Cilt 55, No 2, S: 113 - 120
Türk Hij Den Biyol Derg 1998

DRINKING WATER ANALYSES OF KADIKÖY DISTRICT IN İSTANBUL

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SUMMARY

In this study, 500 samples from water stations from Kadıköy district of Istanbul as well as 30 bottled water, 15 well water and 25 tap water samples were analyzed both from chemical and microbiological standpoints in order to determine whether they fit water quality and safety standards set by Turkey as well as international standards.

Our findings show that most water sold at water stations are safe but one must make sure that water station where the water is bought perform regular monitoring of their quality. Among 321 water station samples, none showed ammonia but 41 out of 492 samples contained coliform bacteria (8.3 %). In 243 samples the average amount of chlorine determined was 23.95 Ò7.8mg/lt. Among 324 samples, 37 were nitrite positive (11.4%).

Well waters were almost uniformly contaminated with bacteria. Among the well water samples that were analyzed 13.3% showed ammonia (4/30), 70.3% tested showed coliform bacteria (19/27) and 65.5%showed nitrite (19/29).

The city water samples showed no ammonia and no coliform bacteria and only 12.5%tested showed nitrite (1/8). This shows that tap water is safe from microorganisms eventhough it may not be esthetically desirable.

All bottled waters are safe and has good quality. Among seven brands of bottled water samples none showed ammonia, coliform bacteria or nitrite.

Key Words: Drinking water, water station, water quality, İstanbul

İSTANBUL KADIKÖY YAKASINDAKİ İÇME SULARININ ANALİZİ

ÖZET

Bu çalışmada İstanbul-Kadıköy yakasındaki su istasyonlarından 550, şişe sularından 30, kuyu sularından 15 ve musluk sularından 25 örnek hem kimyasal hem de mikrobiyolojik analizlerden geçerek Türk ve uluslararası su kalitesi standartlarına göre sağlıklı olup olmadığı araştırıldı.

Bulgularımıza göre su istasyonlarında satılan suların büyük çoğunluğu sağlıklı olmakla beraber suyun satın alındığı su istasyonlarının muntazam aralıklarla kontrol edildiğinden emin olunmalıdır. 321 su istasyonu örneğinden hiç birinde amonyak bulunmamış fakat 492 örnekten 41'inde (%8.3) bakterial kontaminasyon görülmüştür. 243 örnekte ortalama klor miktarı ortalama 23.95 7.8mg/l olarak bulunmuş, 324 örneğin 37'sinde de (%11.4) nitrit gözlenmiştir.

Yapılan analizler sonucu kuyu sularının bakteri içerdiği görülmüştür. Örneklerin % 13.3'ünde amonyak, %70.3 'ünde koliform bakteri, % 65.5 'inde de nitrit saptanmıştır.

Musluk sularının bakteri içermemesine rağmen içiminin istenilen kalitede olmadığı gözlenmiştir.Sekiz örnekden hiçbirinde koliform bakteri veya amonyak bulunmamış fakat bir örnekde eser miktarda nitrit bulunmuştur. (%12.5).

Şişe sularının hepsi sağlıklı ve iyi kalitedeydi. Yedi değişik markalı örneğin hiçbirinde amonyak, koliform bakteri ve nitrit saptanmadı.

Anahtar Kelimeler: İçme suyu, su istasyonları, su kalitesi, İstanbul

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INTRODUCTION

Water is the single most important life-sustaining nutrient on earth but it also has the capability of making people ill. Contamination of local water supplies with microorganisms, toxic chemicals and radioactive substances has made us fear that the water we drink from the tap is unhealthy. In order to prevent fecal-oral diseases, some have installed water-treatment devices in their homes, some drink only bottled water and others use the water stations to fulfill their needs. Such alternatives are expensive and their safety is also in question .

A good quality drinking water must be obtained from an approved source and must undergo minimum treatment consisting of ozonation and filtration or an equivalent disinfection process. Natural water must come from an underground source and may have no dissolved solids added or deleted. Spring water must flow naturally to the surface and meet the definition of natural water (1).

The consumer cannot assume that the bottled water and water bought from water stations is pristine. Microorganisms and small amounts of many organic chemicals have been detected in such water. Truly "pure" water contains only hydrogen and oxygen and is not available naturally and is never used (1). The water that is consumed is altered in a wide variety of ways and water quality is determined by several characteristics such as aesthetic and physical factors, hazardous microbiological, inorganic, organic, chemical and radioactive contaminants and purposeful additives.

Water's esthetic and physical factors primarily affect taste, odor and visual appearance. For example, excessive iron makes water a red-brown color and imparts a metallic taste but it is not a health hazard(1,2). Excessive calcium and magnesium cause hard water leading to hard white deposits in pipes and kettles and drinking water with a high mineral content may have a laxative effect but generally speaking hard water is not considered a health hazard and may be beneficial to cardiovascular system (2,3).

Corrosivity which is a function of pH, inorganic carbonate, calcium and total dissolved solids in itself is not hazardous but can cause a leaching effect on metal pipes and lead to release of toxic metals such as lead and cadmium (4,5).

Natural organic chemicals such as vegetable and animal waste have always contaminated the water supply but now there are new synthetic organic chemicals that appear as contaminants of the drinking water. One important group is the THMs which result from chlorination of water containing decaying vegetable matter (1,4). These have been found to be carcinogenic (1). Other synthetic organic chemicals such as trichloroe thylene, tetrachloroethylene and chloroform are just as dangerous (6,7).

As water percolates through the soil and rock, it is naturally contaminated by small quantities of radioactive, carcinogenic substances and man-made radioactive wastes can add to this contamination (1,6,7).

Numerous inorganic solids have been found in drinking water such as lead, nitrates, asbestos and pesticides and all are hazardous to health (1). For example, lead leached from plumbing fixtures can cause toxicity to a child's developing brain and lead to neurologic damage (4). Nitrate contamination comes primarily from fertilizer run-off with additions from animal and human fecal contamination (8). Nitrates are particular health risk for infants less than six months of age since in their immature digestive systems nitrate is transformed into nitrite that reacts with hemoglobin which is the oxygen carrying substance in the blood and turns it into methemoglobin which binds oxygen and makes it unavailable to the tissues. The result is a potentially lethal syndrome called methemoglobinemia (6,7). Nitrites can also react with other substances to form nitrosamines, which are known animal carcinogens. Asbestos fibers in shower water may be released to the air and cause respiratory problems (1).

Microorganisms can cause more disease than any other single agent found in water and can lead to gastrointestinal illnesses. As an indicator of contamination, total coliforms are measured. Coliforms are bacteria that grow naturally and in great quantities in mammalian intestinal tracts. Because most of the pathogenic microorganisms found in water are a result of fecal contamination, the presence of coliforms has been used to assess the potential for other microbial contaminants. Although the use of the total coliform rule is helpful, it is not totally safe since the presence of the parasites such as giardia and cryptosporidium can not be determined by testing coliforms (1, 2, 8, 9).

The chlorination of drinking water has greatly reduced the transmission of waterborne diseases. Nonetheless, this is not without risk such as the formation of THMs (6,7). Careful monitoring and appropriate treatment can minimize the health risk of water consumption.

Buying home water treatment systems may not be the answer that we are looking for, since most devices only improve the esthetic quality of the drinking water such as taste and odor. Some home water treatment devices may actually degrade the safety of the water. Most water softeners add sodium as they extract calcium and magnesium and this may increase the risk of cardiovascular disease as well as causing problems for those with salt restricted diets or with sodium sensitive hypertension. In addition, most water treatment devices require regular maintenance to ensure their efficacy and to ensure that they do not add contaminants to the water. For example, if charcoal filters are not regularly flushed or changed, they may add microbial agents and return to the water the synthetic, inorganic contaminants that they were intended to remove (9).

To ensure the safety of our drinking water we should determine the source, be aware of changes in taste, odor and color such as a sharp chemical taste or oily consistency and monitor the water or make sure the water station where the water is taken perform regular monitoring of their water quality.

One of the major problems facing rapidly developing nations such as Turkey is the population explosion. In metropolitan cities such as Istanbul where the city boundries are limited by water and mountains, the forests are being cleared to make way for the rapidly growing population. This results in the loss of natural plant life as well as the loss of clean water supplies.

In the last few years, İstanbul has been plagued by the problem of not having enough drinking water. Being a big city situated between the two dardanels at the edge of the Marmara sea, İstanbul is the industrial, commercial, cultural and touristic center of Turkey. Yearly average rainfall in İstanbul is between 500-1,000mm and 85% of rainfall is during the months of September and October. In 1990, the population of Istanbul reached 7.5 million comprising 13.2% of the population of Turkey. In the last few years water usage per person has averaged to be around 140-200 liters. Water needs have been estimated to be 212 l/person/day for the year 2000, 244 l/person/day for the year 2010 and 284 l/person/day for the year 2040. At this point, the amount of water that is supplied to the city of İstanbul is 654X106 m3/year (10).

With the population being close to 10 million, natural water sources in nearby areas can no longer answer this city's needs. The City of Istanbul department of Water and Sanitation (İSKİ) has warned that the city does not have enough water to go around and that they can only supply certain neighborhoods on certain days of the week with water. Also, already available water sources such as Elmalı and Ömerli dams are quickly becoming too polluted to be used as drinking water.

In order to serve the drinking water needs of the city, more than 3,000 water selling stations have opened up within the city. Some high-rises have tried to resort to opening up wells in their own backyards but due to the city's poor underground sewer system, most of these wells are too polluted to be used.

Keeping those in mind, we have decided to survey some of the most well known bottled waters on the market and some of the most used water stations in Kadıköy district of İstanbul. We have also analysed a few well water and tap water samples but our major goal was to determine the quality of water sold at water stations. These water stations have multiplied in number overnight to more than 1000 in the district and are in great demand by the consumer since there is not adequate city water to serve the area consistently. Another reason is that the water from the tap is considered to be undesirable from esthetic point of view by the consumers.

MATERIAL AND METHOD

In this study, 500 water station, 15 well water and 25 tap water samples were collected. Sample collections were performed using sterile methods. Samples were transported in coolers to the laboratory and microbiological inoculations were performed. The time from collection to inoculation was less than one hour. Inoculation media used in this study were Single-strength lactose broth, double strength lactose broth, brilliant green lactose bile broth and eosin methylene blue agar. The number of total coliforms in different water samples was determined by a statistical estimation called the most probable number (MPN) test. Any contamination with coliform bacteria , >0.005mg/l nitrite or >0.005mg/l ammonia was considered unacceptable concentrations (11).

For chemical analyses, flame photometer by Buck Scientific, Inc. and Spectrophotometer DR/2000 Hach Shimadru UV 120-02 were used and analyses were performed according to the standards set by TSE-266.

Water hardness was calculated using an EDTA solution according to the standards set by TSE-266 and the results were given in Fr Hardness unit.

Turbidity measurements were made using Hach Spectrophotometer DR/2000 and pH measuremets were done on Haanra Instrument HL8314.

FINDINGS

RESULTS AND DISCUSSION

Any of the 321 samples received from the water stations did not show ammonia but 41 samples out of 492 contained 1 or more coliform bacteria in 100 ml (8.3 %). The samples containing coliform bacteria were further studied and the results of chemical analysis are shown in Table 1. None of these samples contained ammonia. In 243 samples the average amount of chlorine determined was 23.95 7.8mg/lt. Among 324 samples, 37 were nitrite positive (11.4%). Turbidity, pH and hardness levels of the samples tested were all within the acceptable range.

The well water samples were also analyzed and 4 out of 30 samples showed ammonia (13.3%), 19 out of 27 tested samples showed coliform bacteria (70.3%) and 19 out of 29 showed nitrite (65.5%). As Table 3 shows, it is possible for water samples to have ammonia without of coliform bacteria. The reason for this contradictory absence is the presence of chlorine as a desenfectant. Chlorine is able to kill bacteria but is unable to change the amount of ammonia or nitrite already present in the sample. It is also possible to have chlorine as well as coliform bacteria in a given sample. The reason for this finding is the fact that the chlorine is found in the bound form as opposed to the free form and only free chlorine has a disenfectant activity. None of the samples containing ammonia, nitrite or coliform bacteria can be used as a source for drinking water. Most of the well water samples had normal pH level but higher than normal hardness and turbidity.

Any of the city water samples did not show ammonia and no coliform bacteria and only one out of six tested samples showed nitrite (12.5%). The presence of nitrite may be due to the contamination of the water storage depots in apartment buildings. Turbidity, pH and hardness levels of the samples tested were all within the acceptable range. Looking at city water sample analysis results supplied by İSKİ in 1997; from 57,780 sample analysis 99% showed normal pH (6.5-8.5), 92% showed normal turbidity (0-5), 92% showed the presence os free chlorine and 92% had no coliform bacteria (12). Eventhough results supplied by İSKİ reflect city water analysis throughout the city of İstanbul, they roughly correlate with our sample results obtained from the Kadıköy district of İstanbul.

The seven bottled water samples showed no ammonia, coliform bacteria or nitrite. Turbidity, pH and hardness levels of the samples tested were all within the acceptable range.

As seen from the tables presented, the water that is sold at the water stations is mostly clean but can be easily contaminated during processing, transportation or filling and therefore it is not the best solution for serving the water needs of a big city such as İstanbul.. The city water is clean of bacterial contamination and does not constitute a health risk for the general population. The water that has been already bottled and sold in markets for public consumption, is almost always clean and of good quality. And finally the water that is obtained from wells is almost always contaminated mostly with human and animal waste products and unsuitable to drink.

Due to the fact that bottled water is too expensive for most people to consume in large quantities, it is evident that water sold at the water stations will continue to satisfy the needs of a large portion of the population of the city of İstanbul.

Tablo 1. Chemical and microbiologic analyses of water from water stations.

No	Ammonia (<0.05mg/l)*	Chlorine (<250mg/l)* (0)*	Coliform Bactena	Nitrite (<0.05mg/l)*	PH (5.5-8.5)*	Color (<10Pt-Co)*	Free chlorine (-)*	Hardness (-)*	Turbidity (<5 FTU)*
94-011			79						
94-013	-	37	70	+	7.55	clear	-	6.04	clear
94-014	-		240	-			-	4.5	clear
94-015	-		14	-			-	4.5	clear
94-026	-		14	-			-		clear
94-028	-	8	2	-	7.8	clear	-	6	clear
94-030			54						
94-035			17						
94-036			9						
94-045	-	8	33	-	8.07		-	13.8	
94-048	-	0.6	24	+	8.10		+	7	
94-050	-	0.6	170	+	8.10		+	7	
94-053	-	12	5	+	6.62		-	3.3	
94-055	-	1	22	+	7.48		-	9.2	
94-058	-	16	1600	-	6.74	3		3.4	1
94-127	-	6	2	+	7.20	3	-	3.8	1
95-179	-	14	34	+	7.54	5		11.9	1
95-180	-	12	2	+	7.40	6		13.2	4
95-185	-		5	-	6.42	6		2.3	0
95-224	-	8	2	-	7.67	8		10	1
95-241	-		5	+	7.63	4		11.3	1
95-242	-	11.6	5	-	7.71	4		11.8	1
95-244	-	9	23	+	7.61	4		10.9	1
95-245	-	8	5	-	7.70	5		11.2	2
95-246	-	11	2	+	7.48	3		11.9	1
95-253	-	7.70	34	+	7.70	1		8	0
95-266	-		33	+	7.66	6		10.1	2
95-282	-		33	-	7.90	25		7.37	4
95-284	-		2	-	7.57	19		2.68	0
95-300	-		17	-	7.68	3		13.5	0
95-320	-	15	5						
95-321			33						
95-322	-		14						
95-341	-	9.8	5	-	7.71	4		5.2	2
95-343	-	9.3	2	-	7.58	6		8.1	2
95-359	-		33	-	7.54	6		5.2	2
95-396			2						
95-488			2						
95-507			5						
95-589			2						
95-590	-	20	2	-		14		3.7	2

*According to reference 11

Tablo 2. Average microbiologic and chemical values at water stations.

	Ammonia (mg/l)	Conductivity (S/cm)	Chlorine (mg/l)	Coliform (No/100 ml)	Nitrite (mg/l)	Organics (mg/lt)	pH	Color (Pt-Co)	Free chlorine (mg/lt)	Hardness (Fr)	Turbidity (FTU)
n	321	208	243	492	324	82	315	275	123	322	274
np	-			41	37				13		
nn	321			251	287				110		
nx		0.31	23.95	5.41		1.37	7.17	10.12		8.05	2.019
SS		±1.55	±7.8	±73.56		±0.85	±0.45	±12.81		±18.21	±2.24

n : number of samples
np : number of positive samples
nn : number of negative samples

Tablo 3. Chemical and microbiologic analyses of well water.

No	Ammonia (<0.05mg/l)*	Chlorine (<250mg/l)	Coliform 8acteria	Nitrite (<0.05mg/l)* (0)*	Organics (<3.5 mg/l	PH (5.5-8.5)*	Color (<10Pt-Co)*	Free chlorine (-)*	Hardness (-)*	Turbidity (<5 FTU)*
94-014			240							
94-019	-	20	70	+		7.94	clear	-	24.6	clear
94-023	-	130		+			clear		18.5	clear
94-025	-	56	2	-	4	8.05	clear	-	33.6	clear
94-027	-	120	110	+		6.90	clear		34.4	clear
94-039	-	128	220	+	0.9	7.76			51.4	
94-043	-	124	240	+	0.8	7.56	clear		125	clear
94-044	-	48	1600	-	0.9	7.66			20.8	
94-047	-	34	1600	+		7.1	51		55	8
94.052	-	100	2	-	2.4	8.20	471	-	15.2	96
94.059	-	196	-	+		7.2	10		30.4	16
94.062	+	251	-	+		8.41	407		30.5	78
94.063	+	160	-	+		8.52	13		15	2
94.066	-	80	350	-		7.26	0		37	0
94-070	-	96	1600	+		7.35	17		40	3
94-081	+		46	-		7.65	0		45	0
94-084	+		17	+		7.80	13		30.6	2
94-122	-	55		+		7.58		-	38.3	
94-124			1600							
94-128	-		7	+						
94-139	-	8	350	+	3	7.3	28	-	29.8	3
94-140	-	56	-	+		7.32			31.5	
95-228	-	580		+		7.27			69	
95-229	-	700		+		7.54			55	
95-238	-	48	-	-		7.58	2		30.7	1
95-239	-	23	-	-		7.00	16	-	10.7	2
95-240	-	23	-	-		7.07	1	-	10.6	0
95-272	+	143	-	+		7.46	11	+	51.4	1
95-302	-	118	300	-		7.60	23	-	47	4
95-305	-	37		-		7.19	86		15.2	17
95-336		8.7	300		1.5	7.72	1			0
95-591	-	210	94	+		7.39	5	-	56.2	2
95-613	-	12			0.47	7.2	4		21.8	1
95-614	-	14			0.58	7.76	11		5.6	1

*According to reference 11

Tablo 4. Average microbiologic and chemical values of well water.

	Ammonia (mg/l)	Conductivity (S/cm)	Chlorine (mg/l)	Coliform (No/100 ml)	Nitrite (mg/l)	Organics (mg/l)	pH	Color (Pt-Co)	Free chlorine (mg/lt)	Hardness (Fr)	Turbidity (FTU)
n	30	17	29	27	29	9	30	20	11	30	20
np	4				19				1		
nn	26				10				10		
nx		1.19	123.40	324		1.62	7.54	58.5		35.96	1185
SS		0.76	157.81	555.48		1.24	0.39	132.11		23.06	26.31

Tablo 5. Chemical and microbiologic analyses of city water.

No	Ammonia (<0.05mg/l)*	Chlorine (<250mg/l)*	Coliform Bacteria (0)*	Nitrite (<0.05mg/l)*	PH (5.5-8.5)*	Color (<10Pt-Co)*	Free chlorine (-)*	Hardness (-)*	Turbidity (<5 FTU)*
94-020	-	40	0	trace	7.51	clear	present	8.8	clear
94-021	-	40	0	none	7.51	clear	present	8.8	clear
94-051	-	30	0	none	7.30	45	present	7.7	0
94-085	-		0	none	7.0	11		10	2
94-088	-	28	0	none	7.45	43	present	9.9	8
94-141	-	96	0	none	7.47	17	present	30	2
94-142	-	60	0	none	7.47	21	present	22.8	3
94-167	-	22	0	none	6.72	54	present	10.6	9

*According to reference 11

Tablo 6. Average microbiologic and chemical values of city water.

	Ammonia (mg/l)	Conductivity (S/cm)	Chlorine (mg/l)	Coliform (No/100 ml)	Nitrite (mg/l)	pH	Color (Pt-Co)	Free chlorine (mg/lt)	Hardness (Fr)	Turbidity (FTU)
n	8	5	7	9	8	8	6	7	8	6
np	0			-	2			7		
nn	8			9	6			0		
nx		0.47	45.12	0		7.30	31.83		13.57	4
SS		0.29	25.55	0		0.29	17.67		8.19	3.63

Tablo 7. Chemical and microbiologic analyses of bottled water.

No	Ammonia (<0.05mg/l)*	Chlorine (<250mg/l)*	Coliform Bacteria (0)*	Nitrite (<0.05mg/l)*	PH (5.5-8.5)*	Color (<10Pt-Co)*	Free chlorine (-)*	Hardness (-)*	Turbidity (<5 FTU)*
94-1	-	6	-	-	6.66	1	-	2.3	0
94-2	-	5.4	-	-	8.00	2	-	13.8	0
94-3	-	6	-	-	6.75	0	-	3.4	0
94-4	-	24	-	-	7.5	2	-	2.9	0
94-5	-	6	-	-	7.50	1	-	0.5	0
94-6	-	4	-	-	7.13	1	-	1.9	1
94-7	-	8	-	-	7.15	0	-	3	0

*According to reference 11

Tablo 8. Average microbiologic and chemical values of bottled water.

	Ammonia (mg/l)	Conductivity (S/cm)	Chlorine (mg/l)	Coliform (No/100 ml)	Nitrite (mg/l) (mg/ll)	pH	Color (Pt-Co)	Free chlorine	Hardness (Fr)	Turbidity (FTU)
n	7	7	7	7	7	7	7	7	7	7
np	0				0			0		
nn	7				7			7		
nx		0.1614	8.4857	0		7.2414	1		3.9714	0.1428
SS		0.1023	6.9415	0		0.4672	0.1864		4.4376	0.3779

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