

SEASONAL VARIATION OF FLUORIDE ACCUMULATIONS IN ARTIFICIAL POND WATERS ON THE GELIBOLU PENINSULA (TÜRKİYE)

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Abstract

Fluoride has a special importance on especially dental health and high or low levels of fluoride in drinking water may cause dental problems. The Gelibolu Peninsula is located in the northwest part of the Anatolia has a great agricultural potential. There are 4 significant artificial ponds located in the Gelibolu Peninsula (GP) used for irrigation and drinking water supply. The aim of this research was to determine the fluoride accumulations in water of these artificial ponds and to assess the water quality in terms of dental health. Also, Cluster Analysis (CA) was applied to detected data in order to classify the stations in terms of fluoride contents. Water samples were taken from Fındıklı, Değirmendüzü, Tayfur and Uzunhızırlı Ponds during the dry season of 2022 and wet season of 2023 and the fluoride levels of investigated ponds were measured by using spectrophotometric method. The fluoride accumulations in water of artificial ponds of GP were varied from 0.173 – 1.720 ppm. As a result of applied CA, 2 statistically significant clusters were formed named as "Containing relatively higher fluoride zone (C1)" and "Containing relatively lower fluoride zone (C2)".

Keywords: Gelibolu Peninsula, Artificial ponds, Fluoride accumulation.

INTRODUCTION

Fluorine, which is one of the most chemically reactive and electronegative of all the elements, is an essential element. However, it may be toxic by directly inhalation and skin absorption or as a result of chronically high-fluoride diet. Fluoride may enter the human body through mainly drinking water, but foods, drugs and industrial exposure are also among the entryways of fluoride intake [1 – 6].

The Gelibolu Peninsula is located in the southern part of East Thrace, the European part of Türkiye, with the Aegean Sea to the west and the Çanakkale Strait to the east. The region has a significant agricultural potential and an agriculture-based economy dominates in the whole peninsula, in general. Also, as a result of the development of agricultural activities in the region, there are many industrial facilities engaged in agriculture-based production [7 – 10].

The aim of this research was to determine the seasonal variations of fluoride accumulations in water of 4 significant artificial ponds (Fındıklı, Değirmendüzü, Tayfur and Uzunhızırlı) located in the Gelibolu Peninsula (GP).

MATERIALS AND METHODS

1. Sample collection

In this research, 4 significant artificial ponds were selected located in the GP. The map of study area and selected stations (S1 – S4) are given in Figure 1.

Surface water samples were taken from Fındıklı (S1), Değirmendüzü (S2), Tayfur (S3) and Uzunhızırlı (S4) Ponds during the dry season of 2022 and wet season of 2023 by using pre – cleaned polyethylene bottles. Then, the samples were quickly transferred to the laboratory in a +4 °C vehicle fridge for the analysis.

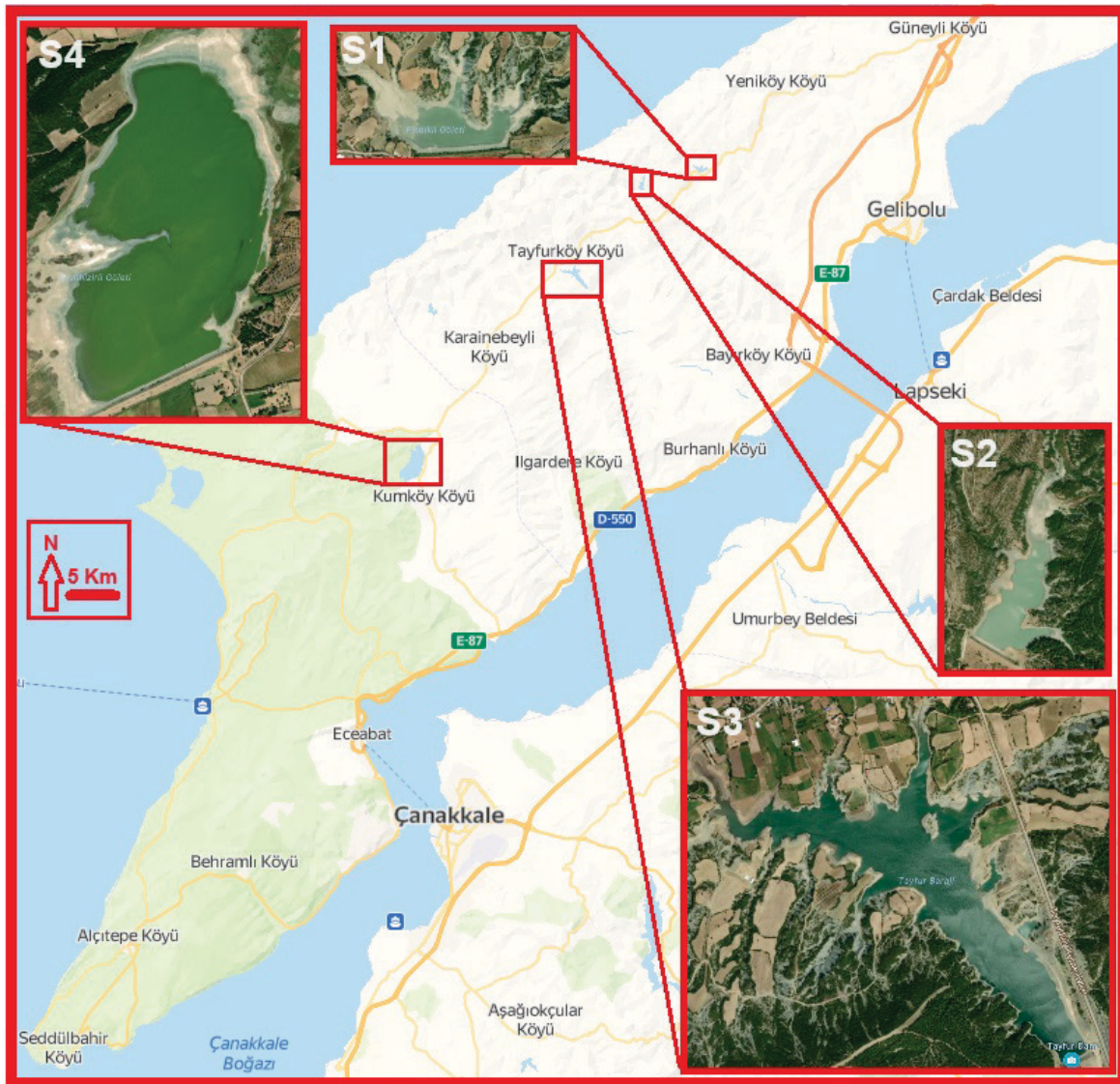


Fig. 1. Gelibolu Peninsula and selected artificial ponds

2. Measurement of fluoride

Fluoride parameter was measured by using Hach branded (DR 3900) Spectrophotometer Device during the laboratory studies.

3. Cluster Analysis

CA was applied to detected data by using PAST statistical packed program in order to classify the stations in terms of fluoride contents.

RESULT AND DISCUSSION

Seasonal variations of fluoride accumulations in water of investigated artificial ponds are given in Figure 2. According to detected data, fluoride 0.173

(S3) – 1.460 (S4) ppm with an average of 0.513 ppm in the dry season, while they were found between 0.242 (S2) – 1.720 (S4) ppm with an average of 0.638 ppm in the wet season. In general, it was also noted that fluoride values increased by approximately 24% in water of stagnant water bodies of GP during the wet season.

While the lowest fluoride values were recorded in Değirmendüzü Pond (S2 – seasonal mean of 0.217 ppm), the highest values were detected in Uzunhızırılı Pond (S4 – seasonal mean of 1.590 ppm).

According to the Turkish Surface Water Quality Regulation [11], It was determined that Uzunhızırılı Pond (S4) has 3rd class water quality (> 1.5 ppm), while the other investigated ponds (Fındıklı, Değirmendüzü

and Tayfur) have 1st class water quality (< 1 ppm) in terms of fluoride contents, in general. It was also noted that the fluoride contents in waters of ponds located in GP

did not exceed the limit value (1.5 ppm) reported by TS266 [12], EC [13] and WHO [14] for drinking water, except for the Uzunhızırılı Pond.

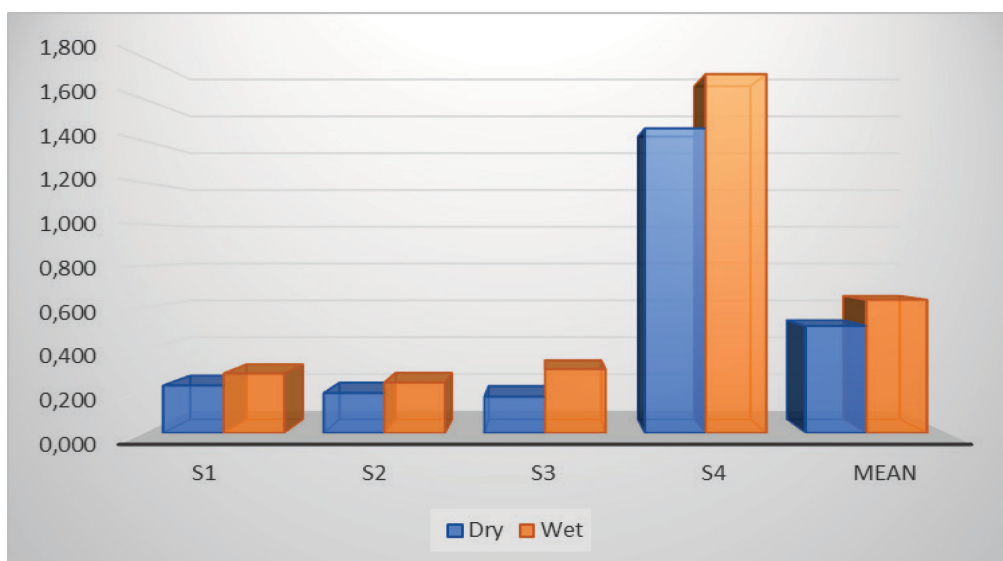


Fig. 2. Fluoride levels in water of GP ponds

When we compare our current study data with similar studies conducted in the drinking water and stagnant water habitats of Marmara Region of Türkiye, the mean fluoride contents detected in the water of artificial ponds of GP are generally higher than the data detected in the drinking water of Havsa, Enez, Süloğlu and İpsala Districts and also higher than the data detected in the water of natural, artificial and dam lakes of Thrace Region [15 – 18] (Table 1).

CA is widely used in water quality assessment research [19 – 23]. According to the results of applied CA, 2 statistically significant clusters were formed (Figure 3). Cluster 1 (C1) was named as "Containing relatively higher fluoride zone" that was corresponded to the station of S4 (Uzunhızırılı Pond). Cluster 2 (C2) was named as "Containing relatively lower fluoride zone" that was corresponded to the stations of S1 (Fındıklı Pond), S2 (Değirmendüzü Pond) and S3 (Tayfur Pond) (Table 1).

Table 1. Comparison of sulphate data

Habitat	Mean Fluoride Level (ppm)	Reference
Ponds of GP	0.576	Current study
Havsa District	0.185	[15]
Enez District	0.251	[16]
Süloğlu District	0.271	[17]
İpsala District	0.095	[17]
Natural Lakes of TR	0.382	[18]
Artificial Lakes of TR	0.276	[18]
Dam Lakes of TR	0.223	[18]

GP: Gelibolu Peninsula
TR: Thrace Region

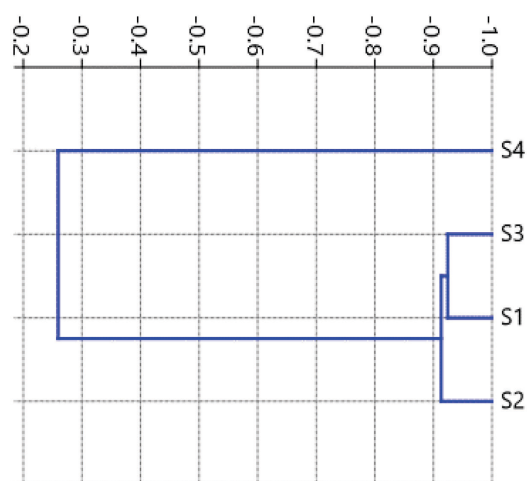


Fig. 3. CA dendrogram

Table 2. Similarity and distance indices results

	S1	S2	S3	S4
S1	1.00000			
S2	0.91640	1.00000		
S3	0.92432	0.91009	1.00000	
S4	0.27736	0.23969	0.26182	1.00000

CONCLUSION

Humans are being exposed to various sources of fluoride, such as water, food and use of excessive toothpaste in their daily life. The control of drinking water quality is one of the basic factors to protect the people against to overly uptake of this element by drinking.

In the current study, fluoride accumulations in water of 4 significant artificial ponds located in the GP were investigated.

As a result of this investigation, the fluoride accumulations in water of artificial ponds were varied from 0.173 – 1.720 ppm with an average of 0.576 ppm.

It was also noted that fluoride values increased by approximately 24% in water of lotic habitats of GP during the wet season.

The applied CA was classified the ponds as "Containing relatively higher fluoride zone – C1" and "Containing relatively lower fluoride zone – C2".

It has been also determined that the Fındıklı, Değirmendüzü and Tayfur Ponds located in the C2 cluster have 1st class water quality and did not exceed the drinking water limit in terms of fluoride levels, while the Uzunhızırılı Pond located in the C1 cluster has 3rd class water quality and exceeded the drinking water limit in terms of fluoride levels.

This study is also important as it shows the importance of permanent water quality monitoring studies to protect and ensure the sustainability of freshwater ecosystems.

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REFERENCE

- [1] 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. *Biol Trace Elem Res.*, 174 (1): 150-157.
- [2] 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 İçme Suyu Fluor Oranı Farklı 3 İlçesinde Dental Fluorosis Ve Diş Çürüğü Prevalansinin Değerlendirilmesi. *Yeditepe Üniversitesi Diş Hekimliği Fakültesi Dergisi*, 15 (2): 219-223.
- [3] Tokatlı, C., Güner, Ş., 2020. Fluoride Levels in Drinking Water and Assessment of Water Quality in terms of Teeth Health in a Significant Watershed in Thrace Region. *Acta Aquatica Turcica*, 16 (2): 238-245.
- [4] Varol, M., Tokatlı, C., 2023. Evaluation of the water quality of a highly polluted stream with water quality indices and health risk assessment methods. *Chemosphere*, 311: 137096.
- [5] Jannat, J. N., İslam, K. M. S., İslam, H. M. T., İslam, M. S., Khan, R., Bakar, S. M. A., Varol, M., Tokatlı, C., Chandra, P. S., İslam, A., İdris, A. M., Malafaia, G., Islam, A. R. T., 2022. Hydrochemical assessment of fluoride and nitrate in groundwater from east and west coasts of Bangladesh and India. *Journal of Cleaner Production*, <https://doi.org/10.1016/j.jclepro.2022.133675>.
- [6] Mia, Y., İslam, A. R. T., Jannat, J. N., Jion, M. M. F., Sarker, A., Tokatlı, C., Siddique, A. B., İbrahim, S. M., Senapathi, V., 2023. Identifying factors affecting irrigation metrics in the Haor Basin using integrated Shannon's entropy, fuzzy logic and automatic linear model. *Environmental Research*, 226: 115688.
- [7] Anonymous, 2021. Çanakkale Provincial Environmental Report for the Year 2021. Republic of Türkiye Çanakkale Governorship Provincial Directorate of Environment, Urbanization and Climate Change.
- [8] <https://www.gelibolu.bel.tr/>
- [9] <http://www.gelibolu.gov.tr/>
- [10] Tokatlı, C., Uğurluoğlu, A., Muhammad, S., 2023. Ecotoxicological evaluation of organic contamination in the world's two

- significant gateways to the black sea using GIS techniques: Turkish Straits. *Marine Pollution Bulletin*, 194: 115405.
- [11] TSWQR (Turkish Surface Water Quality Regulation), 2021. Turkish Surface Water Quality Regulation, Türkiye.
- [15] TS 266. 2005. Sular-İnsani tüketim amaçlı sular. Türk Standartları Enstitüsü, ICS 13.060.20 [In Turkish].
- [16] EC (European Communities), 2007. European Communities (drinking water) (no. 2), Regulations 2007, S.I. No. 278 of 2007.
- [14] WHO (World Health Organization), 2011. Guidelines for Drinking-water Quality. World Health Organization Library Cataloguing-in-Publication Data, NLM classification: WA 675.
- [15] 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.
- [16] Onur, Ş., G., Tokatlı, 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). *International Journal of Agriculture, Environment and Food Sciences*, 4 (2): 173-180.
- [17] Tokatlı, C., İslam, A. R. T., Güner, Ş. O., Ustaoglu, F., İslam, S., Dindar, M. B., 2022. A pioneering study on health risk assessment of fluoride in drinking water in Thrace Region of northwest Türkiye. *Groundwater for Sustainable Development*, <https://doi.org/10.1016/j.gsd.2022.100836>.
- [18] Tokatlı, C., Onur, Ş. G., Dindar, M. B., Malafaia, G., İslam, A. R. T., Muhammad, S., 2023. Spatial-temporal variability and probabilistic health risk assessment of fluoride from lentic ecosystem, Türkiye. *International Journal of Environmental Analytical Chemistry*, <https://doi.org/10.1080/03067319.2023.2198645>.
- [19] 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.
- [20] 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.
- [21] 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.
- [22] Tokatlı, C., 2020. Water quality assessment of Ergene River Basin using multivariate statistical analysis. *Journal of Limnology and Freshwater Fisheries Research*, 6 (1): 38-46.
- [23] Köse, E., Çiçek, A., Aksu, S., Tokatli, C., Emiroğlu, Ö., 2023. Spatio-temporal sediment quality risk assessment by using ecological and statistical indicators: a review of the upper Sakarya River, Türkiye. *Bulletin of Environmental Contamination and Toxicology*, 111: 38.