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Physical and Chemical Quality Assessment of Potable Groundwater in Rural Areas of Khaf, Iran

[1]Abdoliman Amouei, [2]Amir Hossein Mahvi [3]Ali Akbar Mohammadi, [3]Seiedeh Horieh Fallah, [3]Hossein Ali Asgharnia and [4]Ali Akbar Khafajeh

[1]Department of Social Medicine,
School of Public Health, Babol University of Medical Sciences, Babol, I.R. Iran
[2]Department of Environmental Engineering,
School of Public Health, Tehran University of Medical Sciences, Tehran, I.R. Iran
[3]Department of Environmental Engineering,
School of Public Health, Babol University of Medical Sciences, Babol, I.R. Iran
[4]Water & Water Waste Company, Khaf, I.R. Iran

Abstract: Natural water resource is limited and that is essential for human survival. The purpose of this study is investigating the chemical and physical quality of drinking water resource in Khaf villages and compared with Iran and EPAstandards. This study was conducted on drinking water resource in Khaf s villages in the second-half of 2009-2010. 62 sample of deep wells were collected from 31 villages and 14 parameters analyzed according to standard methods suggested by AWWA,2005. The results revealed that parameters of Sulfate, Chloride, Sodium, TDS, EC and Turbidity were respectively at 20, 10, 36, 20,23/3 and 10% which are higher than the standard limits. The fluoride concentration ranged from 0.15 to 3.9 ppm, where 33.3%, 10% samples showed fluoride less and higher than permissible limit respectively. and 56.6% water samples were within optimum limit i.e. 0.5-1.5 ppm. The NO_3^- concentration was less than permissible limit (50 mg/l) in 93.3% villages whereas 6.6% samples showed higher concentration of NO_3^-. This study indicated that most of the physicochemical parameters do not fall within the permissible limit. Therefore, currently the related government departments should focus on strengthening "the three wastes" treatment and sanitation management of drinking water and transmission.

Key words: Physicochemical analysis · Village · Groundwater · Khaf

INTRODUCTION

Water is one of the natural limited resources which is very vital for human survival. Among water resources, underground waters are one of the valuable resources for different kinds of human activities [1]. About 80% of the land is covered by water, about 97% of which is in oceans and seas, that are too salty to directly potable and usable for human activity and about 2.4% of it is trapped on large glaciers and polar ices, so less than 1% of water resources is available for drinking, agriculture, domestic and industrial consumptions [2]. Given the industrialization and the population increase, needs for water with a good quality is also increasing. Although most of water resources have been polluted by agricultural and industrial activities and sewages, but underground water resources are still known as safe water resources that is because of the natural filtration process in soil texture [3]. Contamination of underground water is one of our main concern that it is in one hand because of increasing use for human needs resulted from the population increase and on the other hand because of negative effects of increased industrial activities. Existence of many of these elements in drinking water is essential for human health. However the concentration increase of these elements and their consumption in

Corresponding Author: Ali Akbar Mohammadi, Department of Environmental Engineering, School of Public Health, Babol University of Medical Sciences, Babol, I.R. Iran. Ter: +98-1112234142.

excessive amount may cause serious problems for human health[4, 5].High concentration of chemicals in drinking water can cause some problems for human health. For instance the presence of high levels of nitrate can cause methemoglobinemia which is a very dangerous disease specially for risk groups like children under 3 and people with deficiency in HB MET enzyme [6] And also nitrate can cause cardiovascular and behavioral complications in laboratory animals [7,8]. Fluoride is another anion with natural origin that can have very useful effects in a particular domain. The presence of this anion is essential to participate in the process of ossification, but ofcource high intake of it at long term leads to chronic complications such as dental and skeletal fluorosis, infertility, neurological problems and alzheimer. Therefore World Health Organization considered the guide value of fluorine according to the formation of fluorosisand temperature of studied areas between 0.6 - 1.5 mg/l [9, 10]. Due to the distinctive and ecological features, rural environment of eastern part of Iran has a diverse structure. Several factors are involved in the formation of rural spaces and villages, such as water supply resources, weather conditions, topography, physical condition of land and etc.In these areas dispersion of villages according to spatial distance and also non - homogeneous geographical distribution made some problems for Abfa organization to monitor the quality of water and proper distribution of water [11]. Safe drinking water provision is one of the important goals in human societies that following it development and progress achievement will be possible, but in these areas it hardly achieved. Water quality control in rural areas seems such an important issue for that several researches have been done in Iran and other countries [12-14].

MATERIALS AND METHODS

Khaf city is one of the cities of Razavi Khorasan province of Iran with a population over 100 thousand. It covers an area approximately of 9797 sq. km. which is located on geographical coordinates by longitude of lies between 28° 59’ to 60° 56’ latitude and 33° 40’ to 35° 05’ latitude. is about 121 km broader with Afghanistan.

The present research was a descriptive - cross sectional study. 62 samples have been taken from 31 water resources in two seasons of autumn (low rain) and spring(high rain) between 2009 - 2010 and 16 parameters were analyzed, all steps of sampling and data analysis have been done based on standard method of water and wastewater tests [15]. Experiments have been done in two total categories of system tests and titrimetric tests. Titrimetric tests including temporary and permanent hardness,calcium,magnesium and chloride and also system tests including PH measured by meter device PHwtw model,electrical conductivity(EC) by Esi meter wbw, turbidity by turbidity meter device (wbw, hach 50161/co150) model by the brand of Hach P2100 made of US have been analyzed by the precise of 0.01. The analysis of anions and cations of fluoride, nitrate and sulfate was also done by spectrophotometer hach (DR 5000 model) in water and wastewater laboratory of Torbat Heidarieh. The data was recorded in the computer and analyzed by Excel software and descriptive statistics like minimum, maximum, mean and standard deviation.

RESULT AND DISCUSSION

The results of chemical and physical analysis of water quality for the villages of Khaf during 2009-2010 are presented on Table (1) and have been compared with the latest number (1053) of national water standard of Iran observed in Table 2 [16]. EC is a numerical expression of ability of an aqueous solution to carry electric current. The values of EC ranged from 391-3930 µmhos/cm. Minimum and maximum EC was reported from Ahmadabad and Zozon villages respectively (Table 1). By analyzing the results, according to table 2, 71 percentages of villages are located in the optimum range and 23.3% and 6.6% of them the amount of EC was less and more than the standard level respectively. TDS ranged from 287 to 3590 mg/l. concentration of TDS was observed from Ahmadabad and Mojanabad villages respectively (Table 1) According to national water standard of Iran, TDS should be between 1000-1500 mg/l. TDS was found to be within limit in 66% villages, lower in 13.3% villages, Whereas20% villages showed TDS higher than limit. The results have also shown (Table 1) that the highest (83 mg/l)and lowest(1.54 mg/l) concentration of nitrate ions were for the village of Ebrahimi and SHahrak respectively. table 2 has shown that the concentration of nitrate in 93.3 and 6.6% of villages are lower and higher than the standard level respectively. According to the results of (Table 1 Fig 1), it was observed that the lowest amount (0.15mg/l) of fluorine was in village of Saddeh and the highest (3.59mg/l) was for village of Mahabad. And also according to table 2, 56.6 percentage of villages are located in the desirable range and 33.3% and 10% of them the amount of fluorine was less and more than the standard level respectively. In all samples, PH was at

Table 1: Showing values of various parameters village of Khaf City

Code	Name of village	pH	Tur	EC	TDS	TH	Ca.H	NO3	NO2	SO4	CL-	F^-	Ca+2	Mg+2	Na+
1	Mahabad	8.2	0.71	2070	1336	105	59	19.3	0.01	500	170	1.26	23.6	11.1	392.1
2	Seidabad	8.07	0.94	848	572	105	67	9.7	0.01	117	86.4	0.98	26.8	9.2	148.9
3	Chamanabad	7.8	0.33	944	661	317	178	9.9	0.01	166	77.7	0.75	71.2	33.7	77
4	KHalilabad	8.0	0.48	765	525	208	113	5.45	0.01	123	66.2	0.31	45.2	23.0	80
5	Hasanabad	8.0	0.26	918	620	216	121	3.86	0.01	166	77.7	0.38	48.4	23.0	117
6	Ahmadabad	8.0	2.24	391	287	141	83	9.1	0.01	36.1	26.1	0.17	33.2	14	25.2
7	Aliabad	8.2	0.24	622	449	97	53	3.86	0.01	85.0	40.8	0.44	21.2	10.6	100
8	Mahabad	8	0.49	1405	991	97	63	15.6	0.01	333	114.4	0.63	25.2	8.2	269.2
9	Sarab	7.9	40.4	693	693	240	139	2.87	0.07	157	38.8	0.49	55.6	24.5	54.3
10	KHargerd	8	0.25	1388	514	198	93	11.8	0.01	216	192	0.71	37.2	25.5	217
11	Biasadabad	8.1	0.92	1266	931	157	75	14.3	0.02	164	194	0.85	30.0	15	212
12	Baghebakhshi	8.0	0.62	1375	807	103	67	40.9	0.02	256	151	-	26.8	8.74	256.2
13	Kalshor	8.1	2.5	2260	906	186	111	33.2	0.01	394	283	0.93	44.5	18.2	406
14	Zozon	7.9	41.8	3930	1517	345	261	67.7	0.39	594	756	1.1	104	20.2	682
15	Tizab	7.5	1.94	3040	2434	523	248	19.8	0.01	740	398	0.98	99	66	499
16	Faindar	7.9	0.33	736	549	210	91	7.3	0.02	145	34	0.44	36.5	28.9	79.5
17	CHahe gaji	8.0	0.5	1037	696	55	36	22.5	0.02	131	22	0.76	14	4.4	206
18	Berabad	8.0	0.5	1675	1063	188	91	11.2	0.02	246	268	0.89	36	23	271
19	Ebrahimi	8	1	3010	1904	135	95	83	0.02	599	446	1.68	38	9.7	590
20	Mehrabad	7.4	7.25	680	1019	152	72	8.93	0.02	102	128.3	0.53	28.3	19.43	155
21	SHahrak	8.3	0.45	454	584	283	139	1.54	0.02	70	11.5	0.32	55.6	34.97	10.2
22	Sijavand	7.8	0.3	587	834	281	166	8.54	0.02	112	54.8	0.9	66.4	27.93	
23	KHeirabad	8.21	0.87	579	783	337	182	4.22	0.01	149	19.6	1	72.4	37.6	40.5
24	Kalshor	8.2	0.4	535	710	250	150	4.3	0.01	115	35	0.6	70	35	45
25	Sadde	8.04	0.35	471	663	202	119	4.99	0.01	85.96	49	0.15	47	20	67.3
26	Bandivan	8.04	0.34	472	599	249	121	2.11	0.01	71.4	13.7	0.53	48.4	30	30
27	GHaleno	8.3	0.52	746	1134	248	123	12.5	0.01	179.5	122.5	0.75	49.2	23.7	172
28	Mojanabad	8.3	0.47	2180	3590	194	99	1.82	0.01	456	730	1.48	39.6	23.7	711
29	Hasanabad	8.2	0.34	1694	2600	98	59	28.3	0.01	332	377	1.64	23.6	9.74	566
30	Mahabad	8.23	0.35	2242	3440	123	79	25.9	0.01	942	311.5	3.59	31.6	10.67	703
31	Dehekhatib	8.2	0.42	1142	762	162	78	11.7	0.02	153	1.1	0.38	34.8	18.21	190

Table 2: Comparison of sources of drinking water in village in the city Khaf with Iran and EPA standard

	Iran national standard 1053		Village %			
Parameter	Maximumallowable	Minimumdesirable	Permissible	Optimum	Higher	EPA standard MCL
pH (ppm)	6.5-8.5	6.5-9	-	100%	-	6.5-8.2
Tur (NTU)	<1	5	13.3 %	76.6%	10%	1
EC (µmhos/cm)	1500	2000	6.6%	71%	23.3%	-
TDS (ppm)	1000	1500	13.3 %	66.6%	20%	500
TH (mg/l)	200	500	40%	56.6%	3.3%	-
NO_3^- (mg/l)	-	50	93.3%	-	6.6%	10(N)
NO_2 (mg/l)	-	3	6.6 %	93.3 %	-	-
SO_4^- (mg/l)	250	400	13.3 %	66.6%	20%	250
CL^- (mg/l)	250	400	16.6%	37.3%	10%	250
F^- (ppm)	0.5	1.5	33.3% (Less than standard)	56.6%	10%	2
Ca^{+2} (mg/l)	300	400	-	100%	-	

Fig 1: Location of Khaf in Iran

desirable level and the highest pH was for village of Shahrak by an amount of 8.31 and the lowest related to village of Mahabad with an amount of 7.42. Therefore all samples are in natural conditions and inclined to alkalinity, so are suitable for drinking. Results also have shown (Table 1) that the highest concentration of sulfate and chloride ions were in villages of Mahabad and Boniabad with the amount of 942 and 1543 mg/l and the lowest was for villages of Ahmadabad and SHahrak by the amount of 36 mg/l. Table 2 shows that in 66.6% and 73.3% of villages the concentrations of sulfate and chloride ions were at desirable range and 13.3 and 16.6% of them were at permissible range and in 20 and 10% of villages the amount of these ions is higher than the standard level.

Results of this study have shown that the amount of calcium and PH in all samples are at desirable range and in 70% of them the parameters of turbidity, electrical conductivity, chloride, magnesium have been at desirable level and in other cases are at permissible range or higher than the standard level. And also in 66.6 % of samples the total concentration of TDS and sulfate are at desirable range and in other cases have been at permissible range or higher than the standard level. The concentration of nitrite and nitrate were at desirable range in 93.3 and 93.3 % respectively,which in 6.6% of samples i.e 2 villages the amount of nitrate is higher than the standard level and it is required to take the necessary actions to solve this issue. Fluoride ion is also at standard and lower than the standard level in 55.6% and 33.3% of samples respectively.Therefore it is necessary to make a proper plan to increase the daily fluoride intake of residents especially for ages of 12-14 in order to prevent the dental problems.The study by Heidari *et al* on chemical quality and the chlorination conditions of drinking water in the villages of Kashan in 2006 have shown that the concentration of nitrate,nitrite,chloride and calcium in all villages were at standard level but of sulfate, magnesium, sodium, turbidity were higher than the standard level and also the concentration of fluoride was lower than the permissible level [13]. According to the study by Miranzadeh *et al.* on the relationship between turbidity, microbial quality and residual chlorine concentration in the drinking water of villages in city of Kashan in 2007, it has been observed that the amount of residual chlorine and turbidity were desirable at all three levels respectively in 86, 22.8 and 75.4 % of rural waters and in 12.3, 29.8 and 0 % of rural waters were undesirable at three levels. [13]. The study of drinking water quality analysis by Wu-yuan Jia *et al.* in rural and surrounding areas of city of Tian an in China in two high and low rain seasons has shown that the existed water of this region is slightly contaminated and the concentration of iron, ammonia cal nitrogen and total coliforms were higher than the determined standard level [14]. The Study by V.K. Guptu on drinking water quality of underground water in Auraiya region of India during 2007-2008 has shown that the turbidity in high rain season was higher than the determined standard by World Health Organization and the concentration of sulfate and soluble solids was also higher than the standard and because of that most waters of this region need treatment before use [17]. The results of the study by Yashbir Singh, Kumar Manish on the interpretation of drinking water quality parameters for villages of Sanganer in India by the use of multivariate statistical analysis in 2010 have shown that the quality of these water come to the wrong and most of them contaminated with high amount of fluoride, nitrate and alkalinity that the contamination is higher than the permissible level and resulted from artificial and organic pollutants sources [18]. The study by Nabanita Haloi on the assessment of underground water quality in some

regions of Brahmaputra flood in Barpeta District, Assam India, with special focus on fluoride, nitrate, and iron analysis during summer and following seasonal period in 2008 have shown that water sources are largely contaminated with iron and as a result of this it will encounter with some problems in future and the quality of waters in Barpeta become weak and will need a better management system to better maintenance of water quality [19].

CONCLUSION

This study indicated that most of the physicochemical parameters such as Sulfate, Chloride, Sodium, TDS, EC, Turbidity and Nitrate do not fall within the permissible limit. Although the fluoride concentration is lower than the Maximum Contaminant Levels in many villages. Therefore, currently the related government departments should focus on strengthening "the three wastes" treatment and sanitation management of drinking water and transmission.

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