International Journal of
Agriculture, Environment and Food Sciences

JAEFS

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2020.2.7 www.jaefs.com

Research Article Int J Agric Environ Food Sci 4 (2): 173-180 (2020)

# Comparison of fluoride contents in terms of teeth health and water quality in drinking water at the northern and southern regions of Meriç River Basin (Edirne/Turkey)

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**Abstract**

This research was carried out to investigate and compare the fluoride accumulations and some physical and chemical properties (dissolved oxygen, oxygen saturation, pH, oxidation – reduction potential, electrical conductivity, total dissolved solid, salinity, nitrate nitrogen) in the drinking water of Enez and Süloğlu Districts, which are located in the northern and southern parts of the watershed of Meriç River. Water samples used for drinking were taken from tap waters in a total of 22 residential areas in the Enez and Süloğlu Districts at the winter season of 2019. Fluoride levels of water samples were determined by using a spectrophotometer and Principle Component Analysis (PCA) was applied to the results. The detected fluoride amounts and physical/chemical data were also evaluated in terms of teeth health of humans. According to the results obtained, although the detected fluoride accumulations both in the northern and southern part of the basin are slightly below the optimum levels for teeth health, it has been found that fluoride concentrations did not exceed the permitted values for drinking water. The minimum and maximum fluoride levels recorded as min. 0.159 ppm (Süloğlu District) – max. 0.475 ppm (Küküler Village) in the northern part of the basin and recorded as min. 0.068 ppm (Hasköy Village) – max. 0.603 ppm (Karaincirli Village) in the southern part of the basin. As a result of PCA, 2 factors named as “Agricultural Factor” and “Fluoride Factor” explained 79% of the total variance. It was also determined that contamination rates in terms of physicochemical variables of investigated regions were found as South Region of the Basin > North Region of the Basin in general.

**Keywords:** Drinking water quality, Enez and Süloğlu Districts, Fluoride, Teeth health

## Introduction

Fluorine is an essential element that is easily soluble in water, soil, and air. It is one of the most reactive chemical element which do not exist on its own in the natural environment but rather in the form of fluoride. This element may enter the body through food, water, industrial exposure, drugs and drinking water which is the main source of fluoride intake (75–90% of daily intake) (Güner et al., 2016). Surface waters have fluoride levels less than 0,5 mg/l, while groundwater can contain higher concentrations of fluoride depending on geological conditions (Day and Giri, 2016). There are many countries around the world where fluoride naturally occurs in groundwater. India and China are endemic areas where fluorosis is severe and widespread. Turkey is also in this geographical fluoride belt and there are endemic regions with different fluoride concentrations in drinking water. Fluoride ion is highly electronegative and it can easily be attracted by positively charged calcium ions in teeth and bones. Major health concerns by fluoride include dental and skeletal fluorosis as well as other non-skeletal manifestations (Andezhath et al., 1993). Excess fluoride intake

**Cite this article as:**
Güner, Ş.O., Tokatli, C. (2020). Comparison of fluoride contents in terms of teeth health and water quality in drinking water at the northern and southern regions of Meriç River Basin (Edirne/Turkey). Int. J. Agric. Environ. Food Sci., 4(2), 173-180
**DOI:** https://doi.org/10.31015/jaefs.2020.2.7
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**Received:** 04 February 2020 **Accepted:** 24 April 2020 **Published Online:** 15 June 2020
**Year:** 2020 **Volume:** 4 **Issue:** 2 (June) **Pages:** 173-180
**Available online at :** http://www.jaefs.com - http://dergipark.gov.tr/jaefs

through drinking water for a prolonged period may result in dental fluorosis. Children are more susceptible to dental fluorosis during tooth development and drinking water with excess fluoride levels may result in different degrees of tooth mottling since pathological changes in dental fluorosis are time and dose-dependent (Tokatlı and Güner, 2018; Onur et al., 2019).

Another important element is nitrogen compounds in drinking water resources. Nitrate is a compound of nitrogen that is found naturally in moderate concentrations in many environments. The nitrate amount in groundwaters and surface waters is mostly in low concentration but nitrate levels may reach higher concentrations due to agricultural runoff or contamination with human or animal wastes (Rodvang and Simpkins, 2001; Tokatlı et al., 2013; Ustaoğlu et al., 2017; Tokatlı, 2018). Along with fluoride, nitrate may pose a major environmental health hazard if the optimal levels are exceeded. Nitrates in groundwater represent a widely distributed pollution concern. The key concern regarding the usage of groundwater with excessive concentrations of nitrates is related to human health effects, particularly concerning infants. The major effects are associated with losses in oxygen transport/transfer capabilities in the blood. The toxicity of nitrate to humans is due to the body's reduction of nitrate to nitrite. This reaction takes place in the saliva of humans of all ages and the gastrointestinal tract of infants during their first 3 months of life (WHO, 2011a; Tokatlı, 2014).

Considering the adverse effects of these chemicals, World Health Organization (WHO, 2011b) has set some guidelines for the permissible concentrations of these elements in waters used for drinking (11.3 ppm for nitrate and 1.5 ppm fluoride).

Enez District, which is the south studied area in this study, is located on the south west corner of Edirne City. The eastern half of the district is on the Pelin Plateau extending north of the Saroz Gulf in the Aegean Sea. The main livelihood of the people of Enez is agriculture and animal husbandry. Fishing is also carried out in our central and coastal villages (Anonymous, 2016). Süloğlu, which is the north studied area in this study is located on the northern half of Edirne City and on the Lalapaşa plateau. The economy of the district is predominantly agricultural. The drinking water of the villages in the investigated regions is being provided by the drilling and spring waters, in general (Anonymous, 2016).

This study aimed to determine the drinking water qualities of north and south region in the Meriç River Basin and compare the fluoride accumulations in the water used as drinking water resources of these districts in terms of teeth health of humans.

## Material and Method

### Investigated region and sample collection

In this study, sampling was performed in winter season of 2019 from a total of 22 stations from the settlement areas located in the Enez (south part of the study area) and Süloğlu Districts (north part of the study area). The samples were taken from the tap water used in the houses of the villages and the obtained water materials put into polyethylene bottles. The sampling localities of villages are presented in Table 1 and map of the watershed of Meriç River with the investigated areas are presented in Figure 1.

### Physical, chemical and statistical analysis

Measurements of dissolved oxygen, oxygen saturation, pH, oxidation – reduction potential (ORP), electrical conductivity (EC), total dissolved solid (TDS) and salinity were measured by using Hach branded (HQ40D) Portable Multi – Parameter Measurement Device and turbidity parameter was measured by using Hach branded (2100Q) Portable Turbidimeter Device during the field studies. The water samples were transported to the laboratory to determine the other chemical features. Nitrate nitrogen (NO3-N) values were determined by using Hach branded (DR890) Colorimeter Device; Fluoride rations were determined by using classical spectrophotometric method and "Hach Lange DR 3900 Spectrophotometer" device (wavelength range 320 – 1100 nm). Cuvette Test LCK 323 was used in spectral photometer. This method provides fluoride ions react with zirconium to form a colourless zirconium fluoride complex.

**Table 1.** Location properties of villages

| Enez District | | | Süloğlu District | | |
|---|---|---|---|---|---|
| Location | Coordinate | | Location | Coordinate | |
| | North | East | | North | East |
| Yenice | 40.700 | 26.149 | Domurcalı | 41.816 | 26.819 |
| Çavuşköy | 40.688 | 26.171 | Sülecik | 41.814 | 26.850 |
| Büyükevren | 40.651 | 26.228 | Tatarlar | 41.835 | 26.886 |
| Abdürrahim | 40.641 | 26.258 | Taşlısekban | 41.802 | 26.877 |
| Hasköy | 40.665 | 26.317 | Yağcılı | 41.784 | 26.829 |
| Kocaali | 40.666 | 26.345 | Geçkinli | 41.731 | 26.848 |
| Şehitler | 40.692 | 26.293 | Küküler | 41.715 | 26.896 |
| Işıklı | 40.719 | 26.309 | Akardere | 41.681 | 26.930 |
| Çeribaşı | 40.664 | 26.256 | Büyükgerdelli | 41.735 | 26.951 |
| Karaincirli | 40.627 | 26.297 | Keramettin | 41.787 | 26.977 |
| Vakıf | 40.616 | 26.258 | Süloğlu | 41.767 | 26.911 |

This causes the red zirconium lake which is present to lose colour (https://tr.hach.com/). Principle Component Analysis (PCA) is a powerful multivariate statistical method that facilitates the interpretation of large data. It is widely used in ground and surface water quality evaluation studies on all over the globe (Liu et al. 2003, Kazi et al. 2009, Tokatlı et al. 2014, Tokatlı 2017). Principle Component Analysis (PCA) was made by using the "SPSS 17" package program.

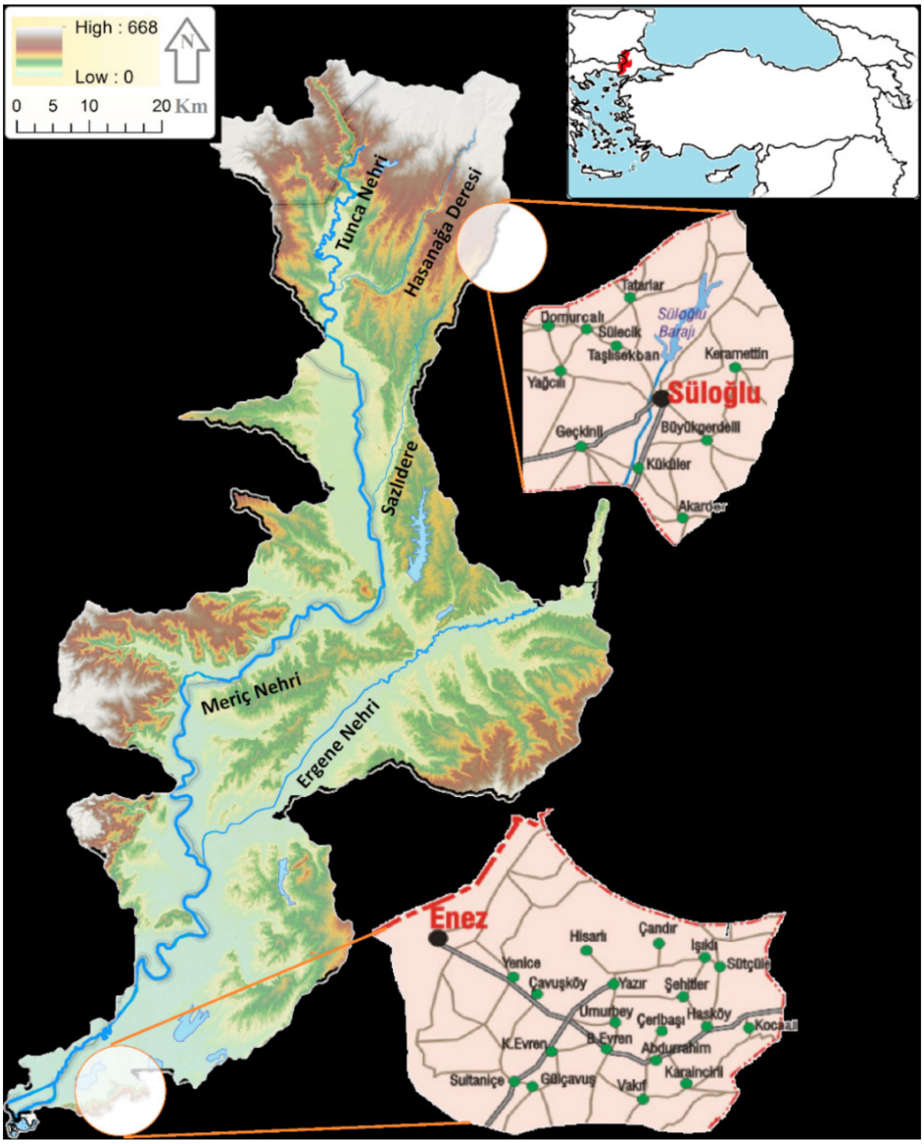

**Figure 1.** Map of Meriç River Basin and investigated residential areas

## Results

### Physical and chemical data

Results of the physical and chemical data detected in the drinking water of Enez and Süloğlu Districts and some water quality and drinking water standards are presented in Table 2. Fluoride distribution map of investigated villages is presented in Figure 2. Correlation graphics between fluoride and the other investigated parameters are presented in Figure 3.

According to the results of Pearson Correlation Index, no statistically significant relationship was determined between the fluoride and any physical and chemical parameters (Figure 3).

### Principle Component Analysis (PCA)

Principle Component Analysis (PCA) is a powerful multivariate statistical method that facilitates the interpretation of large data. It is widely used in ground and surface water quality evaluation studies on all over the globe (Liu et al. 2003, Kazi et al. 2009, Tokatlı et al. 2014, Tokatlı 2017).

In this research, PCA was used to detect the effective varifactors. Low and non – correlation variables were removed from present application to improve the reliability of the PCA and a total of 6 variables were used to detect the effective varifactors (n = 22 for all parameters).

Kaiser Meyer Olkin (KMO) test result, which means the measure of sampling competence, was recorded as 0.727 in this application. Eigenvalues over 1 were taken as criterion assessing the principal components in this application (Figure 4). Component plot is given in Fig. 4 and factor loadings before and after rotation is presented in Figure 5.

DOI: https://doi.org/10.31015/jaefs.2020.2.7

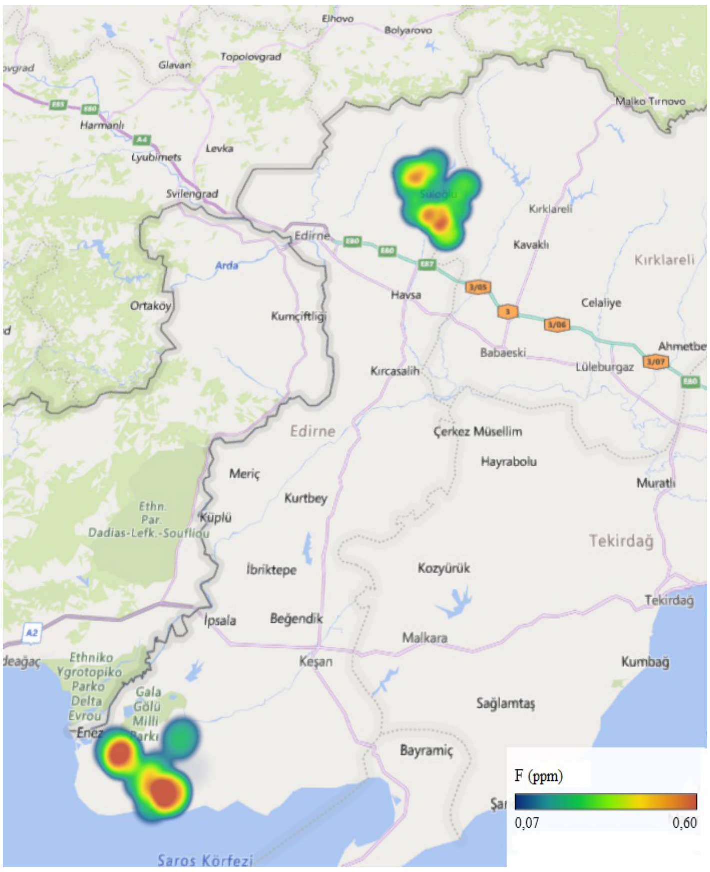


**Figure 2.** Fluoride distribution map in the studied area

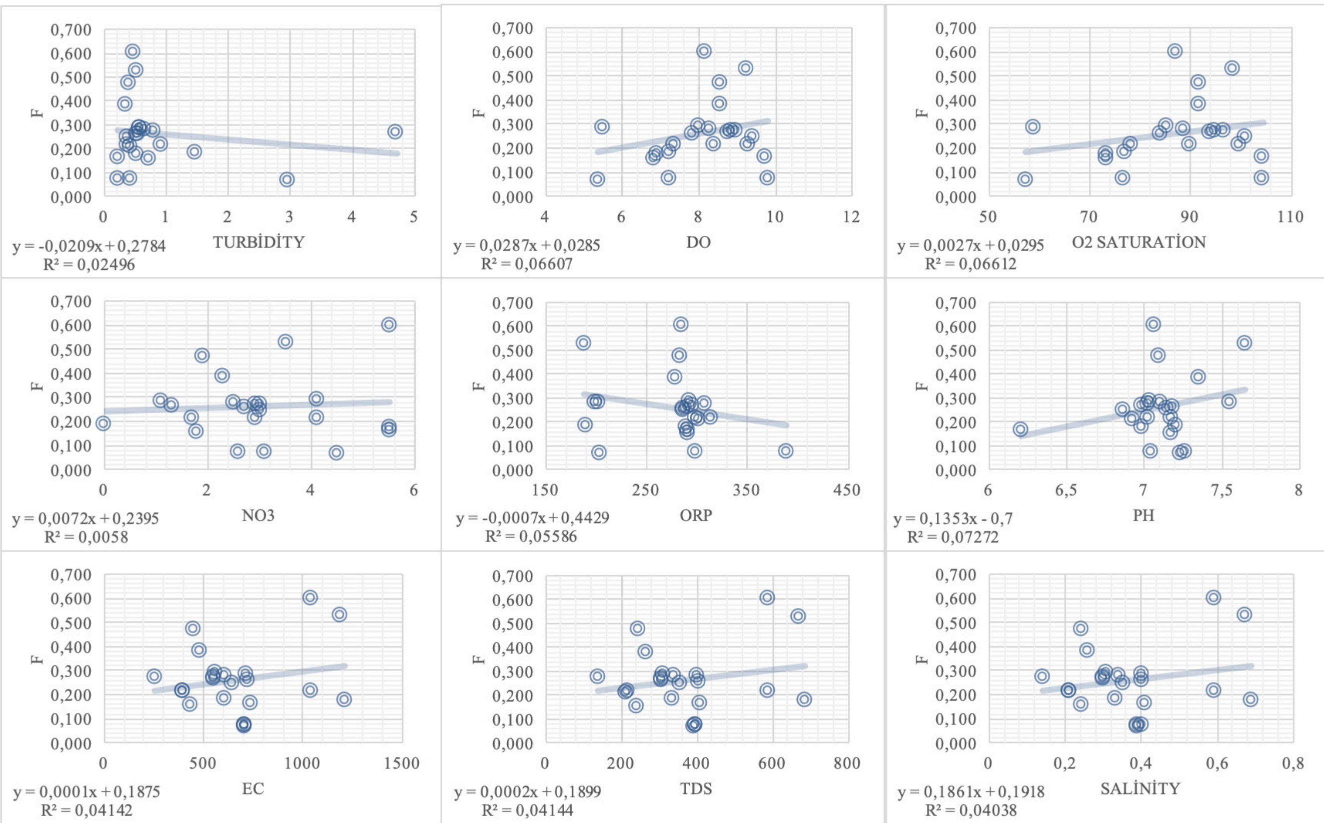


**Figure 3.** Correlation data between fluoride and the other physical and chemical variables

**Table 2.** Results of investigated parameters and limit values

| **Some Limits and the Data of Present Study DO** (ppm) | | **Parameters** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **$O_2$ Sat.** (%) | **pH** | **ORP** | **EC** (mS/cm) | [a]**TDS** (ppm) | **Sal.** (‰) | **Tur.** (NTU) | **$NO_3$** (ppm) | **F** (ppm) | |
| **Turkish Regulations Water Quality Classes** (2015) | **I. Class** (Very Clean) | >8 | >90 | 6.5-8.5 | - | 400 | 500 | - | - | 5 | 1 |
| | **II. Class** (Less Polluted) | 6 | 70 | 6.5-8.5 | - | 1000 | 1500 | - | - | 10 | 1.5 |
| | **III. Class** (Much Polluted) | 3 | 40 | 6.0-9.0 | - | 3000 | 5000 | - | - | 20 | 2 |
| | **IV. Class** (Extremely Polluted) | 3> | 40> | Out of 6.0-9.0 | - | >3000 | >5000 | - | - | >20 | >2 |
| **Drinking Water Standards** | **TS266** (2005) | - | - | 6.5-9.5 | - | 2500 | - | - | 5 | 50 | 1.5 |
| | **EC** (2007) | - | - | 6.5-9.5 | - | 2500 | - | - | - | 50 | 1.5 |
| | **WHO** (2011) | - | - | - | - | - | - | - | - | 50 | 1.5 |
| **Results of South region in the Basin** | **Yenice** | 8.27 | 88.5 | 7.55 | 198 | 605 | 336 | 0.34 | 0.64 | 2.5 | 0.281 |
| | **Çavuşköy** | 9.21 | 98.4 | 7.65 | 188.7 | **1184** | 670 | 0.67 | 0.5 | 3.5 | 0.529 |
| | **Büyükevren** | **5.51** | **59** | 7.1 | 201.8 | 714 | 398 | 0.4 | 0.56 | 1.1 | 0.285 |
| | **Abdürrahim** | 7.21 | 77.1 | 7.2 | 189.4 | 603 | 335 | 0.33 | 1.46 | 0 | 0.187 |
| | **Hasköy** | **5.36** | **57.2** | 7.23 | 203.4 | 704 | 393 | 0.39 | 2.94 | 4.5 | 0.068 |
| | **Kocaali** | 7.19 | 76.8 | 7.04 | 389.1 | 708 | 396 | 0.4 | 0.22 | 3.1 | 0.075 |
| | **Şehitler** | 9.78 | 104.4 | 7.26 | 298.4 | 704 | 394 | 0.39 | 0.42 | 2.6 | 0.076 |
| | **Işıklı** | 7.31 | 78.1 | 7.17 | 298.2 | **1037** | 586 | 0.59 | 0.91 | 4.1 | 0.220 |
| | **Çeribaşı** | 6.87 | 73.4 | 6.99 | 288 | **1209** | 686 | 0.69 | 0.51 | 5.5 | 0.178 |
| | **Karaincirli** | 8.13 | 86.9 | 7.06 | 284.4 | **1041** | 588 | 0.59 | 0.46 | 5.5 | 0.603 |
| | **Vakıf** | 7.84 | 83.7 | 7.14 | 286 | 718 | 402 | 0.4 | 0.55 | 2.7 | 0.258 |
| | **Min** | 5.36 | 57.2 | 6.99 | 188.7 | 603 | 335 | 0.33 | 0.22 | 0 | 0.068 |
| | **Max** | 9.78 | 104.4 | 7.65 | 389.1 | 1209 | 686 | 0.69 | 2.94 | 5.5 | 0.603 |
| | **Mean** | 7.5164 | 80.318 | 7.2173 | 256.85 | 838.82 | 471.27 | 0.4718 | 0.8336 | 3.1909 | 0.2509 |
| | **SD** | 1.3556 | 14.467 | 0.2074 | 64.846 | 230.27 | 133.11 | 0.1346 | 0.7701 | 1.7009 | 0.1757 |
| **Results of North region in the Basin** | **Domurcalı** | 8.97 | 96.6 | 7.02 | 306.9 | 255 | 137 | 0.14 | 0.79 | 3 | 0.275 |
| | **Sülecik** | 8.39 | 90 | 7.02 | 312.5 | 395 | 215 | 0.21 | 0.37 | 1.7 | 0.220 |
| | **Tatarlar** | 9.28 | 99.5 | 6.92 | 300.8 | 393 | 215 | 0.21 | 0.4 | 2.9 | 0.216 |
| | **Taşlısekban** | 9.7 | 104.1 | 6.21 | 291.2 | 735 | 409 | 0.41 | 0.21 | 5.5 | 0.168 |
| | **Yağcılı** | 9.4 | 100.8 | 6.86 | 286.3 | 638 | 353 | 0.35 | 0.36 | 3 | 0.248 |
| | **Geçkinli** | 8.82 | 94.6 | 6.98 | 294.4 | 550 | 304 | 0.3 | 4.71 | 2.9 | 0.273 |
| | **Küküler** | 8.55 | 91.7 | 7.09 | 282.4 | 446 | 245 | 0.24 | 0.39 | 1.9 | 0.475 |
| | **Akardere** | 8.54 | 91.6 | 7.35 | 278 | 482 | 265 | 0.26 | 0.34 | 2.3 | 0.384 |
| | **Büyükgerdelli** | 8.74 | 93.7 | 7.18 | 291.3 | 549 | 303 | 0.3 | 0.5 | 1.3 | 0.267 |
| | **Keramettin** | 7.95 | 85.3 | 7.03 | 292.2 | 560 | 309 | 0.31 | 0.57 | 4.1 | 0.293 |
| | **Süloğlu** | 6.81 | 73.2 | 7.17 | 290.8 | 436 | 239 | 0.24 | 0.73 | 1.8 | 0.159 |
| | **Min** | 6.81 | 73.2 | 6.21 | 278 | 255 | 137.5 | 0.14 | 0.21 | 1.3 | 0.159 |
| | **Max** | 9.7 | 104.1 | 7.35 | 312.5 | 735 | 409 | 0.41 | 4.71 | 5.5 | 0.475 |
| | **Mean** | 8.65 | 92.827 | 6.9845 | 293.35 | 494.45 | 272.31 | 0.27 | 0.8518 | 2.7636 | 0.2707 |
| | **SD** | 0.7853 | 8.4022 | 0.2901 | 10.143 | 131.25 | 74.187 | 0.0744 | 1.2912 | 1.2077 | 0.0918 |

[a]Turkish Regulations 2004; [b]Uslu and Türkman 1987; Sal. Salinity; Tur. Turbidity; Sat. Saturation
EC – European Communities; WHO – World Health Organization; TS266 – Turkish Standards Institute
Class III – IV water quality given in bold

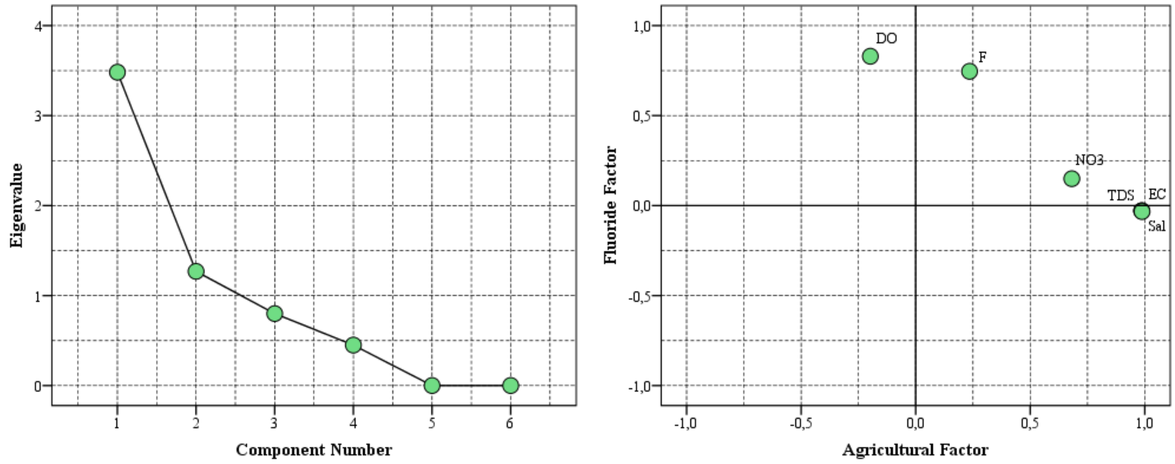


**Figure 4.** Eigenvalues (left) and component plot (right)

As a result of PCA, 2 factors explained 79% of the total variance (Table 3). First factor (F1) named as "Agricultural Factor" and it was explained 58% of total variance, which was related to the variables of salinity, TDS, EC and nitrate parameters (Figure 5). Second factor (F2) named as "Fluoride Factor" and it was explained 21% of total variance, which was related to the variables of dissolved oxygen and fluorine parameters (Figure 5).

**Table 3.** Total variances explained in FA

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| **1** | 3.481 | 58.022 | 58.022 | 3.481 | 58.022 | 58.022 | 3.481 | 58.018 | 58.018 |
| **2** | 1.269 | 21.147 | 79.170 | 1.269 | 21.147 | 79.170 | 1.269 | 21.151 | 79.170 |

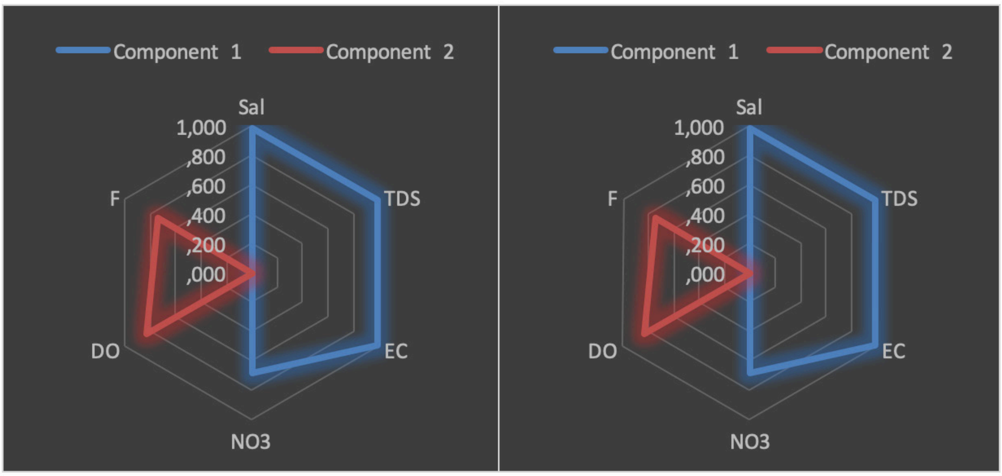


**Figure 5.** Component matrix before (left) and after (right) rotation

**Discussion**

According to the Water Pollution Control Regulation criteria in Turkey (2015), all the investigated villages both in northern and southern regions of Meriç River Basin ranges between Class I and Class II water quality in terms of pH, TDS, nitrate and fluoride rations. It was also determined that while the Süloğlu District (northern part) has Class I – II water quality in terms of dissolved oxygen, oxygen saturation and electrical conductivity, the Enez District (southern part) has Class II – III water quality in terms of these parameters. In addition, all the investigated physical and chemical parameters were recorded under the drinking water limit values specified by WHO (2011b), EC (2007) and TS266 (2005).

Groundwater plays such an essential role for the human population therefore its quality and safety has become issue of concern across the world. It is the main source of drinking water and contaminants found in groundwater may possess health hazards for humans (Howard et al., 2006). Among these contaminants nitrate and fluoride are the more widespread. Drinking water is a direct source of fluoride exposure and depending on the concentration and daily consumption, it can have adverse health effects on human health (Ayoob and Gupta, 2006).

Drinking water with optimal fluoride levels has preventive effect on dental caries. However, health may be adversely affected if excessive amounts are ingested through drinking water. Exposure to fluoride concentrations more than optimal level may result in fluorosis (Güner et al., 2016).

In the present study area, the concentrations of fluoride range from 0.068 to 0.603 ppm. It was observed that 22 samples have fluoride concentrations within the acceptable limits for drinking water specified by WHO (2011), EC (2007) and TS266 (2005). $NO_3$–N levels ranged from 0–5.5 ppm in the study region, which were also found in the limits of Turkish Regulations Water Quality Classes (2015).

Chen et al. (2017) conducted a study in the Semiarid Region of Northwest China and reported $NO_3$–N and $F^-$ concentrations in groundwater were in the ranges of 2.66–103 and 0.11–6.33 ppm, respectively. Of the 50 samples in their study, 30 and four samples have high $NO_3$–N and $F^-$ levels exceeding the acceptable limits for drinking purpose recommended by the WHO (10 and 1.5 ppm), respectively.

Adimalla et al. (2019) assessed the drinking water quality and risks of fluoride and nitrate contamination in terms of human health in Nirmal Province of South India. The levels of fluoride in the drinking water ranged from 0.06 to 4.33 ppm (with a mean of 1.13 ppm). 20.59% of the total drinking water samples, the content of fluoride was more than its permissible limit of 1.5 ppm and the very high fluoride concentration was noticed in the villages of Karegaon (4.33 ppm), Mudhol (2.56 ppm), and Bamangaon (2.44 ppm).

In a study performed in the Meriç River Basin (Tokalı and Güner, 2018), fluorine accumulations in groundwater of Havsa District, which is located in the Edirne Province of Turkey in Thrace Region were investigated. Drinking water samples were collected from 15 stations including almost all the residential areas of the Havsa District and the fluoride levels were found between 0.006 ppm (Bakışlar Village) – 0.567 ppm (Hasköy Village), which were within the limits recommended by WHO (2011b).

In another research performed in the same region (Güner et al., 2017), tap water qualities of Havsa and Suloglu regions were investigated in terms of oral health and the prevalence of dental caries and dental fluorosis in children were evaluated. According to the results of this study, as similar to the results of the present research, it was found that dental caries levels were lower in the optimal fluoride area (0.703 ppm in Havsa District) than below-optimal fluoride area (0.357 ppm in Süloğlu District). It was also reported that optimal fluoride concentrations may have a positive effect on reducing dental caries among children in their study population.

Onur et al. (2019) investigated fluoride levels in drinking water in 3 districts of Edirne and evaluated children in terms of dental caries and dental fluorosis. According to the fluoride levels in drinking water, the region was divided into 3 groups; group 1: <0.5 ppm, group 2: 0.5-1.2 ppm and group 3: 2.39 ppm. It was reported that increase in fluoride concentrations in drinking water increased the severity of dental fluorosis. Children living in the area with high fluoride level in drinking had less dental caries on their permanent teeth and high dental fluorosis scores compared with children living in areas with low and optimal fluoride levels in drinking water.

## Conclusions

In this study, drinking water quality and fluoride accumulations in drinking water of northern and southern regions on the Meriç River Basin were investigated. Also Principle Component Analysis were applied to detected data in order to evaluate the data properly and according to the results of this application, “Agricultural Factor” and “Fluoride Factor” were determined as effective factors on drinking water quality. The detected fluoride levels in the northern and southern part of the basin are recorded as slightly below the optimum levels for teeth health and any investigated parameter in any investigated location did not exceed the permitted values for drinking water. As a result of this study, it was also determined that contamination rates of drinking water were found as southern region (Enez District) > northern region (Süloğlu District) in general.

In conclusion, the findings in the present study can provide a real insight into drinking water safety at Meriç River Basin. Since fluoride concentrations detected in drinking waters are below optimal level it is beneficial to evaluate the children residing in this area in terms of dental health.

## Compliance with Ethical Standards

**Conflict of interest**

The authors declare that for this article they have no actual, potential or perceived the conflict of interests.

**Author contribution**

The contribution of the authors is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

**Ethical approval**

Not applicable.

**Funding**

This research has been supported by the Commission of Scientific Research Projects of Trakya University (TÜBAP 2018/154).

**Data availability**

Not applicable.

**Consent for publication**

Not applicable.

**Acknowledgements**

Authors are thankful to the Commission of Scientific Research Projects of Trakya University (TÜBAP) about their financial supports.

## References

Adimalla, N., Li, P., Qiana, H. (2019). Evaluation of groundwater contamination for fluoride and nitrate in semi-arid region of Nirmal Province, South India: A special emphasis on human health risk assessment (HHRA). Human and Ecological Risk Assessment, 25 (5): 1107–1124. Doi: 10.1080/10807039.2018.1460579

Andezhath, S. K., Kumar, A., Bhatnagar, M., Bahudur, R.

(1993). Prevalence of endemic fluorosis with gastro-intestinal manifestations in people living in some North-Indian villages. Fluoride, 26 (2): 97-104.

Anonymous (2016). Edirne İl Çevre Durum Raporu (Environment Status Report of Edirne Province). Edirne Valiliği, Çevre ve Şehircilik İl Müdürlüğü (in Turkish).

Ayoob, S., Gupta, A. K. (2006). Fluoride in Drinking Water: A Review on the status and stress effects. Critical reviews in Environmental Science and Technology, 36, 433-487. Doi: 10.1080/10643380600678112

Chen, J., Wu, H., Qian, H., Gao, Y. (2017). Assessing nitrate and fluoride contaminants in drinking water and their health risk of rural residents living in a semiarid region of northwest China. Exposure and Health, 9: 183–195. Doi: 10.1007/s12403-016-0231-9

Dey, S., Giri, B. (2016). Fluoride fact on human health and health problems: A review. Medical & Clinical Reviews, 2 (1):11. Doi: 10.21767/2471-299X.100011

EC (European Communities) (2007). European Communities (Drinking Water) (no. 2), Regulations. S.I. No. 278 of 2007.

Güner, Ş., Haznedaroğlu, E., Sezgin, B. I., Okutan, A. E., Menteş, A. (2017). Prevalence of dental caries and fluorosis in two towns of Edirne, Turkey. Caries Research, 51:290–385.

Güner, Ş., Uyar-Bozkurt, S., Haznedaroğlu, E., Menteş, A. (2016). Dental fluorosis and catalase immunoreactivity of the brain tissues in rats exposed to high fluoride pre- and postnatally. Biological Trace Element Research, 174 (1): 150-157. Doi: 10.1007/s12011-016-0695-2

Howard, G., Bartram, J., Pedley, S., Schmoll, O., Chorus, I., Berger, P. (2006). Groundwater and public health. Protecting groundwater for health: Managing the quality of drinking-water sources. WHO, IWA Publishing, London.

Kazi, T. G., Arain, M. B., Jamali, M. K., Jalbani, N., Afridi, H. I., Sarfraz, R. A., Baig, J. A., Shah, A. Q. (2009). Assessment of water quality of polluted lake using multivariate statistical techniques: A case study. Ecotoxicology and Environmental Safety, 72: 301– 309. Doi: 10.1016/j.ecoenv.2008.02.024

Liu, C. W., Lin, K. H., Kuo, Y. M. (2003). Application of factor analysis in the assessment of groundwater quality in a blackfoot disease area in Taiwan. Science of the Total Environment, 313, 77–89. Doi: 10.1016/S0048-9697(02)00683-6

Onur, Ş. G., Sezgin, B. I., Tokatlı, C., Haznedaroğlu, E., Eda, A., İldeş, G. Ç., Kalaoğlu, E. E., Yazıcı, B., Menteş, A. (2019). Edirne'nin içme suyu fluor orani farkli 3 ilçesinde dental fluorozis ve diş çürüğü prevalansinin değerlendirilmesi. Yeditepe Üniversitesi Diş Hekimliği Fakültesi Dergisi, 15 (2): 219-223 (in Turkish).

Rodvang, S. J., Simpkins, W. W. (2001). Agricultural contaminants in quaternary aquitards: A review of occurrence and fate in North America. Hydrogeology Journal, 9 (1): 44-59. Doi: 10.1007/s100400000114

Tokatlı, C. 2014. Drinking water quality of a rice land in turkey by a statistical and GIS perspective: Ipsala District. Polish Journal of Environmental Studies, 23 (6): 2247-2258. Doi: 10.15244/pjoes/26967

Tokatlı, C. (2017). Bio – ecological and statistical risk assessment of toxic metals in sediments of a worldwide important wetland: Gala Lake National Park (Turkey). Archives of Environmental Protection, 43 (1): 34-47. Doi: 10.1515/aep-2017-0007

Tokatlı, C. (2018). Drinking water quality assessment in villages located in Meriç River Basin (Edirne, Turkey). Sigma Journal of Engineering and Natural Sciences, 36 (3): 871-886.

Tokatlı, C., Çiçek, A., Köse, E. (2013). Groundwater quality of Türkmen Mountain (Turkey). Polish Journal of Environmental Studies, 22 (4): 1197-1208.

Tokatlı, C., Güner, Ş. (2018). Fluorine accumulations in drinking water of Havsa District (Edirne, Turkey) and assessment of water quality in terms of teeth health. Sigma Journal of Engineering and Natural Sciences, 36 (3): 887-894.

Tokatlı, C., Köse, E., Çiçek, A. (2014). Assessment of the effects of large borate deposits on surface water quality by multi statistical approaches: A case study of the Seydisuyu Stream (Turkey). Polish Journal of Environmental Studies, 23 (5): 1741-1751.

TS 266. (2005). Sular-İnsani tüketim amaçlı sular. Türk Standartları Enstitüsü, ICS 13.060.20.

Ustaoğlu, F., Tepe, Y., Aydin, H., Akbaş, A. (2017). Investigation of water quality and pollution level of lower Melet River, Ordu, Turkey. Alınteri Journal of Agricultural Sciences, 32(1): 69-79. Doi: 10.28955/alinterizbd.319403

WHO (World Health Organization) (2011a). Nitrate and Nitrite in Drinking-Water. WHO/SDE/WSH/07.01/16/Rev/1.

WHO (World Health Organization) (2011b). Guidelines for Drinking-water Quality. World Health Organization Library Cataloguing-in-Publication Data, NLM classification: WA 675.