

RESEARCH ARTICLE

Anionic detergent, LAS pollution in coastal surface water of the Turkish Straits System

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Abstract

In this study anionic detergent, LAS concentration was surveyed in the coastal surface water of the Turkish Straits System (TSS) in January and August of 2012. Samples were taken at 15 stations in the TSS, which consists of Straits of Istanbul and Çanakkale and the Sea of Marmara. The mean value of LAS was found for January in the Istanbul Strait as 22.88 µg/L, in the Çanakkale Strait as 24.24 µg/L, in the Sea of Marmara Sea as 26.06 µg/L and for August in the Istanbul Strait as 43.43 µg/L, in the Çanakkale Strait as 48.25 µg/L, in the Sea of Marmara as 42.15 µg/L. The highest pollution was found at Kadıköy and the lowest at Anadolu Feneri for both months. Significant differences were found between seasons ($p<0.05$).

Keywords: LAS pollution, coastal waters, Turkish Straits System

Introduction

Coastal ecosystems receive large quantities of pollutants, which are used as the principal constitute of commercial detergents. Among these, linear alkylbenzenesulfonate (LAS) is the anionic surfactant used most in the formulation of detergents, with a consumption rate of 5.5 g/day per person in developed countries. As a result, LAS can be considered as a good indicator of urban-source pollution (Gonzalez-Mazo *et al.* 1997). Due to its widespread use, it has been detected in various concentrations in river water, seawater (2 – 510 ppb) and sediment (0.4–49 µg/g) (Gonzalez-Mazo *et al.* 1997; Matthijs *et al.* 1999).

Despite the negative effects on the marine environments, there are only a few studies on the LAS pollution in the sea water. Furthermore, published data on LAS pollution in some cities vary from 2 to 510 µg/L in the Bay of Cadiz

(Gonzalez-Mazo *et al.* 1997), 416 µg/L in Yorkshire stream surface water (Fox *et al.* 2000) and 52.6 µg/L in Lake Dianchi (Wang *et al.* 2010).

Anionic detergent is toxic for marine life and its film covers surface water and prevents penetration of oxygen to water from air. From 1 to 20 ppm surfactant is fatal to some fish (Weith and Konasewich 1975; Spehar *et al.* 1979). In the research on *Oncorhynchus mykiss* in aquarium, the lethal dose is 12,5 mg/L for single dose and 35 mg/L for progressive dose (Koç and Güven 2002) and also affects on plasma parameters (Koç *et al.* 2001).

Since LAS is removed very efficiently in wastewater treatment plants (Leon *et al.* 2006), and subsequently in river waters (Takada *et al.* 1994; McAvoy *et al.* 2003; Whelan *et al.* 2007), LAS concentrations in estuarine and coastal waters are typically below 50 mg/L where sewage treatment systems are installed (Gonzalez-Mazo *et al.* 1998; Lara-Martin *et al.* 2008). Higher concentrations, up to 2500 mg/L, have been detected in coastal waters close to untreated discharge outlets (Gonzalez-Mazo *et al.* 1998).

LAS pollution was investigated in various parts of the Turkish Sea; the highest value (µg/L) was found in the Istanbul Strait as 41.05, in the Çanakkale Strait as 25.02 (Güven *et al.* 2008), Küçükçekmece Lagoon (Topçuoğlu *et al.* 1997), 398.78 in 2007 at Şile-Ayancık (Black Sea) (Güven *et al.* 2010), Ali Ağa (Güven *et al.* 2008). There has been no data on the LAS pollution in Turkish seawater since 2007.

In this study LAS pollution levels were investigated at five stations in the Istanbul Strait, six stations in the Çanakkale Strait and four stations in the Sea of Marmara in 2012.

Materials and Methods

Study Area

Sampling stations are shown in Figure 1. Samples were taken from the surface water manually in January and August of 2012.

Apparatus

Material, UV spectrophotometer (Shimadzu, UV-1800).

Chemical and solvent (chloroform No: 602-006-00-4) were used Merck products.

Analytical Procedure

MBAS method (Standard methods, 1995) was used in this assay.

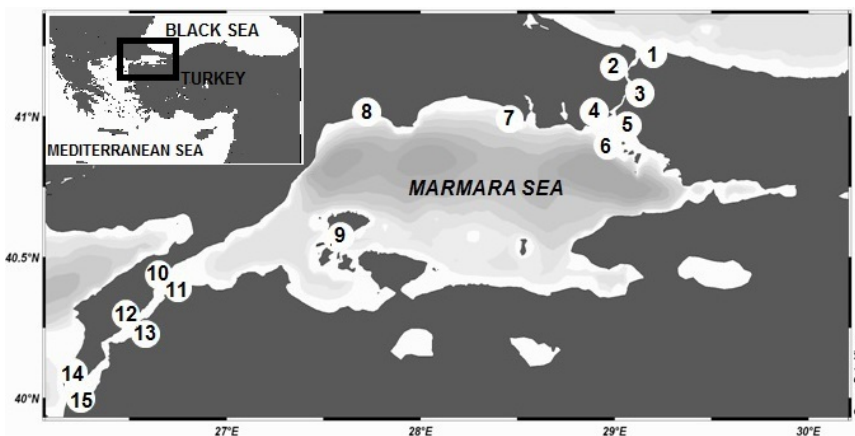


Figure 1. Sampling stations: 1- Anadolu Feneri, 2- Rumeli Kavağı, 3-Anadolu Hisarı, 4- Kumkapı, 5- Kadıköy (Istanbul Strait); 6- Kınalı Island, 7-Büyükçekmece, 8-Tekirdağ, 9- Marmara Island (Sea of Marmara); 10-Gelibolu, 11-Lapseki, 12-Karakova, 13-Gocuk, 14- Seddülbahir, 15-Kumkale (Çanakkale Strait).

Sea water samples were collected in 2.5 L amber glass bottles. 10 ml chloroform was added into the sample for preservation and they were stored under cold chain and in the dark during transportation to the laboratory. 700 ml sample was taken into a separatory funnel and alkalinized with 0.1 N NaOH (reagent 6 drops of phenolphthalein in alcohol) then acidified by 0.1 H₂SO₄. After addition of 25 ml methylene blue solution (1/1000) it was extracted 3 times with 30 ml of chloroform. The organic phases were combined and shaken with 50 ml wash solution (6.8 ml conc. H₂SO₄, 50 g NaH₂PO₄ in 1000 ml distilled water) then filtered. The volume of filtrate was adjusted to 100 ml with chloroform. Standard curve was plotted with LAS obtained from LEVER Izmit, Turkey. Its absorbance was measured in at 652 nm against a blank of chloroform. The mean value was obtained for triplicate analysis for each sample.

For the statistical analysis, the IBM SPSS Statistic 19 Package was used. A two-way ANOVA was carried out to assess the difference in detergent concentrations between seasons and stations.

Results and Discussion

Detergent concentrations were shown in Table 1 and in Figure 2 for January and August in 2012.

Detergent concentrations were at the range of 14.88 – 31.12 µg/L in January and 30.63- 58.73 µg/L in August samples. The highest concentration was found at Kadıköy (Station 2) and the lowest value was found at Anadolu Feneri (Station 4) in January. This result matches a previous study made by Balcıoğlu (2012) in

which stations having higher concentrations were located around wastewater treatment plants and discharge points of Istanbul). Similarly, Kadıköy had the highest detergent concentration and Anadolu Feneri had the lowest value in August.

Table 1. Detergent concentrations for January and August in 2012.

Stations	Conc. (µg/L)		Stations	Conc. (µg/L)	
	January	August		January	August
1	14.88	30.63	9	22.67	30.77
2	21.79	31.33	10	27.78	55.63
3	26.44	47.60	11	25.65	50.33
4	20.17	48.87	12	27.50	32.23
5	31.12	58.73	13	23.21	51.60
6	26.34	35.97	14	20.10	50.13
7	27.47	49.97	15	21.22	50.13
8	27.74	51.87			

A two-way ANOVA was carried out to test the difference between seasons and stations (Table 2). The significance difference was found in detergent concentrations between summer and winter seasons as well as between stations ($p < 0.05$). Interaction of independent variables (stations and seasons) also had significant effects on detergent concentrations ($p < 0.05$).

Table 2. The result of the two- way ANOVA for detergent concentrations in the TSS table.

Two-way ANOVA	Df	F	Sig.
Season (January/August)	1	6363.761	<0.05
Station	14	148.892	<0.05
Season * Station	14	76.352	<0.05

Güven *et al.* (2002) reported that the highest detergent concentrations were found in winter months. However, summer findings were slightly higher than winter values in this study. This may be attributed to the locations of summer houses at most stations. Therefore the increase in the populations in these regions is considered as a factor of the high concentrations (Balçioğlu 2013).

The results obtained from the Marmara Sea, Istanbul Strait and Çanakkale Strait, pollution levels differed between stations as well as between seasons. Although LAS level was found as 243.99 µg/L in the Sea of Marmara in 2004 (Güven and Çoban 2013), it was found as 42.15 µg/L in the Istanbul Strait (Güven *et al.* 2008), the highest pollution level found in this study was 58.73 µg/L. Similarly, the level was found as 34.55 µg/L in the Çanakkale Strait in 2005 (Güven *et al.* 2008), the present finding was 48.25 µg/L.

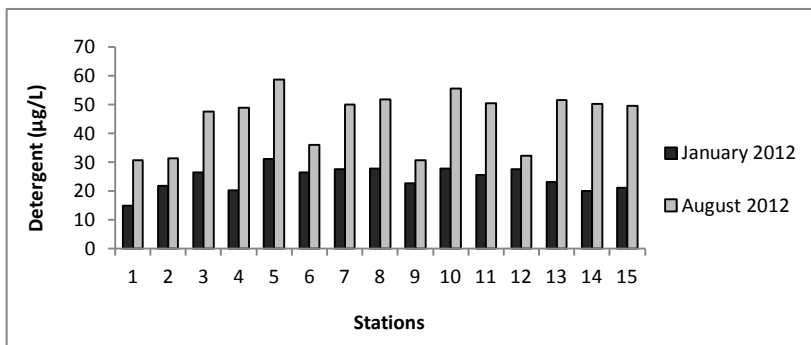


Figure 2. Detergent concentrations for January and August months.

The higher concentrations found south of Kadıköy were recorded Gelibolu, Tekirdağ and Lapseki stations. Tekirdağ is one of the industrially developed cities around the Marmara Sea. Gelibolu and Lapseki are bilateral stations located at the entrance and they are more urbanized than other stations in the Çanakkale Strait. Similar results were indicated as the entrance was more polluted than the exit in the Çanakkale Strait (Güven and Ilgar 2002).

Value of the surface-active substances should be kept below the permitted value (≤ 0.3 mg/L) according to regulations on quality of swimming water published in the Official Journal in 2006. In this study, mean values were 0.024 mg/L for January and 0.045 mg/L for August. These results were matched as II. class water criteria according to use of the Marine and Coastal waters published in Turkish Official Journal in 2008.

There is not a legal limit for LAS pollution in seawater. Only the existence of 0.02 µg/L concentration changes the taste of seawater (Güven *et al.* 1999).

According to the findings, substantial differences were found between the results of this work and results of the studies carried out before 2007. The concentrations of LAS vary according to ecological conditions of seawater, sampling place and time, concentration of sewage, distance from discharging points and biodegradation of LAS.

A two-way ANOVA was carried out to test the difference between seasons and stations (Table 2). The significance difference was found in detergent concentrations between summer and winter seasons as well as between stations ($p < 0.05$). Interaction of independent variables (stations and seasons) also had significant effects on detergent concentrations ($p < 0.05$).

Türk Boğazlar Sistemi'nde değişik istasyonlarda kıyıs al yüzey suyu LAS düzeyleri

Özet

Bu çalışmada Marmara Denizi'nin farklı kıyılarından 2012 yılının Ocak ve Ağustos aylarında toplanan yüzey suyu örneklerindeki deterjan konsantrasyonları (LAS) tayin edildi. Örnekler Marmara Denizi, İstanbul ve Çanakkale Boğazları'nda 15 istasyondan alındı ve analiz edildi. Her bir istasyondan alınan üç örnek üzerinde çalışıldı, ortalaması alındı ve istatistiksel analizi yapıldı. Ortalama değerler Ocak ayı için İstanbul Boğazı'nda 22.88 µg/L, Çanakkale Boğazı'nda 24.24 µg/L ve Marmara Denizi'nde 26.06 µg/L, Ağustos ayı için İstanbul Boğazı'nda 43.43 µg/L, Çanakkale Boğazı'nda 48.25 µg/L ve Marmara Denizi'nde 42.15 µg/L olarak hesaplandı. Hem Ocak hem de Ağustos ayında en yüksek konsantrasyon Kadıköy istasyonunda, en düşük konsantrasyon ise Anadolu Feneri istasyonunda bulundu. Yapılan istatistiksel analizde deterjan değerlerinde mevsimlere göre farklılık bulundu ($p<0.05$).

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