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Chemical and Bacteriological Evaluation of Drinking Water in Adana Province and its Districts

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The study of the contamination level of drinking water used in Adana, Turkey was conducted at 5 stations, twice at each station, one in 2002 and one in 2003. In the water samples, nickel, cyanide, phenol, zinc, copper, lead, total chrome, cadmium, nitrate, nitrate-nitrogen, total phosphor and fecal coliform were investigated and the results were evaluated through variation analysis in repeated measurements on SPSS program. It was found that there is phenol and lead contamination in all the stations, nickel and copper contamination in three stations, zinc, total chrome and total phosphor in one station.

Key Words: Drinking water, Chemical, Bacteriological contamination.

INTRODUCTION

Adana province is located on the delta watered by Seyhan and Ceyhan Rivers. Mediterranean climate dominates the province, whose annual approximate temperature is 18.7°C. It has a total population of 1,850,000. The distribution of the population in the region including the working area is as follows: 1,130,000 in the central sub-provinces (Seyhan and Yüreğir); 11.930 in the sub-province Karataş which is 47 km away from Adana and located by the coast; 5029 in Tuzla affiliated to the sub-province Karataş; and 11.997 in sub-province Doğankent which is located on the South of Adana city centre at a distance of 17 km[1–3]. Drinking water used in the Adana province and its sub-provinces is provided from the stroken wells and stored in a depot and distributed to the settlements through networks after being chlorinated[3, 4]. The water obtained from 131 separate wells in the city centre is collected in four different regions and distributed to the settlements through networks after being chlorinated. This process is realized by

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discharge of the water to the network following the collection of the water obtained from 3 wells, 2 in Tuzla and 3 in Doğankent in one well. Over the province, 72% of the population use this water network while only 25% have access to the use of sufficient amount of water. Only 30% of the population have access to the treated water and 70% of the population are devoid of healthy drinking water.

Considering the above-mentioned points, this study aims at determining the contamination level of drinking water in Adana province and sharing our views concerning how to improve the quality of water.

EXPERIMENTAL

In this study, Adana province was divided into four equal regions, considering the rivers of Seyhan dividing the province into two parts from north to south on the local map and the passageway within the province which divides the province into two regions from east to west. 5 stations, including four from Seyhan sub-province, 2 from Yüreğir sub-province, 3 from Doğankent were determined as the sample collection points (Fig. 1).

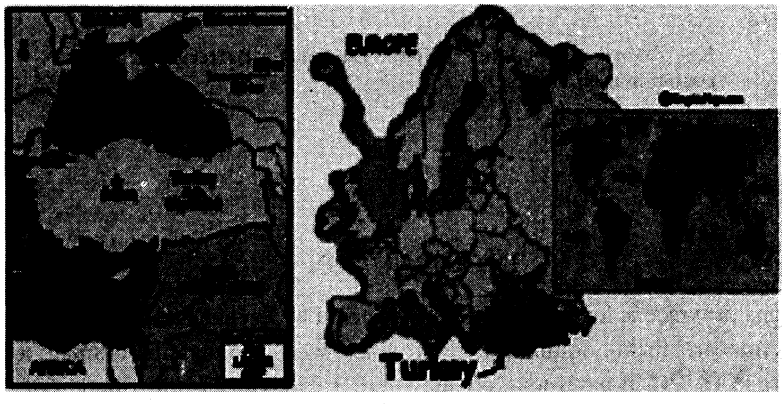

Fig. 1. Working place

The study was conducted by being repeated twice on seasonal basis, covering the years of 2002 and 2003 (Winter: January, Spring: April, Summer: July, Autumn: October). In the water samples, nickel, cyanide, phenol, zinc, copper, lead, total chrome, cadmium, nitrate, nitrate-nitrogen (NO_3-N), total phosphor (T-P) (mg L^{-1}) and fecal coliform were investigated. The analyses were conducted in the laboratories of Department of Environmental Health and Bacteriology, Medical Faculty, Çukurova University, with standard methods. CADAS 30S UV-Vis spectrophotometer was used in the analyses. The findings were evaluated through variation analysis in repetitive measurements on SPSS program[5-10].

RESULTS AND DISCUSSION

Approximate values concerning the chemical contamination parameters in the drinking water is given in Table-1, its distribution in Table-2, distribution of fecal coliform as the parameter of bacteriological contamination in Fig. 2, its seasonal distribution in Fig. 3 and the one with significant difference with the values measured in the analyses made in stations can be found in Figs. 4 and 5.

TABLE-1
THE TWO-+YEARLY MEAN CHEMICALS VALUES IN DRINKING WATER ACCORDING TO STATIONS

Stations	Year	The measures of chemicals (mg L^{-1}) and (p) values										
		Ni (p=0.4)	CN	Phenol (p=0.09)	Zn (p=0.9)	Cu (p=0.3)	Pb (p=0.2)	T-Cr (p=0.2)	Cd	NO_3 (p=0.3)	NO_3-N (p=0.9)	T-P (p=0.8)
Seyhan (1)	2002	0.10	< 0.01	0.06	1.07	0.18	0.03	0.02	< 0.01	21.70	8.90	0.02
	2003	0.08	< 0.01	0.08	1.06	0.20	0.03	0.02	< 0.01	20.90	9.30	0.03
	M[a]	0.09	< 0.01	0.07	1.06	0.19	0.03	0.02	< 0.01	21.30	9.10	0.02
Yüreğir (2)	2002	0.06	< 0.01	0.07	0.40	0.19	0.04	0.12	< 0.01	8.40	3.20	0.01
	2003	0.06	< 0.01	0.08	0.38	0.21	0.05	0.14	< 0.01	7.20	2.80	0.02
	M[a]	0.06	< 0.01	0.07	0.39	0.20	0.05	0.13	< 0.01	7.80	3.00	0.02
Doğankent (3)	2002	0.08	< 0.01	0.07	0.35	0.06	0.03	0.02	< 0.01	4.90	1.30	0.01
	2003	0.10	< 0.01	0.08	0.37	0.08	0.04	0.03	< 0.01	5.30	1.30	0.02
	M[a]	0.09	< 0.01	0.07	0.36	0.07	0.03	0.03	< 0.01	5.10	1.30	0.02
Karataş (4)	2002	0.02	< 0.01	0.07	0.28	0.05	0.03	0.03	< 0.01	2.90	0.70	0.36
	2003	0.04	< 0.01	0.08	0.30	0.06	0.03	0.03	< 0.01	2.20	0.50	0.41
	M[a]	0.03	< 0.01	0.07	0.29	0.05	0.03	0.03	< 0.01	2.50	0.60	0.38
Tuzla (5)	2002	0.04	< 0.01	0.08	0.31	0.01	0.06	0.01	< 0.01	0.31	0.07	0.09
	2003	0.05	< 0.01	0.09	0.30	0.03	0.07	0.02	< 0.01	0.42	0.11	0.10
	M[a]	0.04	< 0.1	0.09	0.31	0.02	0.06	0.01	< 0.01	0.36	0.09	0.09

[a]M: Mean

On comparing the annual mean values of chemical parameter measured (Table-1), no statistically significant difference was found. When these mean values were compared, it was found that there is phenol and lead contamination with values over the criteria in all of the stations, nickel and copper contamination in Seyhan (1), Yüreğir (2) and Doğankent (3) stations, zinc contamination in one Seyhan (1) station, total chrome contamination in Seyhan (1), Yüreğir (2) and Doğankent (3) stations and total phosphor in Karataş (4) station[5–8, 11–13].

Phenol is one of the most important substances present in the wastes of organic chemistry industries, such as paper industry, mining and painting industry is present in room deodorants and disinfecting the cleaning substances. Presence of such industrial substances in the investigated regions has made us conclude that underground water resources may mix up with these industrial effluents[9–13].

Lead is used in the industries of mining, automotive, electrical goods, domestic appliances, plastics production and paint production in our region. Previous studies conducted in Adana province and other regions have also confirmed the possibility that the wastes of these sectors may constitute a source of water contamination[14–19]. On the other hand, it is believed that nickel and copper contamination in the three stations, zinc, total chrome and total phosphor contamination in one station have been caused by mines and use of agricultural chemicals and fertilizers[15, 16, 19, 20].

The differences in the values found in the measurements performed in the stations, especially in terms of inorganic contamination levels, are due to the industrial activities and the use of agricultural fertilizers on the regions from where the samples were taken. Furthermore, this finding is in agreement with the findings of the studies carried by many researchers[14–17].

TABLE-2
THE CHEMICAL VALUES IN DRINKING WATER ACCORDING TO SEASONS

Seasons	Stations	The measueres of chemicals (mg L^{-1})										
		Ni	CN	Phenol	Zn	Cu	Pb	T-Cr	Cd	NO_3	NO_3-N	T-P
Winter	Seyhan (1)	0.16	< 0.01	0.10	1.48	0.19	0.03	0.02	< 0.01	16.90	8.80	0.03
	Yüreğir (2)	0.06	< 0.01	0.08	0.30	0.18	0.05	0.08	< 0.01	6.00	9.10	0.01
	Doğankent (3)	0.13	< 0.01	0.12	0.25	< 0.01	0.05	0.02	< 0.01	5.60	1.40	0.01
	Karataş (4)	0.01	< 0.01	0.09	0.18	< 0.01	0.05	0.04	< 0.01	3.70	0.80	0.66
	Tuzla (5)	0.08	< 0.01	0.06	0.18	< 0.01	0.09	0.01	< 0.01	0.31	0.06	0.03
Spring	Seyhan (1)	0.05	< 0.01	0.03	1.05	0.16	0.02	0.02	< 0.01	22.80	7.10	0.01
	Yüreğir (2)	0.04	< 0.01	0.06	0.35	0.18	0.03	0.17	< 0.01	11.10	1.10	0.02
	Doğankent (3)	0.10	< 0.01	0.08	0.56	0.09	0.02	0.04	< 0.01	4.70	1.10	0.03
	Karataş (4)	0.05	< 0.01	0.06	0.28	0.02	0.01	0.04	< 0.01	2.20	0.60	0.04
	Tuzla (5)	0.05	< 0.01	0.11	0.29	0.02	0.05	0.02	< 0.01	0.50	0.12	0.17
Summar	Seyhan (1)	0.06	< 0.01	0.03	0.77	0.20	0.04	0.02	< 0.01	29.70	14.60	0.01
	Yüreğir (2)	0.06	< 0.01	0.07	0.60	0.22	0.05	0.21	< 0.01	4.20	0.80	0.01
	Doğankent (3)	0.02	< 0.01	0.05	0.42	0.02	0.05	0.02	< 0.01	4.90	1.10	0.02
	Karataş (4)	0.04	< 0.01	0.08	0.35	0.08	0.01	0.03	< 0.01	2.10	0.50	0.01
	Tuzla (5)	0.02	< 0.01	0.11	0.47	0.03	0.02	0.01	< 0.01	0.31	0.08	0.13
Autumn	Seyhan (1)	0.08	< 0.01	0.12	0.95	0.22	0.02	0.02	< 0.01	15.80	5.90	0.05
	Yüreğir (2)	0.07	< 0.01	0.08	0.31	0.21	0.06	0.06	< 0.01	10.10	1.10	0.03
	Doğankent (3)	0.12	< 0.01	0.05	0.21	0.10	0.03	0.03	< 0.01	5.30	1.50	0.02
	Karataş (4)	0.01	< 0.01	0.08	0.34	0.06	0.04	0.02	< 0.01	2.10	0.40	0.80
	Tuzla (5)	0.02	< 0.01	0.07	0.28	0.01	0.10	0.02	< 0.01	0.32	0.12	0.04

When the distribution over seasons as shown in Table-2 was examined, Phenol contamination was detected in all seasons. On the other hand, lead contamination was present only in spring and summer in the station numbered 4; nickel, zinc, copper and total chrome contamination was present in all seasons in most of the stations.

According to Fig. 2, both in 2002 and 2003, fecal coliform measurements were between the values of 34.1–86.5 EMS/100 mL in Seyhan (1) and Yüreğir (2). As for the stations Doğankent (3), Karataş (4) and Tuzla (5), very high values such as 215–252 EMS/100 mL were detected. In addition, it was found that the present findings concerning the bacteriological contamination were in line with those of the previous studies conducted in Adana region.

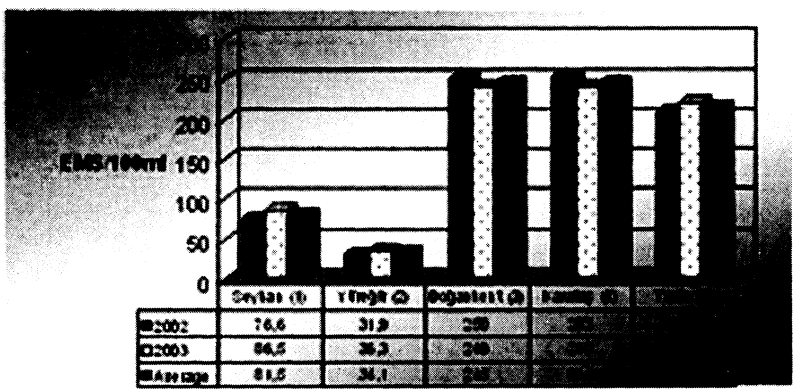

Fig. 2. The measurement of fecal coliform according to stations (p = 0.03)

According to Fig. 3, coliform values measured were between 53.8–107.5 EMS/100 mL during the year in Seyhan (1) and Yüreğir (2) stations and it was measured as 5.2 EMS/100 mL in winter and 0 EMS/100 mL in spring only in Yüreğir station. However, the fecal coliform values measured in Doğankent (3), Karataş (4) and Tuzla (5) were 235–350 EMS/100 mL.

It is thought that contamination in the station areas with bacterial contamination has been caused by the insufficient infrastructure (sewerage and water treatment facilities), poor general hygiene, performance of waste disposal, which have not been realized in line with the standards. It was also found that this assumption is shared with the previous studies[15, 16, 18–21].

The difference in the annual mean values obtained in two years (2002 and 2003) in all measurements made is not statistically significant and the same appeals to the comparison of (p) values in the comparison of the annual mean values of two years (Table-1).

In addition, it was reported that the highest bacterial water contamination was recorded in spring, summer and autumn while the lowest contamination was

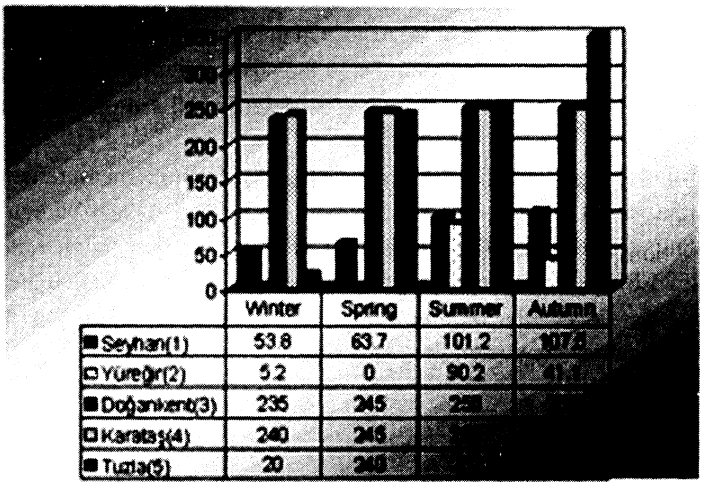

Fig. 3. The measurement of fecal coliform according to seasons (p = 0.02)

recorded in winter and that the difference was significant especially in the chemicals phenol (p = 0.04) and lead (p = 0.02) (Figs. 4 and 5)[22-25].

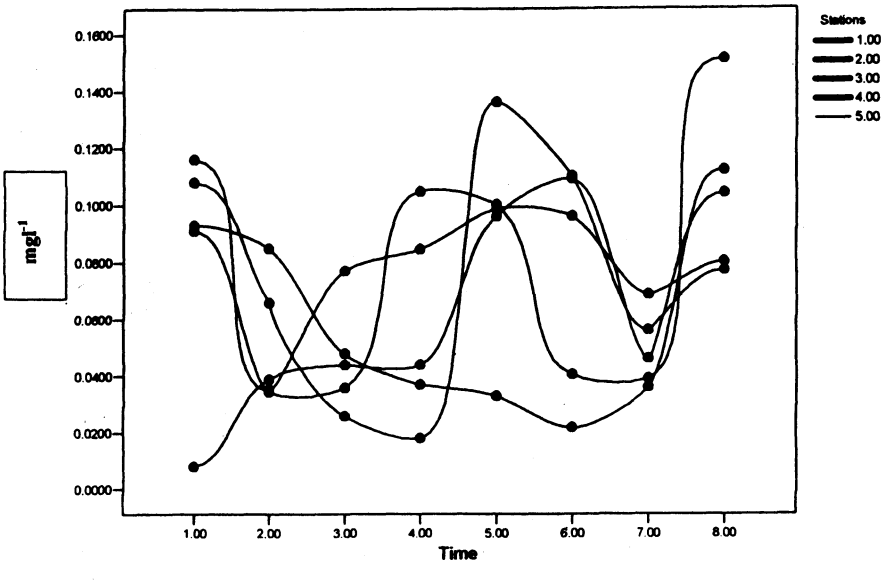

Fig. 4. The measurement of phenol according to seasons (p = 0.04)

Time: 1: January 2002, 2: April 2002, 3: July 2002, 4: October 2002, 5: January 2003, 6: April 2003, 7: July 2003, 8: October 2003. Stations: 1: Seyhan, 2: Yüreğir, 3: Doğankent, 4: Karataş, 5: Tuzla.

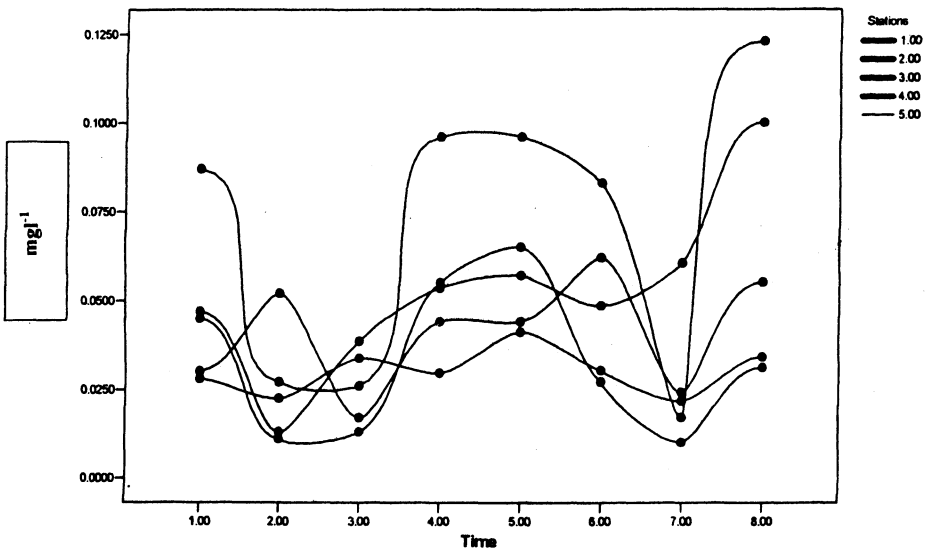

Fig. 5. The measurement of lead according to seasons (Pb) ($p = 0.02$).

Time: 1: January 2002, 2: April 2002, 3: July 2002, 4: October 2002, 5: January 2003, 6: April 2003, 7: July 2003, 8: October 2003. Stations: 1: Seyhan, 2: Yüreğir, 3: Doğankent, 4: Karataş, 5: Tuzla.

Conclusions

It is necessary that new arrangements should be made in order to allow the provision of drinking water from treatment facilities, instead of wells, to ensure that the domestic and industrial waste are disposed after the necessary treatment, to make use of the agricultural chemicals and fertilizers under control and redesign of the reconstruction and infrastructure of our region in such a way that it would protect the delta.

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