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THE INVESTIGATION OF PHYSICOCHEMICAL PARAMETERS OF DRINKING AND GROUND WATERS IN ŞANLIURFA AND ADIYAMAN

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ABSTRACT

The purpose of this research was to analyze the physico-chemical qualities of drinking and ground waters in the Şanlıurfa and Adıyaman provinces of Turkey. The water quality parameters were pH, calcium (Ca^{++}), magnesium (Mg^{++}), sodium (Na^{+}), potassium (K^{+}), electrical conductivity (EC), sodium absorption rate (SAR), chlorine (Cl^{-}), and bicarbonate (HCO_3^{-}). The International Organisation for Standardization (ISO) and Turkish Standard (TS) methods were used in this study. A total of 193 water samples were collected from 13 districts. The cations were analyzed using ICP-OES. According to the physico-chemical analyses of the samples, pH levels were within the standard levels and the mean values of EC, Ca^{++}, Mg^{++}, Na^{+}, K^{+}, Cl^{-}, HCO_3^{-}, and SAR were 419.20±138.88, 2.703±4.825 me/L, 1.371±0.875 me/L, 1.058±1.285 me/L, 0.281±0.907 me /L, 1.115±0.640 me/L, 3.45±1.83 me/L and 0.722±0.369, respectively. The analyses revealed that the quality of the water investigated was within acceptable limits, therefore, it is deemed appropriate for an evaluation as drinking and ground water.

Key words: Water, ICP-OES, pysico-chemical qualities, Şanlıurfa, Adıyaman

INTRODUCTION

Water is an imperative resource and a fundamental nutrition for life. In vertebrates, 70% of the body weight is comprised of water, and in domestic animals 60%. It is the main component of electrolyte balance and osmoregulation in metabolism [1].
The total quantity of water in the world is 1.4 billion km^3. Of this total, 97.5% is found as salt water in oceans and seas, and 2.5% is as fresh water in rivers and lakes. Moreover, since 90% of it is found in poles and underground, it can be readily understood how little the total amount of freshwater is available for humans to benefit from [2]. World's renewable water supply is 42,650 km^3/year [3]. The gross renewable water potential in Turkey is estimated as 234 billion m^3 [4]. However, under today's technical and economical conditions, the water potential above ground that can be consumed for various purposes is 95 billion m^3 coming from domestic rivers and 3 billion m^3 from rivers flowing from neighboring countries, making a total of 98 billion m^3 annually [4]. With the underground water potential being 14 billion m^3, the annual consumable above ground and underground water potential is approximately 112 billion m^3, of which 44 billion m^3 is used. Contrary to what to the idea that Turkey is a water-rich country, when the annual amount of water per capita is taken into account, it is actually a country with a water shortage. The annual available water per capita is around 1.519 m^3 [4].
On the one hand, the growing demand for water is parallel with the population growth; on the other hand, changes in living standards both have revealed the social and economic significance of water resources. Turkish Statistical Institute predicts that in 2030 the population will reach 100 million [5]. Correspondingly, in 2030 the amount of usable water per capita will be 1.120 m^3/year in Turkey [6]. Therefore, proper use of the existing water resources is vital for their continuity. In addition to determining the intended uses accurately, identifying water quality determining criteria is also essential for healthy living and rational use of water.

The aim of this research was to establish some quality characteristics of the drinking and ground water samples taken from 15 districts of Şanlıurfa and Adıyaman provinces and surrounding villages, which was designated as the research area. These findings bear significance, since this is the first study to show the physico-chemical parameters of the water samples in Şanlıurfa and Adıyaman.

MATERIAL AND METHOD

1. Study Area

This study area is located in the southeastern region of Turkey between 37° 12' N and 37° 46' N, and 38° 50' E and 38° 16' E, with a landmass of 26.455 km^2. The study area has a relatively high altitude that is between 510 m (Şanlıurfa) - 669 m (Adıyaman) above sea level. Water from these regions is used for drinking and domestic purposes. Both cities are located around the world's 6^{th} largest dam, Atatürk Dam, and their main livelihood is based on livestock production.

2. Sampling

In this study, 193 water samples from the city centers and surrounding districts of Şanlıurfa and Adıyaman cities were collected between January and December 2016 in 1000 mL polypropylene bottles as two samples from each point. The distributions of the samples are given in Table 1. Collected samples were stored at 4-5 °C until analysis.

Table 1. Distribution of the samples according to city and districts

Sample collection points	Sample number
Şanlıurfa / Center	67
Şanlıurfa / Birecik	38
Şanlıurfa/ Bozova	20
Şanlıurfa/ Akçakale	15
Şanlıurfa/ Siverek	15
Şanlıurfa/ Harran	9
Şanlıurfa/ Halfeti	5
Şanlıurfa/ Hilvan	5
Şanlıurfa/ Suruç	3
Adıyaman/ Center	9
Adıyaman/ Kahta	2
Adıyaman/ Besni	1
Adıyaman/ Samsat	1

2.3. Physical and chemical analyses

The pH of the water samples was determined using a pH meter according to the usage directives and the electrical conductivity (EC) values with an EC meter. Analyses of the elements, calcium (Ca^{++}), magnesium (Mg^{++}), sodium (Na^{+}), potassium (K^{+}), were performed on ICP-OES (Optima 7000 DV Perkin-Elmer) and the units given as ppm were converted to me/L. The bicarbonate (HCO_3^{-}) content of the water samples was determined by titration with diluted sulfuric acid with known normality using a methyl orange indicator. The sodium absorption rates (SAR) were calculated using the formulation below [7].

$$SAR = \frac{Na+}{\frac{\sqrt{Ca^{+2}+Mg^{+2}}}{2}}$$

In addition, chlorine (Cl^{-}) detection in the water samples was done by the silver nitrate ($AgNO_3$) titration method[7]. The statistical data was calculated using the Microsoft Excel 2010 version.

RESULTS AND DISCUSSION

The physico-chemical properties of the analyzed 193 water samples from Şanlıurfa and Adıyaman are given in Table 2.

The pH of the water is an important indicator of pollution and environmental condition which affects the biochemical processes [8,9]. The water samples showed a pH range between 6.71 and 8.30. According to the standard of TSE-266, the pH of the drinking and municipal waters should be between 6.5 and 9.5 [10]. Therefore, these samples are within the standard range. The average pH values of the water samples of this study appear parallel with the pH data of a study conducted in India in 2009 [11]. In the study investigating the physico-chemical properties of the drinking water from the Trabzon (Iyidere) province of Turkey, the pH values were found between 5.78 and 8.58, which corresponds to a more alkaline character compared to our results [12].

The average EC value in this study was found as 419.206±138.88 µS/cm. Moreover, as stated in the classification system of the U.S. Salinity Laboratory Staff (1954) [13], 1.5% of our samples (3 samples) were observed to be in class C1 (Low-salinity water, <250 µS/cm), 92.2% (178 samples) in C2 (Medium-salinity water, 250-750 µS/cm) and 6.2% (12 samples) in C3 (High-salinity water, 750-2250 µS/cm). In their study conducted on spring water samples from the Adana province, Dönderici et al. (2010), reported EC values of 25.9-195.5 µS/cm, which is lower than our findings [14].

The minimum-maximum Ca^{++} concentrations were determined as 0.468-51.01 me/L and the average value as 2.703±4.825 me/L. Calcium is a substantial macro element that plays roles in functions such as bone metabolism of vertebrates, nerve conduction and maintaining the electrolyte balance of the blood [1]. Furthermore, Mg^{++} concentrations were demonstrated in between 0.058 and 7-654 me/L, and the average as 1.371±0.875 me/L. Magnesium, the cofactor of many of the intracellular and extracellular enzymatic reactions, is the most abundant element in the body after Ca^{++}, Na^{+} and K^{+}, with the greater part being in the bones. Generally, in drinking waters hardness is caused by the Ca^{++} and Mg^{++} ions, which can also be defined as water's property of settling soap [15]. In the study by Vereb et al., [12] from the Trabzon province, average calcium content was reported as 0.55 me/L, which is less than our findings. World Health Organization (WHO) determined the upper limit of Ca^{++} and Mg^{++} contents in drinking waters as 5.0 me/L and 4.16 me/L, respectively [16]. Alemdar et al. (2009), in their study on the Bitlis province drinking waters, demonstrated the average Mg^{++} level as 0.51±0.01 me/L [17]. This value is lower than the presented study's results.

Table 2. Physicochemical properties of the water samples

Parameter	Minimum	Maximum	Average	Standard deviation
pH	6.712	8.30	7.698	0.371
EC (µS/cm)	211	1021	419.206	138.88
Ca (me/L)	0.468	51.01	2.703	4.825
Mg (me/L)	0.058	7.654	1.371	0.875
Na (me/L)	0.017	11.91	1.058	1.285
K (me/L)	0.010	8.094	0.281	0.907
Cl (me/L)	0.425	7,600	1.115	0.646
HCO_3 (me/L)	0.76	8.80	3.455	1.183
SAR	0.06	2.55	0.722	0.369

Sodium and potassium are elements that have crucial functions in maintaining the water-electrolyte balance and cellular electric potential. When the Na^{+} levels were evaluated, the minimum and maximum values were found as 0.17 and 11.91 me/L, respectively, and the average as 1.058±1.285 me/L. All the samples that were analyzed were observed to be in class S1 (Low-sodium water, SAR<10). Sefie et al., (2015), conducted a study on 109 groundwater samples from Malaysia and reported them all in class S1 [7]. Potassium in waters comes from rocks and stones, and due to its low solubility, its concentration in water is lower than sodium [18]. The K^{+} content of the water samples ranged between 0.010 and 8.094 me/L, and the average value was estimated as 0.281±0.907 me/L. In the study by Udhayakumar et al. (2016), on water samples from Tamil Nadu (India), the potassium concentrations were determined between 2.82-8.71 me/L [18]. This appraisal is much higher than the potassium concentrations demonstrated in the presented study.

The permissible limit of Cl^{-} by WHO is 200 mg/L (5.63 me/L) [16]. The average Cl^{-} content was noted as 1.115±0.646 me/L, while the highest and lowest values were measured as 0.425 and 7.600 me/L, respectively. According to the classification of the Turkish Standards Institute on Cl^{-} contents, 191 water sample were designated as 'very good' (0-4 me/L) and 2 were 'good' (4-7 me/L) [19]. In a study from Nigeria, the chlorine concentrations were reported between 2.2-4.4 me/L, which is higher than the presented findings, bringing geographical diversity to mind [20].

Another significant anion of water, HCO_3^{-} concentrations, were varying between 0.76-8.80 me/L and the average was calculated as 3.455±1.183 me/L. Bicarbonate bears a potent buffering property in maintaining the acid-base balance in extracellular fluids [1]. The sodium absorption range of the water samples was measured as 0.722±0.369. While the minimum SAR value was 0.06, the maximum was 2.55. It has been demonstrated that usage of SAR is an important criteria as an index of alkaline damage [6].

CONCLUSION

In this study, in the water samples collected from the Şanlıurfa and Adıyaman provinces the parameters of pH, EC, Ca, Mg, Na, K, Cl, HCO_3 and SAR were investigated in order to determine the physico-chemical quality. Since the data obtained from the water samples constituting the material of this study, displayed that the quality of the waters are within the acceptable limits, it has been accepted appropriate to evaluate as drinking and utility water.
Based on these findings, continuous monitoring of the quality parameters of the existing water resources in Şanlıurfa and Adıyaman provinces, where human population is increasing and agriculture and livestock are prevalent, are suggested in terms of correct use of water resources. The findings of this study will form a baseline for future investigations.

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REFERENCES

1. Karagül H, Altıntaş A, Fidancı U, Sel T. Klinik Biyokimya, Medisan Yayınevi. 2000, Ankara.
2. http://www.suski.gov.tr/yer-alti-su-kaynaklari.html. Erişim tarihi; 15.12.2016.
3. Shiklomanov IA. Appraisal and assessment of world water resources. *Water International*. 2000; *25*, 11–32.
4. http://www.dsi.gov.tr/toprak-ve-su-kaynaklari. Erişim tarihi;15.12.2016.
5. http://www.tuik.gov.tr/PreHaberBultenleri.do?id=15844.
6. Varol F, Bellitürk K, Sağlam MT. Tekirdağ İli Sulama Sularının Özellikleri. *Tarım Bilimleri Dergisi*. 2005; *11*(4).
7. Sefie A, Aris AZ, Shamsuddin MKN, Tawnie I, Suratma S, Idris AN, Ahmad WKW. Hydrogeochemistry of groundwater from different aquifer in Lower Kelantan Basin, Kelantan, Malaysia. *Procedia Environmental Sciences*. 2015; *30*, 151-156.
8. Singh KP, Malik A, Sinha S, Singh VK, Murthy RC. Estimation of source of heavy metal contamination in sediments of Gomti River (India) using principal component analysis. *Water Air and Soil Pollution.* 2005*; 166*, 321–341.
9. Nazeer S, Hashmi ZM, Malik RN. Heavy metals distribution, risk assessment and water quality characterization by water quality index of the River Soan, Pakistan. *Ecological Indicators.* 2014; *43*, 262–270.
10. http://maraskaski.gov.tr/wp-content/uploads/2016/01/ts266.pdf.
11. Ramakrishnaiah CR, Sadashivaiah C, Ranganna G. Assessment of water quality index for the groundwater in Tumkur Taluk, Karnataka State, India. *Journal of Chemistry*. 2009; *6*(2), 523-530.
12. Verep B, Serdar O, Turan D, Şahin C. İyidere (Trabzon)'nin Fiziko-Kimyasal Açıdan Su Kalitesinin Belirlenmesi. *Ekoloji*. 2005; *14*(57), 26-35.
13. U.S.Salinity Laboratory Staff. Diagnosis and lmprovement of Saline and Alkali SoiJs, AgT. Handbook. 1954; No. 60, 125-126.
14. Dönderici ZS, Dönderici A, Başarı, F. Kaynak Sularinin Fiziksel Ve Kimyasal Kaliteleri Üzerine Bir Araştırma. *Türk Hijyen ve Deneysel Biyoloji Dergisi*. 2010; 167.
15. Yılmaz F. Mumcular Barajı (Muğla-Bodrum)'nın Fiziko-Kimyasal Özellikleri. *Ekoloji* 2004; 50, 10-17.
16. WHO. Guideline for drinking water quality 2 nd Ed. Recommendation. World Health Organization general 1.1982; 30-113.
17. Alemdar S, Kahraman T, Ağaoğlu S, Alişarlı M. Bitlis ili içme sularının bazı mikrobiyolojik ve fizikokimyasal özellikleri. *Ekoloji*. 2009; *19*(73), 29-38.

18. Udhayakumar R, Manivannan P, Raghu K, Vaideki S. Assessment of physico-chemical characteristics of water in Tamilnadu. *Ecotoxicology and environmental safety.* 2016; *134*, 474-477.
19. Anonim. Resmi Gazete. Tarih: 7 Ocak 1991, Sayı No: 20748.
20. Adefemi SO, Awokunmi EE. Determination of physico-chemical parameters and heavy metals in water samples from Itaogbolu area of Ondo-State, Nigeria. *African Journal of Environmental Science and Technology*. 2010; *4*(3).