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Research Article

Tekirdağ ile İstanbul Arası Marmara Denizi'nde Müsilaj Tehlikesinin Araştırılması

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Öz

Marmara Denizi'nde müsilaja neden olan koşulların güncel durumunun belirlenmesi için yapılan bu çalışmada çalışma alanından on adet deniz suyu numunesi alınmıştır. Alınan numunlerde ICP-OES cihazı ile ağır metal analizleri yapılmıştır. Ve anlık olarak pH, sıcaklık, tuzluluk ve çözünmüş oksijen analizleri yapılmıştır. Ağır metal analiz sonuçlarına bakılığında numune lokasyonlarında deniz suyu kriterlerinin sağlandığı görülmektedir. İç Sulara Ve Denizlerdeki İstihsal Yerlerine Dökülmesi Yasak Olan Zararlı Maddeler Ve Alıcı Ortama Ait Kabul Edilebilir Değerlere göre analiz sonuçları incelendiğinde Ca, Mg ve K değerlerinin bütün lokasyonlarda sınır değerlerini aştığı görülmektedir. Ayrıca numune lokasyonlarında çözünmüş oksijen değerlerinin düşüklüğü dikkat çekicidir. Sıcaklık, tuzluluk ve pH değerleri ise Marmara Denizi ortalama değerlerini sağlamaktadır.

Anahtar Kelimeler: Marmara Denizi, Ağır Metal, Müsilaj, Çözünmüş Oksijen

Mucilage Hazard on the Marmara Sea Coasts Between Tekirdağ and Istanbul

Abstract

In this study, which was carried out to determine the current status of the conditions causing mucilage in the Marmara Sea, ten seawater samples were taken from the study area. Heavy metal analyzes were performed on the samples taken with the ICP-OES device. And pH, temperature, salinity and dissolved oxygen analyzes were made instantly. Considering the heavy metal analysis results, it is seen that sea water criteria are met in the sample locations. When the analysis results are examined according to the Harmful Substances Prohibited from Being Spilled into Inland Waters and Marine Production Sites and the Acceptable Values for the Receiving Environment, it is seen that Ca, Mg and K values exceed the limit values in all locations. It is also noteworthy that the dissolved oxygen values are low in the sample locations. Temperature, salinity and pH values provide the average values of the Marmara Sea.

Keywords: Marmara Sea, Heavy Metals, Mücilage, Dissolved oxygen

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1. Introduction

Considering the geological formation and strategic location of the Marmara Sea, its scientific importance is quite great. The Sea of Marmara, formed approximately 5-20 million years ago, is an inland sea located on the continental crust. Although its surface area is small compared to other seas, it has more than 1000 m deep pits. Thanks to the straits, the Black Sea and Mediterranean Sea waters, which have different hydrological and physical characteristics, are exchanged (Yümün and Kam, 2021; Kam and Yümün 2021).

Surface and bottom currents and hydrological differences create the unique characteristics of the Marmara Sea. Apart from these currents, there are no large flow water mass movements through streams in the Marmara Sea, especially on the Tekirdağ coast. Decreased or absent water transfer may lead to increased salinity and pollution due to evaporation, especially during the summer months. Because less transfer reduces the possibility of the sea cleaning itself. The coasts of the Marmara Sea are very risky in terms of industrial and domestic pollution (Yümün 2017;Yümün and Kam, 2019;Yümün et.a. 2022). In addition, overfishing, incorrect and excessive application of fertilizers and pesticides used in agricultural activities, intense maritime traffic and atmospheric convection are other issues that create stress on the Marmara Sea. Mass fish deaths and eutrophication, which occur periodically in the Marmara Sea, may occur as a result of these pollutions. Especially in recent years, mucilage (sea saliva) covers the sea surface, creating environmental pollution and threatening marine life. The mucilage formed in the Sea of Marmara did not disappear from the sea surface for a long time and prevented sunlight from entering the inner parts of the sea. With the lack of sunlight, in-sea photosynthesis has come to a halt and accordingly, dissolved oxygen values in the sea have decreased. Decreasing oxygen in the environment means flora and fauna are in danger. Mucilage, also known as sea saliva or sea snot, is a ball-shaped substance consisting of a slime-like transparent substance, dead algae, and organic and inorganic substances (Yümün et. al. 2023). Although it is not dangerous at first, the organic and inorganic pollutants it contains pass into the water over time (Yümün and Önce 2017;Dinçer et.al.2019;Kam et. al. 2021; Yümün and Önce Nişancıoğlu 2023).

Mucilage is triggered depending on environmental conditions. Mucilage has been seen in many regions of the world from past to present. Mucilage may last for several days or months. The incidence of massive mucilaginous aggregates is increasing in the oceans, especially in the Mediterranean, the Pacific Ocean and the North Sea, the Southern Bay of Biscay (off the coast of France), and in recent years off the coasts of the USA such as California (Alldredge et.al. 2002; Rouaud et.al. 2019). The first case of mucilage in Turkey was observed in Erdek Bay in 1992 (Koncagül et. al. 2022; Tüfekçi et.al. 2010). Between 2020-2021, a dense mucilage covering a large surface area was observed in the Marmara Sea. In diving studies, it was measured that the mucilage density in the mucilage region varies between 5 and 25 m depth (Karadurmuş and Sarı 2022; Polat et.al.2023). Mucilage is a formation rich in bacteria and organic matter, such as E-coli (Kayhan and Yön Ertuğ, 2022, Yüksek 2021). Research has shown that mucilage formation is caused by organisms such as phytoplankton, diatoms, benthic macroalgae, cyanobacteria, and heterotrophic bacteria (Mecozzi et.al. 2001; Aydın 2021). Many studies have been conducted on mucilage formation and its effects in the study area (Yümün et.al. 2022; Yümün and Kam 2019; Öztürk and Ediger 2023; Yümün et. al. 2021). Initial examinations revealed that the mucilage was of organic origin. Mucilage spread rapidly to cover most of the Sea of Marmara, and was especially concentrated in coastal areas to attract people's attention (Yücel et.al. 2021). When we look at the study area, it is seen that industry, tourism and agricultural activities and population are dense. There is no large-scale river flowing into the region. The absence of rivers reduces the sea's ability to clean itself. These factors leave the Marmara Sea vulnerable to pollution. No large-scale formation was observed after the mucilage seen in 2021, but a small amount of mucilage formation occurred in the spring of 2023.

2. Material and Method

2.1. Study Area Geology

Although the symmetrical shape of the arc is interrupted by the shelf advancing towards the sea off the coast of Büyük Çekmece, its width largely depends on the structure of the coast. Off the coast of Tekirdağ, it runs completely parallel to the coast and ends at the entrance of the Ganos Mountains. The shelf is connected to the Marmara depressions with very high slopes and steep, narrow and deep valley systems. This situation causes sediments to accumulate in remote areas of the shelf, and the depressions are filled with turbidite currents (Smith et.al. 1995, Aksu et.al. 1999;Kam and Önce 2016;Yümün 2016).

The Thrace Basin, which covers the inner parts of the Thrace Peninsula, forms an elevated structure in most areas on the northern coast of the Marmara Sea. The terraces seen here and there along the coast are evidence that this coast is elevated. It is estimated that before this rise, the Ergene River drained into the Marmara Sea and carried the sediments that filled the Tekirdağ depression in this sea. However, it has been claimed that as a result of the elevation of the southern edge of the basin, this river began to flow into the Aegean Sea via the Enez River (Okay et.al. 1999).

2.2. Analysis Method

Field and laboratory analyzes were carried out to investigate the current effects of sea saliva in the Marmara Sea. During field studies, seawater and mucilage samples were taken from ten points in the Marmara Sea between the coasts of Tekirdağ and Istanbul (Figure 1, Table 1). For analysis, around 500 ml of sample was taken from the dirty seawater in the mucilage area. The samples taken were brought to the laboratory for analysis by paying attention to sample storage methods. In these samples, Na, M, K, Ca, P, Fe, B, P, Cu, Mn, Zn, As, Bi, Cd, Co, Cr, Mo, Ni, Pb, Sb, Hg, Al elements were analyzed. For heavy metal analyses, 15 g of water samples are taken and completed up to 50 ml with ultra-purified water. This prepared water sample is filtered with the help of filter papers. The prepared samples are placed in the measurement unit of the ICP-OES device and readings are made. Physical analyzes were performed instantly at sample locations. In these analyses, EcoSence Brand DO200A Model portable oxygen meter, Trans Instruments brand HP3040 pH, ORP/mV model portable pH and electrical conductivity meter, ZAG INSTRIMENTS brand ATC model portable salinity meter, Multitermeometer brand (-50 - +150 0C) capacity portable thermometer used (Yümün et.al. 2016; Yümün et.al. 2019; Bayrak et.al. 2022).

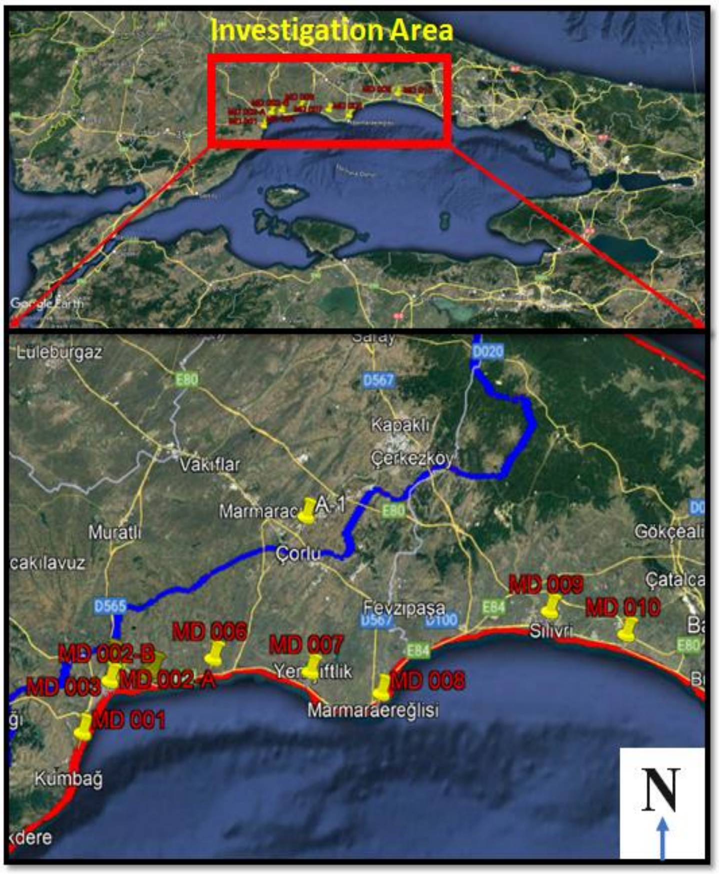

Figure 1. Study area map

Table 1. Study area sample locations

Sample No	Coordinates	
	Doğu (X)	Kuzey (Y)
MD 001	539485.01	4528494.22
MD 002-A	542625.88	4535579.84
MD 002-B	542597.66	4535539.77
MD 003	543539.46	4536160.51
MD 004	547626.82	4536806.16
MD 005-A	548537.64	4537191.23
MD 005-B	548573.48	4537186.40
MD 006	556881.09	4539234.09
MD 007	570697.37	4538162.60
MD 008	580821.61	4535801.16
MD 009	603957.14	4548027.37
MD 010	614856.94	4545466.72

3. Results and Discussion

The analysis results of water samples taken between Tekirdağ and Istanbul are shown in table 3. The analysis results obtained from the study area were interpreted according to the relevant values in the Water Pollution Control Regulation. In the analyses, measurements of the elements Cu, Cd, Co, Cr, Mo, Ni, Pb, P, Hg, Fe, As, Mn, Zn, Al, Na, Mg, K, Ca, B, Bi, Sb were carried out. As a result of the analysis, P, Cu, Mn, Zn, As, Bi, Cd, Co, Cr, Mo, Ni, Pb, Sb, Hg, Al elements were below the measurement limits of the device. Table 2 gives the measurement limit values of the elements.

Table 2. Measurement limit values of the elements

LOD <1ppb									
Be	Ca	Mg	Sr	Ba	Y	Zn	Yb	Er	
Lu	Co	Al	Dy	Tm	Fe	Eu	Hb		
Ag	Cd	Mn	Ti	V	Sc	Gd	La		
LOD: 1-10 ppb									
B	Si	W	Cu	Au	Nb	Nd			
Rh	Pd	Ni	Pt	Zr	Pr	Ru			
Tb	Cr	Ir	Ga	Ce	Mo	Sm			
LOD:10-100 ppb									
P	Ge	As	Se	Rb	In	Sn	Te	Cs	Hf
Ta	Re	Os	Hg	Ti	Pb	Bi	Th	U	Sb

Table 3. Heavy metal analysis results of samples

Sample	**Na**	**Mg**	**K**	**Ca**	**Fe**	**B**
	ppm	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
md-001	6609.01	947.84	393.25	309.71	0.07	3.39
md-002	6257.54	905.90	372.43	297.81	0.07	3.18
md-002- discharge	119.99	18.92	30.26	40.90	0.10	0.12
md-003	6653.74	929.83	383.97	309.39	0.06	3.23
md-004	6305.83	940.50	378.71	302.50	0.06	3.14
md-005	6588.53	976.03	384.47	314.94	0.12	3.21
md-005- discharge	326.46	70.56	35.45	64.69	0.14	0.16
md-006	6568.27	955.04	382.51	314.90	0.06	3.20
md-007	6436.41	943.35	377.11	305.80	0.05	3.23
md-008	6413.57	940.28	374.38	305.57	0.05	3.14
md-009	6577.96	936.55	382.47	305.75	0.05	3.16
md-010	6612.83	958.57	386.72	314.74	0.06	3.22
*****	-	-	-	-	**0.10**	-
******	**85 mg/l**	**14mg/l**	**50mg/l**	**800 mg/l**	**0,7 mg/l**	**3,0 mg/l**
*******	-	-	-	-	-	-
********	-	-	-	-	**10mg/l**	-

**General Quality Criteria of Sea Water (Regulation 1, Table-4)*

***Harmful Substances That Are Forbidden To Be Poured Into Inland Waters And Seas And The Acceptable Values Of The Receiving Environment (Regulation 2, Annex-5)*

**** Wastewater Standards For Discharge Of Wastewater To Wastewater Infrastructure Facilities (Regulation 1, Table 22).*

***** Discharge Standards of Mixed Industrial Wastewaters to the Receiving Environment (Small and Large Organized Industrial Zones and Other Industries whose Sector Cannot Be Determined) (Regulation 1, Table 19)*

Figure 2. Locations where samples were taken: Tekirdağ coastal shores

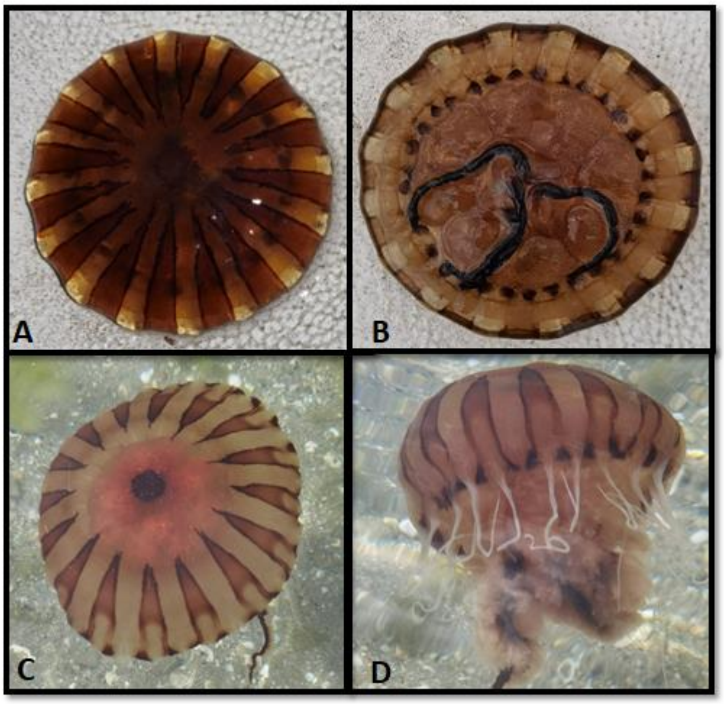

Figure 3. Algal species identified in mucilage samples(Chrysaora hysoscella)

4. Conclusions and Recommendations

All results obtained from the study area: General Quality Criteria of Sea Water (Regulation 1, Table-4), Harmful Substances Prohibited from Being Discharged into Inland Waters and Production Sites in the Seas and Acceptable Values for the Receiving Environment (Regulation 2, Annex-5), Mixed Industrial Wastewaters According to the limit values in the aquatic environment of the elements specified in the Discharge Standards to the Receiving Environment (Small and Large Organized Industrial Zones and Other Industries for which Sector Determination Cannot Be Made) (Regulation 1, Table 19) and the Wastewater Standards Envisaged for the Discharge of Wastewater to Wastewater Infrastructure Facilities (Regulation 1, Table 22) has been evaluated.

Concentration of Cu, Cd, Co, Cr, Mo, Ni, Pb, P, Hg, Fe, As, Mn, Zn, Al, Na, Mg, K, Ca, B, Bi, Sb elements in the water samples taken by ICP-OES values were analyzed. In the study area analysis results, P,Cu,Mn,Zn,As,Bi,Cd,Co,Cr,Mo,Ni,Pb, Sb,Hg, Al values were found to be 0 ppm. When the instantaneous pH measurement results at the locations are examined, all locations meet the SKKY sea water general quality criteria. In addition, the analysis results show that the sampled areas generally meet the sea water criteria. Only the Fe value (0.14 mg/L) in the sample taken from the md-005- discharge point exceeds the limit value in terms of sea water criteria. When Ca, Mg and K values are examined, it is seen that the limit values are exceeded in all locations. When the dissolved oxygen values of the Marmara Sea Tekirdağ coasts are examined, it is seen that the values in the surface area are suitable for vital activities. But studies prove that the amount of dissolved oxygen decreases as you go to the bottom (Yücel et. al. 2021).

There are some factors that support the accumulation of organic matter in the marine environment and the formation of mucilage. In low ionic strength and high pH conditions in the environment, electrostatic repulsions increase due to the negative poles between organic substances (Mosley and Hunter, 2003). Conversely, at low pH resulting from high ionic strengths and anoxic conditions, electrostatic repulsions are minimized and particle aggregation increases. These anoxic conditions may explain the formation of synthetic mucilages.

When the dissolved oxygen value in the marine environment is low, the pH value also decreases. When dissolved oxygen is high, pH values also increase. The total ion content of seawater is expressed by electrical conductivity. In seawater, this value (standardized electrical conductivity at 25°C) varies between 51,750 and 55,500 µS/cm (Özyurt et al., (2001). Since the electrical conductivity depends on the ion concentration, it also changes the acidity of the environment. Electrical conductivity can be considered as one of the preliminary evaluation parameters for the determination of pollution in aquatic environments.

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