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An Investigation on Chemical and Bacteriological Quality of Seyhan River Water in the Province of Adana, Turkey

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This study aims to find out the dimension of water pollution in Seyhan river and make contribution to other studies which may be conducted for the purpose of increasing the water quality. Investigation was conducted from 6 stations on seasonal base in 2001 and 2002. The results of the analysis were presented after being evaluated with variance analysis on SPSS program. The bacteriological pollution in the samples obtained from city stations is attributed to the pollution of phenol, zinc, copper and total phosphor and that there is also bacteriological pollution in the samples obtained from the stations on the way to the shore where the river joins with the sea, which is due to the pollution of nickel, phenol, zinc, copper and lead.

Key Words: Water pollution, Chemical quality, Bacteriological quality.

INTRODUCTION

Seyhan river, which is 560 km in length, originates from Toros mountains and joins with the sea in the sub-province Karataş-Yumurtalik. Its annual flow is 8 km^3 and has an irregular regime. In Adana province (a population of 1,130,000), which is divided by Seyhan River, from north down to south, with a length of 191 km, cotton, corn, wheat, soybeans, pistachio, sunflower, seasonal fruits and vegetables can be grown in each season of the year.

There is Agyatan lagoon, which is fed with Seyhan, and Akyatan lagoon, which is at the shore. Agyatan lagoon has a flora and animal-orginated water products, which is rich in variety in terms of quality and quantity. Akyatan lagoon is in the scope of the Ramsar Act (1998) and it is the biggest lagoon in Turkey in terms of the amount of production and the second biggest lagoon in terms of its size. In addition, it is a very important wetland, as it hosts approximately 2 million living species and its other characteristics[1, 2].

The significance of the Seyhan river for the region is very crucial, as the river is being used for the purpose of power generation, recreation, agricultural irrigation and feeding fisheries. However, it is known that the river has been polluted due to the fact that mines in the region (aluminium, zinc, phosphate, chrome, iron, quartz, managanese, sand-gravel-limestone) have been operated,

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chemical fertilizers and pesticides have been used on an area of approximately 576,000 hectares, in addition to the production activities in the industry (textile, food, metal, fibre, automotive, cement, chemicals, plastics, rubleer, etc.). Furthermore, it is reported that in few parts of the river the water quality is Quality 1; in most of the parts it is 2 and 3; and in some parts it is quality 4[3, 4]. Since the industrial revolution, surface water all around the world, particularly rivers, has been polluted. In many countries, water pollution is the primary problem in river pollution and it constitutes an obstacle before the provision of drinking water and water used for other purposes[5–11]. This study aims to find out the dimension of water pollution in Seyhan river and make a contribution to other studies which may be conducted for the purpose of increasing the water quality.

EXPERIMENTAL

The study was conducted on 6 sample-yielding stations, including 1 station (Number 1) in Tuzla sub-province and 1 station (Number 2) in Karataş sub-province (at locations where the river joins wish the sea), 4 stations (Numbers 3, 4, 5 and 6) in central Seyhan sub-province (Fig. 1). The process of taking samples was performed on a seasonal base (January, April, July, October) and in two repetitive patterns, within the period 2002–03.

In the water samples, nickel, cyanide, phenol, zinc, copper, lead, total chrome (T-Cr), cadmium, nitrate, nitrate-nitrogen (NO_3-N), total phosphor (T-P) and fecal coliform were investigated. The analyses were conducted in the laboratories of Department of Environmental Health and Bacteriology, in the Medical Faculty of Çukurova University, with standard methods. CADAS 30S UV-Vis spectrophotometer was used in the analyses[3, 12–15]. The findings were evaluated through variation analysis in repetitive measurements on SPSS program[16].

RESULTS AND DISCUSSION

As a result of the measurements conducted on the water samples obtained, distribution of the annual mean measurement results over the stations, in terms of chemical polution parameters, is tabulated in Table-1; seasonal distribution of stations' mean values (Table-2), variation of annual fecal coliform mean values over stations (Table-3) while seasonal distribution of station means is given in Table-4.

As seen from Tables 1–4, high levels of Ni, phenol, Zn, Cu and Pb were found in all stations while high levels of T-P was found in the stations located in the centre of Adana.

In the statistical analysis conducted according to years, it was found that there was no significant difference between data of 2002 and those of 2003 and that a difference was found in T-P value during the evaluation of the seasonal distribution, due to the values obtained in autumn and that there was no significant difference between the values of Ni, Cn, phenol, Zn, Cu, Pb, T-Cr, Cd, NO_3, NO_3-N and fecal coliform. Furthermore, in the evaluation of the distribution over stations, it was reported that there was no difference in terms of Cu, T-Cr, Cd and T-P and there was significant difference in terms of other values (Table-1).

TABLE-1
THE MEAN MEASUREMENT OF CHEMICALS IN SEYHAN RIVER ACCORDING TO STATIONS AND YEARS

Stations	Year and means	The measurement of chemicals (mg L^{-1}) and (p) values according to years										
		Ni (0.29)	CN	Phenol (0.53)	Zn (0.17)	Cu (0.06)	Pb (0.32)	T-Cr (0.06)	Cd	NO_3 (0.16)	NO_3-N (0.36)	T-P (0.88)
1	2002	0.29	< 0.01	3.95	0.40	0.03	0.22	0.02	< 0.01	0.60	0.11	0.03
	2003	0.31	< 0.01	4.31	0.44	0.09	0.220	0.02	< 0.01	0.64	0.11	0.03
	Mean	0.30	< 0.01	4.13	0.42	0.06	0.22	0.02	< 0.01	0.62	0.11	0.03
2	2002	0.38	< 0.01	4.89	0.34	0.02	0.17	0.02	< 0.01	0.44	0.12	0.02
	2003	0.42	< 0.01	4.69	0.38	0.02	0.19	0.02	< 0.01	0.46	0.14	0.02
	Mean	0.40	< 0.01	4.79	0.36	0.02	0.18	0.02	< 0.01	0.45	0.13	0.02
3	2002	0.09	< 0.01	0.09	0.23	0.12	0.05	0.02	< 0.01	2.87	0.64	0.10
	2003	0.11	< 0.01	0.11	0.25	0.14	0.07	0.02	< 0.01	3.39	0.68	0.10
	Mean	0.10	< 0.01	0.10	0.24	0.13	0.06	0.02	< 0.01	3.13	0.66	0.10
4	2002	0.07	< 0.01	0.06	0.07	0.18	0.06	0.01	< 0.01	2.99	0.72	0.22
	2003	0.09	< 0.01	0.08	0.09	0.18	0.08	0.01	< 0.01	3.25	0.74	0.24
	Mean	0.08	< 0.01	0.07	0.08	0.18	0.07	0.01	< 0.01	3.12	0.73	0.23
5	2002	0.13	< 0.01	0.09	0.15	0.16	0.16	0.02	< 0.01	2.92	0.70	0.06
	2003	0.15	< 0.01	0.13	0.15	0.16	0.16	0.02	< 0.01	2.92	0.72	0.06
	Mean	0.14	< 0.01	0.11	0.15	0.16	0.16	0.02	< 0.01	2.92	0.71	0.06
6	2002	0.05	< 0.01	0.07	0.14	0.15	0.06	0.01	< 0.01	2.15	0.63	0.34
	2003	0.05	< 0.01	0.07	0.16	0.17	0.06	0.01	< 0.01	2.35	0.65	0.34
	Mean	0.05	< 0.01	0.07	0.15	0.16	0.06	0.01	< 0.01	2.25	0.64	0.34
(p) values according to stations		< 0.01		< 0.01	< 0.01	< 0.001	< 0.002	=0.222		< 0.001	< 0.001	=0.108

TABLE-2
THE MEAN MEASUREMENT OF CHEMICALS IN SEYHAN RIVER ACCORDING TO SEASONS

Seasons	The measurement of chemicals (mg L^{-1}) and (p) values										
	Ni (0.1)	CN	Phenol (0.12)	Zn (0.58)	Cu (0.51)	Pb (0.2)	T-Cr (0.37)	Cd	NO_3 (0.16)	NO_3-N (0.4)	T-P (0.001)
Winter	0.22	< 0.01	1.53	0.20	0.11	0.09	0.02	< 0.01	1.91	0.55	0.02
Spring	0.22	< 0.01	1.46	0.26	0.29	0.12	0.01	< 0.01	2.43	0.53	0.09
Summer	0.35	< 0.01	1.45	0.26	0.12	0.13	0.01	< 0.01	2.52	0.55	0.19
Autumn	0.23	< 0.01	1.75	0.29	0.25	0.09	0.01	< 0.01	2.32	0.57	0.19

TABLE-3
THE MEAN MEASUREMENT OF FECAL COLIFORM
ACCORDING TO STATIONS AND YEAR

Stations $p < 0.001$	Year	EMS/100 mL
1	2002	262.50
	2003	242.50
	Mean	252.50
2	2002	350.50
	2003	322.50
	Mean	336.20
3	2002	235.00
	2003	250.00
	Mean	242.50
4	2002	37.50
	2003	61.20
	Mean	49.30
5	2002	175.00
	2003	155.00
	Mean	165.00
6	2002	7.50
	2003	7.50
	Mean	7.50

TABLE-4
THE MEASUREMENT OF FECAL COLIFORM IN SEYHAN RIVER
ACCORDING TO SEASONAL MEAN VALUES

Seasons	Fecal coliform (EMS/100 mL)	p value
Winter	164.16	
Spring	174.16	$p = 0.95$
Summer	189.58	
Autumn	174.16	

It is believed that the differences in terms of values obtained from stations and particularly levels of inorganic pollution are caused by the industrial activities performed and the agricultural fertilizers used on the areas where the stations are located[17-20].

When the distribution over seasons is examined, the highest Ni ($0.352\ mg\ L^{-1}$) was found in summer, the highest phenol ($1.753\ mg\ L^{-1}$) was found in autumn, the highest Cu ($0.293\ mg\ L^{-1}$) was found in spring and the highest Pb ($0.129\ mg\ L^{-1}$) was found in summer. No significant change was observed in the means obtained in the measurements made on other contaminants.

According to Table-3, fecal coliform measurements were made between values

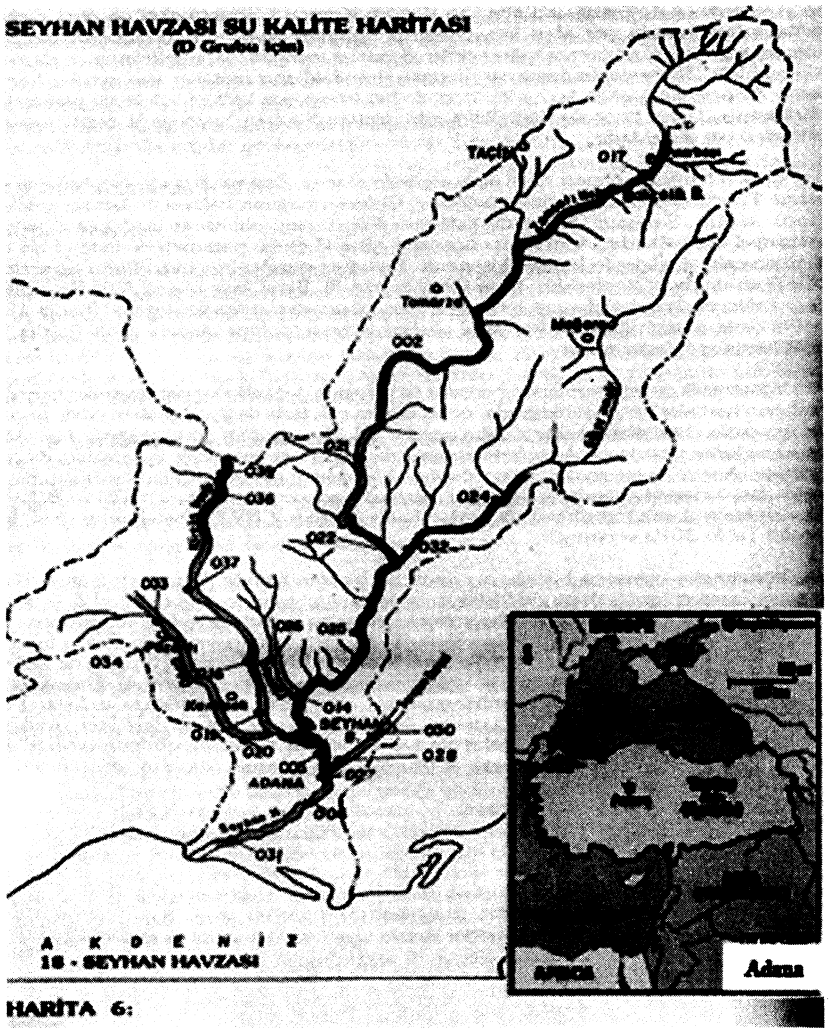

Fig. 1. Location of the investigated area

7.5–61.2 EMS/100 mL both in 2002 and 2004 at the stations numbered 4 and 6 and in other stations high values such as 165–350 EMS/100 mL were found.

Thus, fecal contamination was observed in the stations numbered 3 and 5, which are located at places where the river joins the sea in the city centre. It is estimated that the pollution at the station regions where there is bacterial contamination is caused by the insufficient infrastructure in the settlements (absence of sewerage and waste water treatment), poor hygiene and the performance of treatment activities not in line with the standards. However, there are studies which indicate that the concerned pollution has the same source[2, 4, 9, 21].

In Table-4, seasonal distribution of fecal coliform measurement results ob-

tained from all stations covered by the study was determined as between 164.16–189.58 EMS/100 mL.

On the other hand, it was reported that the pollution of Ni, phenol, Zn, Cu, Pb, T-P and fecal coliform detected in Seyhan river is seen similarly in some other rivers in Turkey, such as Porsuk river in Eskişehir province; Sakarya river in Sakarya province[22]; in Derinçay river in Çorum province[23]; in Nilüfer river in Bursa province[24], in Bakirçay river in Izmir[25] and in 6 interconnected rivers in Düzce province[26]. It was also reported that this pollution was due to the industrial and domestic waste and particularly sewerage discharges. In addition, that there is bacteriologic and chemical pollution in the rivers in England and Wales[5], Siret River in Bukresh[27] and Yangtze River in China[28], due to discharge of industrial, domestic waste and sewerage and mines and detergents, brings us to the conclusion that pollution in Seyhan River is also caused by the same factors[29, 30].

Conclusions

High levels of Ni, phenol, Zn, Cu, Pb and fecal coliform were found at the locations where the river joins the sea in Tuzla and Karataş and high levels of phenol, Zn, Cu, T-P in the city. In the light of these data, it is necessary that the river basin should be taken under protection and it should be forbidden to construct settlements nearby. Furthermore, training should be given to the society in respect to "protection against water pollution", for the purpose of preventing pollution of water and river. Finally, comprehensive studies to be conducted on the locations which are considered to be the source of pollution are needed in order to clearly determine the sources of the pollution in the river.

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