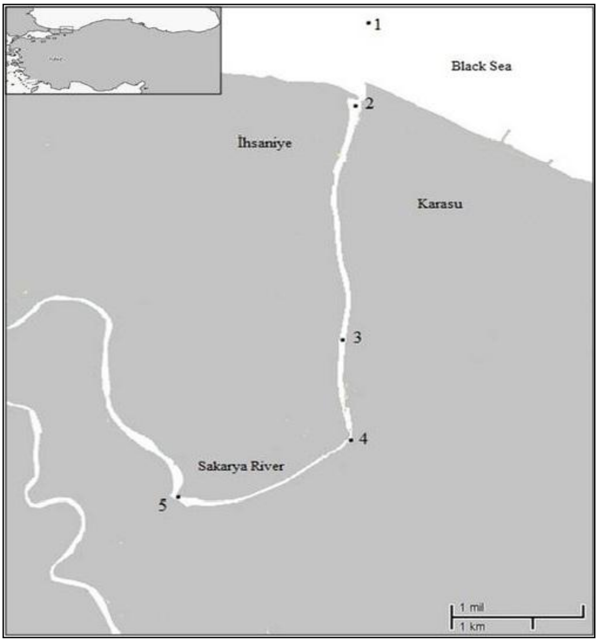

Figure 1. The sampling stations in the studied area

Physicochemical analyses

Temperature, dissolved oxygen (DO), and pH values were measured in situ using portable multi-parameter (Hach Lange HQ 40D) in the stations.

Results

The levels of total coliform and fecal coliform bacteria in the water samples which were taken from the Sakarya River are been summarized in Figures 2, Figure 3 and Figure 4.

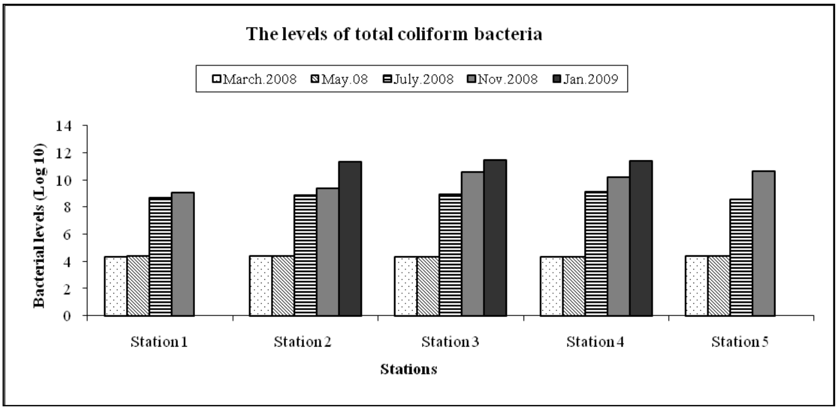

Figure 2. The levels of total coliform bacteria in the water samples (0-30 cm) were taken from the Sakarya River.

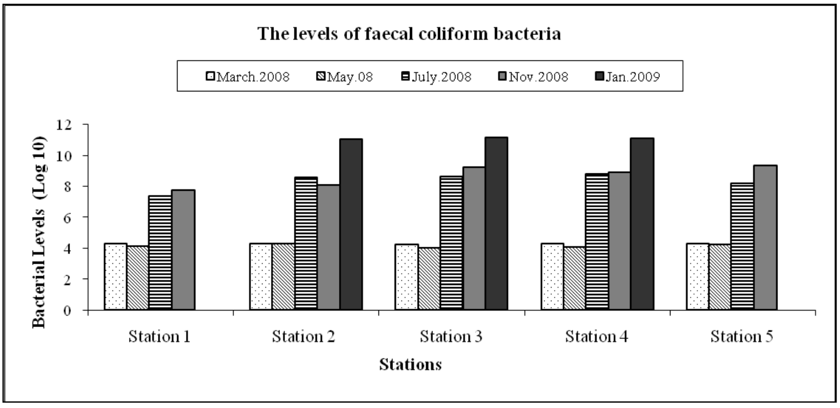

Figure 3. The levels of fecal coliform bacteria in the water samples (0-30 cm) were taken from the Sakarya River.

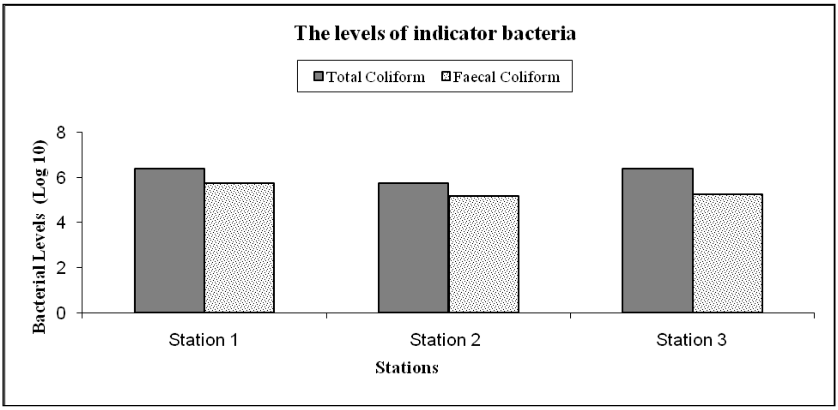

Figure 4. The levels of total coliform and fecal coliform bacteria in deep water (1-5 m) samples were taken from the Sakarya River.

Temperature, dissolved oxygen and pH values of the water samples which were taken from the sampling areas are summarized in the tables below (Tables 2, 3, and 4).

Table 2. Minimum, maximum and average temperature values of the study area.

Stations	Minimum Temperature (°C)	Maximum Temperature(°C)	Mean Temperature(°C)
1	6,8	23,1	12,5
2	6,8	25,0	11,5
3	6,5	25,1	11,6
4	6,4	25,2	11,4
5	6,8	25,4	13,3

Minimum temperature value was recorded to be 6,4 in the Station 4 during the study period.

Table 3. Minimum, maximum and average DO values of the stations.

Stations	Minimum DO (mg/l)	Maximum DO (mg/l)	Mean DO (mg/l)
1	9,9	10,2	9,2
2	9,6	10,2	9,9
3	8,5	10,2	9,7
4	8,8	10,5	9,8
5	9,3	10,2	9,8

DO values were recorded between 8,8 and 10,5 during the study period.

Table 4. Minimum, maximum and average pH values of the stations.

Stations	Minimum pH	Maximum pH	Mean pH
1	8,1	8,4	8,3
2	7,9	8,3	8,2
3	7,9	8,5	8,3
4	7,9	8,4	8,3
5	8,2	8,3	8,3

pH values were recorded between 7,9 and 8,5 during the study period.

Discussion

The indicator bacteria count found in the Karasu region of the Sakarya River was higher than the count in the seawater samples taken from the entrance to the Black Sea from the Sakarya River (Station 1). This situation was interpreted as being attributable to the mixture and dilution of fresh water and seawater. Slight fluctuations in the distribution of total and fecal coliform were observed throughout the sampling period.

However, a distinctive decrease in the bacteria count was not observed. This situation shows that there is a source of continuous pollution that was entering the study areas.

The dissolved oxygen parameter is used to determine possible industrial based pollution. In the previous studies, it was reported that the waters of Sakarya River were classified as, class II and class III according to dissolved oxygen levels (Gümrükçüoğlu *et al.* 2008). In this study, the waters of the Sakarya River were found to conform to class I limit and during the study period, the levels of dissolved oxygen were recorded as between 8.8 mg /L and 10.53 mg/L.

The indicator bacteria counts in deep waters (1-5 m) were slightly lower than the counts found in 0-30 cm surface water. Environmental contamination by human sewage of the surface waters may occur due to direct discharge or inadequate sewage treatment and the lack of monitoring the waters.

The pollution load of the Sakarya basin was reported for BOD, total nitrogen (N), total phosphorus (P) and total suspended solids (TSS) to be 448 700 for kg/day, 89,740 kg/day for, 269 220 kg/day and 17 950 kg/day, respectively (Burak *et al*., 1997). Ankara, Porsuk, Karasu and Çarksuyu are the main sources of pollution of the Sakarya River which place it with the third class group in terms of organic matter pollution. The water quality classes of Sakarya River in terms of NO_2-N values were reported as corresponding to class III and IV (Burak *et al.* 1997).

The findings of the previous studies mentioned above clearly showed that the region is under the influence of different pollution sources. The features of the environment offer suitable opportunities for the bacteria to grow. For example, amount of total suspended solid is a major factor influencing the survival of bacteria in water. This condition is associated with the pressure of salinity and ecological, economical and sustainable productivity of fresh water environments has shown that more importance in terms of protection of public health (Altuğ 2008).

However, the data related to the levels of indicator bacteria in the Sakarya River has not previously been reported. In this preliminary study, the existing bacterial pollution state of Karasu region of Sakarya

River and the level of indicator bacteria which were carried via Sakarya River to the Black Sea were investigated for the first time. For samples which were tested for total coliform, fecal coliform in a one-year term, it was found that the arithmetic mean value was over the national and international limits of water quality at all the stations during the study period.

It is concluded that the Sakarya basin, which is an important water source as the third longest river of Turkey,is under the influence of the domestic waste products and greater care must be taken to reduce contamination. Discharge of wastewater in this area should be reconsidered. Analytical controls will enable a rational and sustainable utilization of natural resources. There is a need for longer term monitoring studies for the purpose of identifying and minimizing the sources of pollution in this area.

Sakarya Nehri yoluyla (Karasu Bölgesi) Karadeniz'e taşınan indikatör bakteri düzeyleri

Özet

Bu çalışmada Sakarya Nehri aracılığı ile Karadeniz'e taşınan bakteri düzeyini belirlemek amacıyla indikatör bakteri sayısı araştırılmıştır. Analizler Sakarya Nehri'nin Karadeniz'e döküldüğü Karasu alanında Mart 2008 Ocak 2009 tarihleri arasında yapılan mevsimlik örneklemelerde 0-30 cm' den alınan yüzey suyu örnekleri ve 1-3 m derinlikten alınan dip suyu örneklerinde yapılmıştır. Örnekler Membran Filtrasyon Tekniği ile m-FC NKS ve m-Endo NKS kullanılarak analiz edilmiştir. En yüksek toplam koliform değerleri $28x10^{12}$ CFU/100 ml, fekal koliform değerleri $14x10^{12}$ CFU/100 ml olarak 3. istasyondan alınan örneklerde bulunmuştur. Çalışma sonuçları bu alanda indikatör bakteri düzeylerinin ulusal ve uluslararası limit değerlerinin üzerinde olduğunu ve bu durumun Karadeniz'in bakteriyel kirliliğini etkilediğini göstermektedir.

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