ECRONICON OPEN ACCESS

EC MICROBIOLOGY
Research Article

Monitoring the Change of Coliform Bacteria of Bedirkale, Boztepe and Almus Dam River in Tokat Province via Environmental Factors

Gokhan Onder Erguven[1]* and Ekrem Aydin[2]

[1]*Department of Chemistry and Chemical Processes, Tunceli Vocation School, Munzur University, Turkey*

[2]*Department of Environmental Engineering, Faculty of Engineering, Firat University, Elazig, Turkey*

***Corresponding Author:** Gokhan Onder Erguven, DDepartment of Chemistry and Chemical Processes, Tunceli Vocation School, Munzur University, Turkey.

Received: May 28, 2019; **Published:** September 30, 2019

Abstract

In this study, we aimed to find out the seasonal change of surface water for the coliform and *Escherichia* bacteria in the Bedirkale, Boztepe and Almus Dam River in Tokat province. Total and *Escherichia* coliform group of bacteria are identified as indicative microorganisms in the dam environment with multiple tube method. This monitoring study was carried out by sampling seasonal of 8 stations between Summer 2017 - Spring 2018. These selected sampling stations are determined as a result of previously performed scientific investigations. In addition to coliform group bacteriological analysis, for understand the effects of environmental factors to these group of bacteria; temperature, pH, dissolved oxygen, oxygen saturation, total dissolved solids, salinity, were measured with OTT-Hydrolab - Data Sonde 5 device. Additionally, secci disc and eutotrophic deep were measured. According to the results of the measurements, we found that water quality parameters effects coliform measurements negativity. As a result of the measurements, it is seen that coliform group of bacteria in surface waters of Boztepe stations, is increasing to other stations in every seasons especially in summer season.

Keywords: *Coliform Bacteria; Dissolved Oxygen; Secci Disc; Eutrophic Deep*

Introduction

Lake ecosystems are vital resources for aquatic wildlife and human needs, and any alteration of their environmental quality and water renewal rates has wide-ranging ecological and societal implicatio [1]. Frequently cited groups are from domestic waste. Approximately 20 - 30% of human waste is undigested food waste, with bacteria and wastewater and forming the remainder [2]. Nearly 1×10^{11} unit bacteria, including approximately 400 species, can be found in 1g of human pollution [3]. Recent studies demonstrated that water sources were mostly contaminated as a result of anthropogenic activities such as domestic waste in addition to natural factors such as rain water, substance transport with surface waters, atmospheric transport and plant pollens [4].

In environmental microbiology, coliform group of bacteria are generally used as indicators of water pollution in lake ecosystem. In 1885, Theodor Esherich concluded that Escherichia coli was not only present in very large quantities in human pollution, but was also associated with typhoid females. This is related with fecal contamination could be used as a pollutant indicator for water [5]. For nearly a century, coliform group of bacteria have been used as indicator organisms, first in evaluating water for fecal contamination [6].

Monitoring the water quality of a lake ecosystem is very important. Microbiological analysis of the study is ongoing, but initial results showed that limits in terms of these criteria were not satisfied at some points in the receiving environments. If scientists do not take necessary measures, urbanization and activities such as recreation around the lake will result I anthropological contamination [7].

Microorganisms require favorable environmental conditions, including sufficient water and nutrients, i.e. macro and micro nutrients such as nitrogen, carbon and some vitamins. Bacteria must maintain a cytoplasmic pH that is compatible with optimal functional and structural integrity of the cytoplasmic proteins that support growth. Most non-extremophilic bacteria grow over a broad range of external pH values, from 5.5 - 9.0 and maintain a cytoplasmic pH that lies within the narrow range of pH 7.4 - 7.8 [8].

A Taxonomic classification methodologies have improved over the last decades, it has become clear that coliform groups, as defined solely by the method used to detect them, are a more diverse and much broader group of bacteria [9].

This study aimed to determine the spatio-temporal variations of the water quality in the Bedirkale, Boztepe and Almus Dam Lake between Summer 2017 and Spring 2018 selected the fecal coliform group as an indicator for microbiological pollution.

Materials and Methods

Study area and sampling stations

Bedirkale, Boztepe and Almus Dam lakes are located in the Tokat province located at Blacksea region of Turkey (Figure 1). Geographical location of Almus dam lake is 40, 24, 27N, 36, 54, 13E (Figure 2). Bedirkale Dam Lake is 40 2 27 North, 36, 27, 28 East (Figure 3) while Boztepe dam lake is located at 40, 17, 54 N,35, 86, 42E (Figure 4).

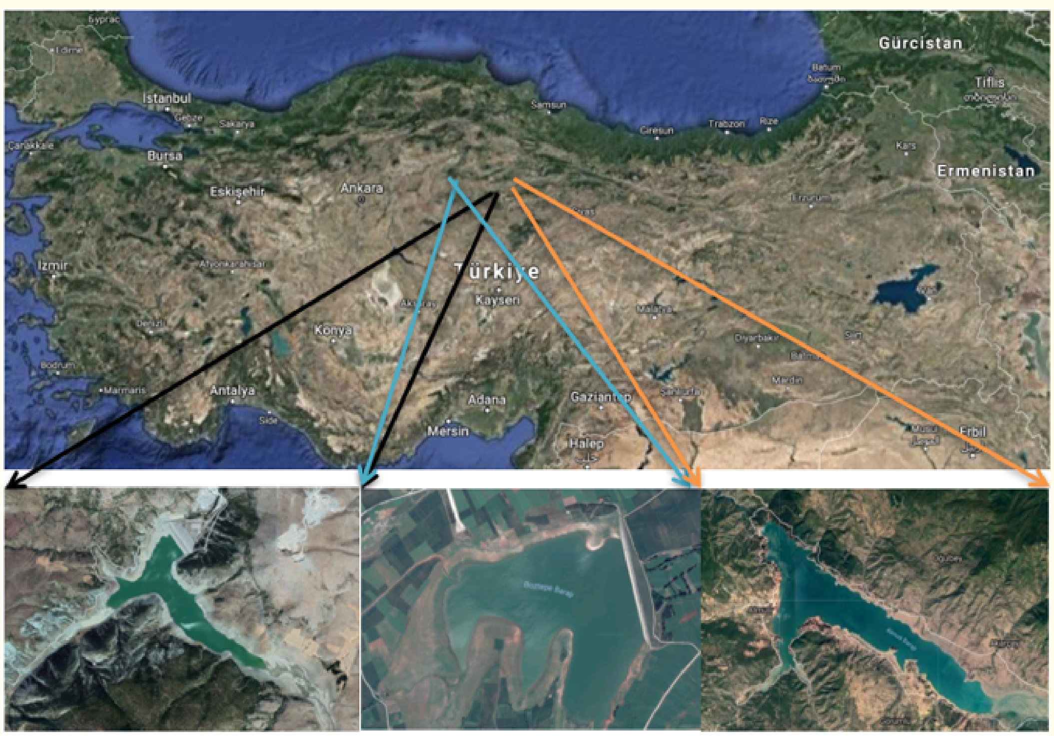

Figure 1: *Studied lakes.*

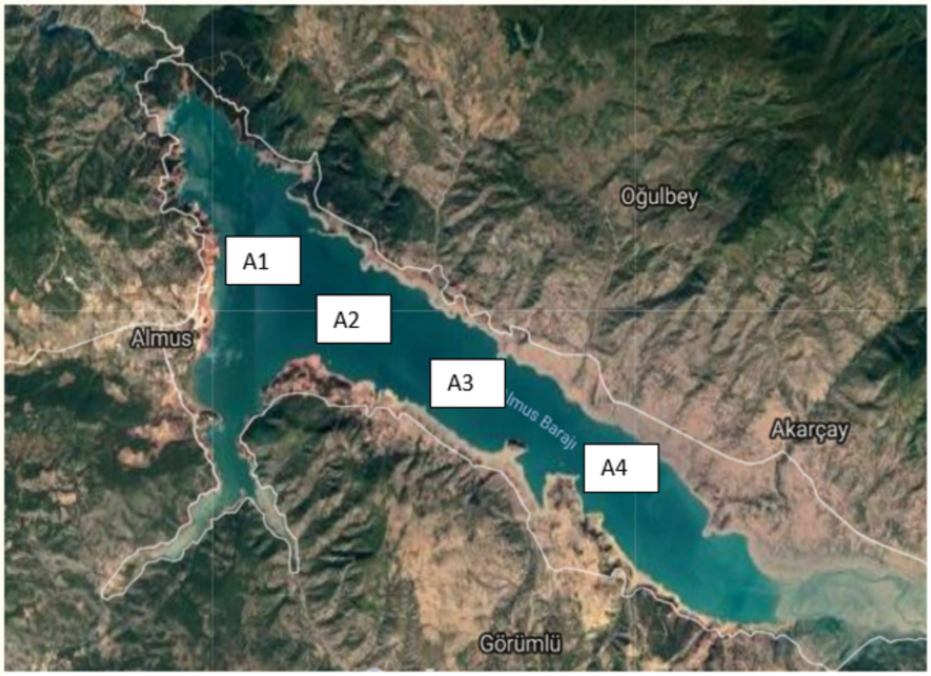

Figure 2: *Sampling stations of the Almus dam lake.*

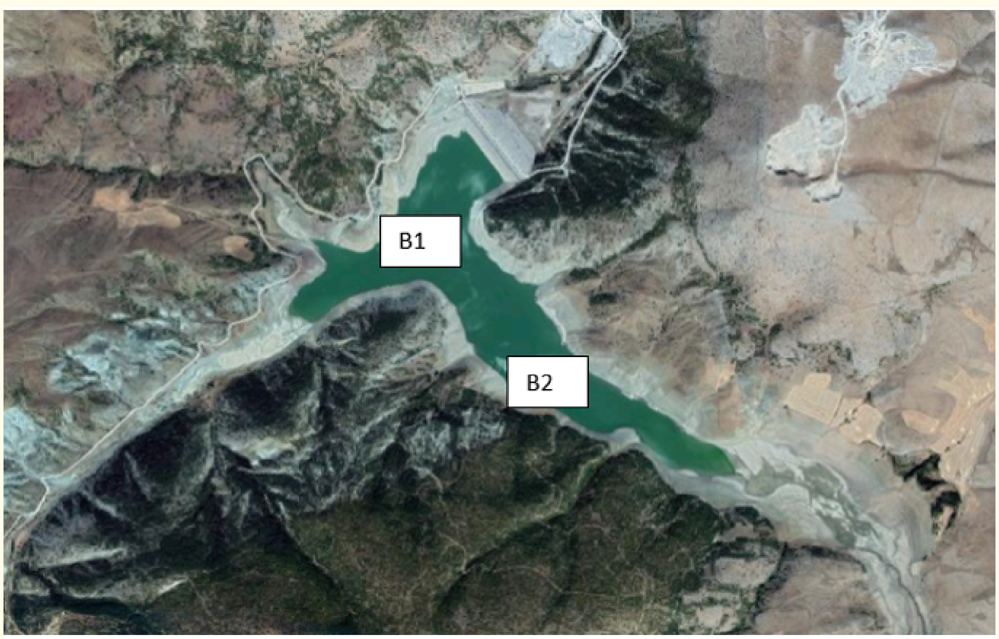

Figure 3: *Sampling stations of the Bedirkale dam lake.*

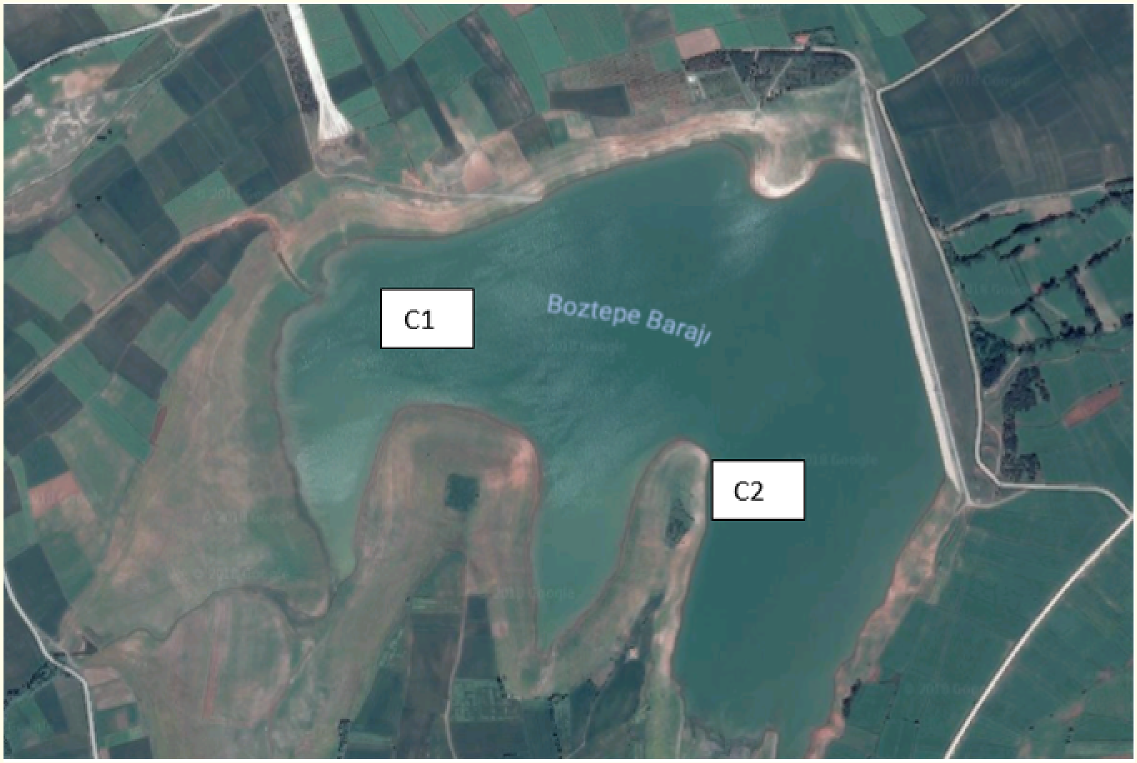

Figure 4: *Sampling stations of the Boztepe dam lake.*

Water samplings were performed from the 11 stations in the second week of every month throughout the study period.

Lake water sampling and analyses

Lake water samples were taken from surface water (0.2m) using a surface sampler device and then transferred into a sterile amber bottle. They were directly placed into ice cordless thermos. Dissolved oxygen (DO), temperature, pH and salinity measurements were taken simultaneously at the sampling site using a multi-parameter probe (Multi 350i/SET WTW), and water transparency was measured using a Secchi disc.

The lake water samples were brought to the laboratory in the iced thermos and analyzed. Coliform bacteria were determined using a Standard method: Multiple Tube Fermentation Technique (SM 9221B) (APHA, 2005). This fermentation technique is a three-stage procedure in which the results are statistically expressed in terms of the Most Probable Number (MPN). These stages are; the presumptive stage, confirmed stage, and completed test. For the analysis to be accurate, a five-tube test is used.

Results and Discussion

Variations in Temperature, pH, Dissolved Oxygen, Total Dissolved Solids, Conductivity, Secci disc, Euthophic depth, Total and Fecal coliform along the study area in all study periods are given in figure 5-8 respectively.

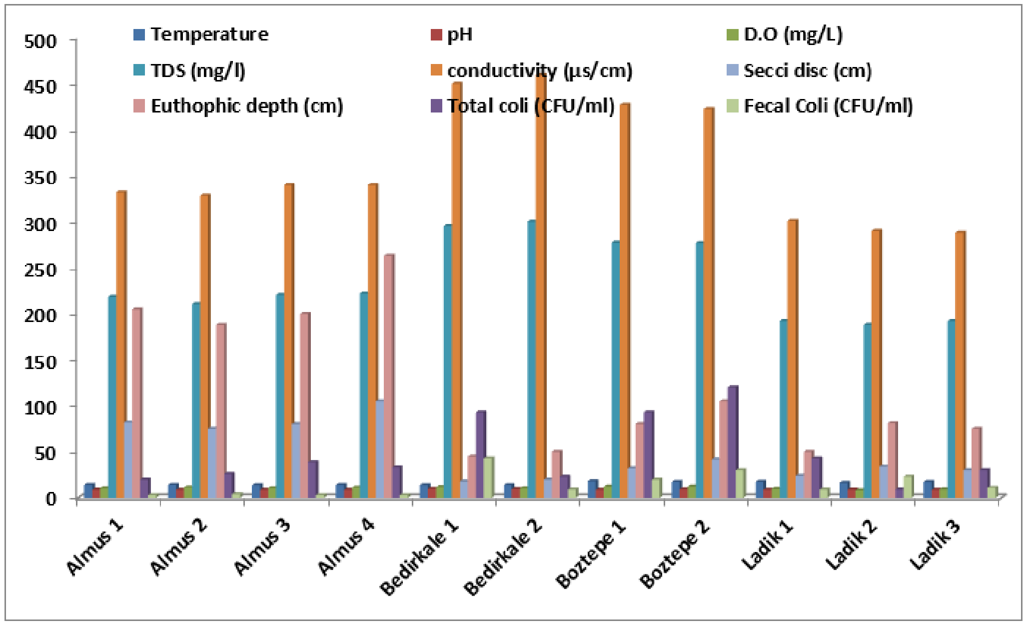

Figure 5: *Variations in Temperature, pH, Dissolved Oxygen, Total Dissolved Solids, Conductivity, Secci disc, Euthophic depth, Total and Fecal coliform along the study area in Spring period.*

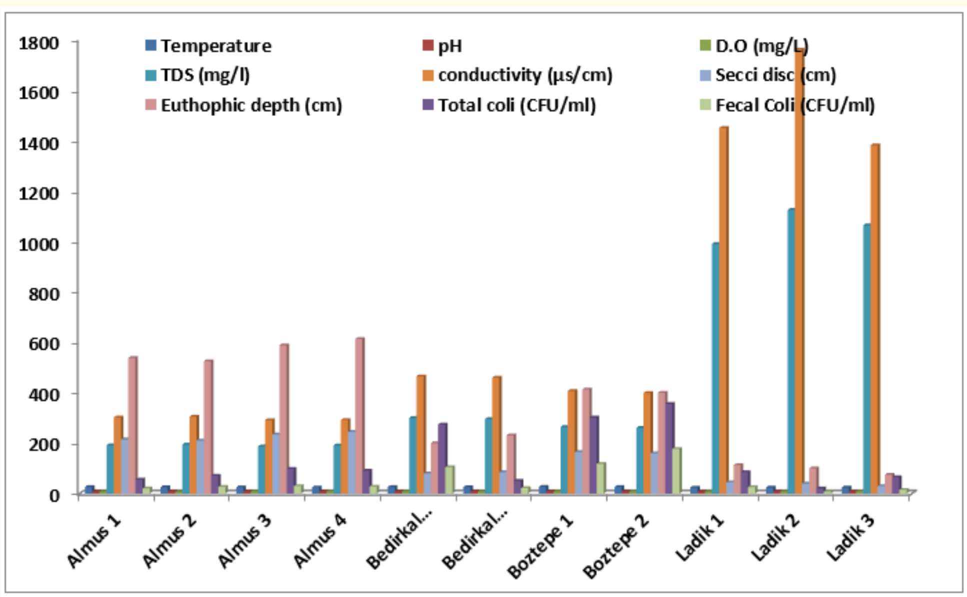

Figure 6: *Variations in Temperature, pH, Dissolved Oxygen, Total Dissolved Solids, Conductivity, Secci disc, Euthophic depth, Total and Fecal coliform along the study area in Summer period.*

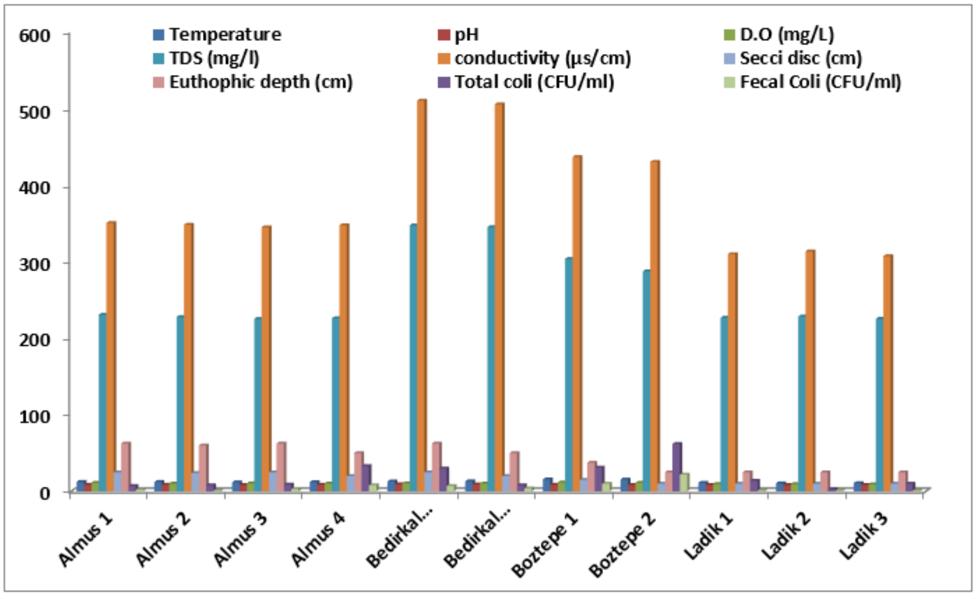

Figure 7: *Variations in Temperature, pH, Dissolved Oxygen, Total Dissolved Solids, Conductivity, Secci disc, Euthophic depth, Total and Fecal coliform along the study area in Autumn period.*

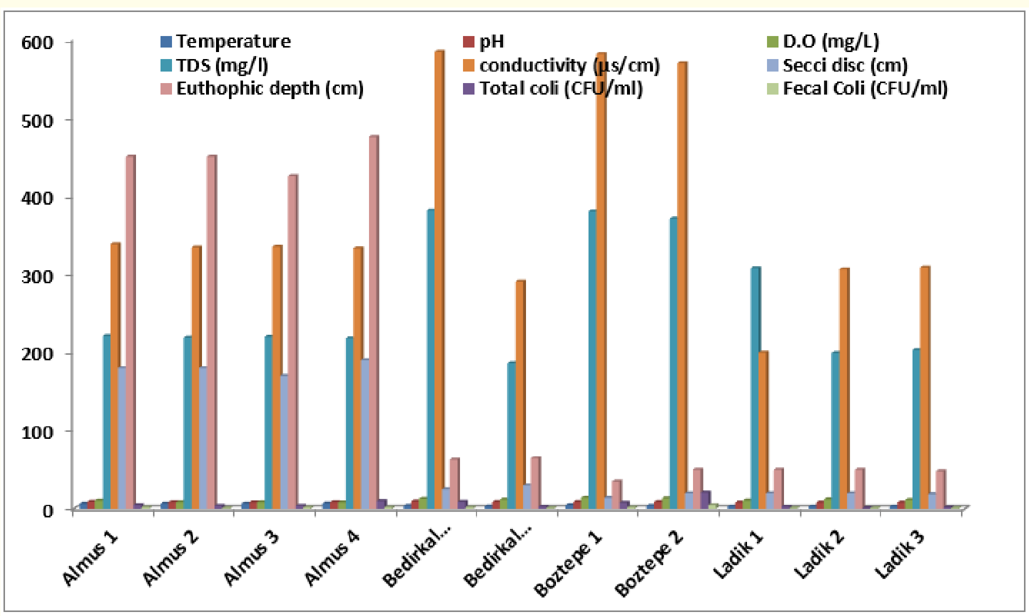

Figure 8: *Variations in Temperature, pH, Dissolved Oxygen, Total Dissolved Solids, Conductivity, Secci disc, Euthophic depth, Total and Fecal coliform along the study area in Winter period.*

Temperature

The surface water temperature in the study area was the highest (27.2°C) in June at Boztepe 1 and the lowest in January (3.1°C) at Ladik 1 and Ladik 2 stations. Short time effects of seasonal weather conditions were evident due to the surface water temperatures and weak water currents and at the same time intervals differed along the study area. The mean seasonal temperatures (3.1 to 27.2°C) showed that the upper is warmer in summer and spring than the lower lakes, while it is colder than the lower lakes in winter. Temperature values displayed strong seasonal variations in the study area. The effect of temperature on coliform groups was the highest in summer and spring when considered a significant positive correlation between temperature and coliform data.

Salinity

Salinity values in the study area decreased considerably from the summer to the winter seasons and it was the lowest (288 µs cm^{-1}) at the winter season of Ladik 3 station in January and the highest (1761 µs cm^{-1}) at the summer season of Ladik 2 station. Mean seasonal salinity values (288 µs cm^{-1} to 1761 µs cm^{-1}) showed that the salinity difference was the highest in winter and autumn. Salinity values are in relationship with varies with wind, currents, evaporation and also precipitation. The lowest salinity values were observed in winter, probably due to high precipitation.

In a previous study, Aslan., *et al.* (2004) reported that during the periods of low salinity, fecal coliform values increased [11]. According the study performed by Aslan-Yılmaz., *et al.* (2004), the results of our study on negative correlation between salinity and coliform groups is consistent. No correlation between coliform and salinity values in summer and spring coincided with higher salinity values at these periods.

Secchi depth

Secchi depth decreased due to high concentration of suspended solids. Mean Secchi depth was the lowest (0.1m) in autumn at the Boztepe and Ladik stations and the highest (2.5m) in summer at the Almus 4 station. Natural factors (water currents, suspended solids, rainfall, etc.) affecting Secchi depth measurements have more effect at the Boztepe and Ladik stations vary with suspended solids. Another important factor that maximizes this effect is the topography of the study area.

Coliform values are quite high at all Almus stations, probably due to high suspended particulate matters (SPM) and other pollutants. Water deposition was higher at the study area during autumn and winter, due to precipitation. Secchi depth were strong negatively correlated with coliform groups during the study periods. High coliform values in surface water were found generally at the Boztepe stations in summer, where Secchi depths were lower for this station. Deteriorating water quality particularly may cause to the increase in coliform values.

Dissolved oxygen and pH

DO concentrations decreased generally from the lower to the upper section as it was Secchi depths and salinity (Figure 6). DO concentrations varied between 7.2 mg L^{-1} (Almus 2, summer) and 14.1 mg L^{-1} (Boztepe 1, winter). These values in each stations tended to rising during winter and spring, while they decreased during summer and autumn. In general, salinity and DO values will be higher when the lake waters enter the interior of the lake with the effect of the southerly winds. Furthermore, an increasing trend in DO values was followed in the winter season. DO values in winter season was found high.

DO values were negatively correlated with coliform groups during summer and autumn. The regions with very low DO values depending on water pollution caused to the high coliform values in the study area. Coliform values increased particularly at the stations with low DO. Our results are similar to the results reported by Aslan-Yılmaz., *et al.* (2004). Aslan., *et al.* (2004) suggested that decreasing values in fecal coliform were detected during high DO concentrations.

pH values varied between 8.1 (Almus 1 Station) in Summer and 9.9 (Bedirkale 1 Station) in Spring during the study period. pH values displayed a strong seasonal variations in the study area. This shows the effect of the rain in winter on the low pH particularly at the upper section. In summer and autumn, pH values were negatively correlated with total coliform and fecal coliform. According to Aslan-Yılmaz., *et al.* (2004) increasing values in fecal coliform were observed during periods of low pH. It is revealed that high coliform values were mostly observed at the area with lower pH.

Total and fecal coliforms

The distribution of total and fecal coliforms in the study period differed among the stations and seasons and the highest coliform values were detected in autumn (Figure 6). The highest total coliform value in surface water was 356 CFU ml^{-1} at the Boztepe 2 station in summer season, while fecal coliform was 1,77 CFU ml^{-1}. The lowest total coliform was 1 CFU/ml at the Ladik 2 station and the lowest fecal coliform was 1 CFU/ml at the Almus 2 station in autumn, Ladik station in Atumn, Almus 2, Bedirkale 2, Ladik stations in winter. The reason of higher total coliform values in Summer is probably due to a lake effluent discharge (Figure 6).

Clear domestic wastewater contains about 10^5 - 10^6 total and 10^4 - 10^5 fecal coliform bacteria [12]. This means, the ratio between them ranges from 10^{-1} - 10^{-2} (Fecal coliform/Total coliform). This is confirmed by when salinity value increased, total and fecal coliform increases. But in at some stations, this is not confirmed. The highest salinity of 1761 µs cm^{-1} seen at Ladik 2 station in summer period and total and fecal coliform amounts were 21 and 8 CFU ml^{-1}. The highest total coliform was 356 CFU ml^{-1} at the Boztepe 2 station in Summer with salinity value of 399 µs cm^{-1}. This shows that the surface water was considerably diluted by wastewater, particularly when total coliform count was high. The total and fecal coliform values confirms that there is significant domestic pollution (comes from animals) but this situation does not affect salinity. Total coliform at all stations from 1 to 356 CFU ml^{-1} in all seasons, whereas fecal coliform 1 to 177 CFU ml^{-1}. The increase in total number of all type of coliforms presents in the receiving environment. Fecal coliform in lakes depends on bacterial loading from pollutants, in receiving waters, and bacterial losses due to death [13].

Conclusion

Water quality is of substantial importance for water uses. Pollution of water sources like lakes is important in terms of individual and community health. The previous studies on the bacteriological pollution have been showed that the total and fecal coliform values were high when the Tokat district was an extremely polluted area. In the earlier study was reported that there was a strong relationship between the bacteriological data and the water pollution, indicating drastically decreased coliform values after recovery of water. Some rehabilitation activities were conducted to solve the pollution problems in the lake ecosystem. Improving the water quality via preventing the pollution could affect the nature of the reservoir basin but it is need to continuously monitor the ecological balance of the lake ecosystem, which is important for fisheries, drinking water and recreation facilities in the receiving environment. Additionally, coliform values still significantly decreases in rainy periods, probably due the dilution coming from the rainy weathers in autumn and winter period. The results of our study showed that the bacteriological pollution increased due to grazing activities. Thus, the most important factor in order to decrease the bacteriological pollution is to provide a full control of the grazing activities.

Bibliography

1. Vincent WF. "Effects of climate change on lakes". In Encyclopedia of Inland Waters (Ed. G.E. Likens) 3 (2009): 55-60.
2. Ormerod K., *et al*. "Bacteriological Examination". MJ Suess Ed., Pergamon Press, Oxford (1982).
3. Moore WEC., *et al*. "Human Fecal Flora: The Normal Flora of 20 Japanese - Hawaiians". *Applied Microbiology* 27.5 (1974): 961-979.
4. Samian M., *et al*. "Identifying Factors Affecting Optimal Management of Agricultural Water". *Journal of The Saudi Society of Agricultural Sciences* 14.1 (2015): 11-18.

5. Dufour AP., *et al*. "Membrane Filter Method For Enumerating Escherichia Coli". *Applied and Environmental Microbiology* 41.5 (1981): 1152-1158.

6. Tortorello M. "Indicator organisms for safety and quality-uses and methods for detection: minireview". *Journal of AOAC International* 86.6 (2003): 1208-1217.

7. Bayhan H., *et al*. "The assessment of water quality in Omerli Dam Reservoir, Istanbul, Turkey". *Fresenius Environmental Bulletin* 26.1 (2017): 977-978.

8. Padan E., *et al*. "The proton electrochemical gradient in Escherichia coli cells". *European Journal of Biochemistry* 63.2 (1976): 533-541.

9. Leclerc H., *et al*. "Advances in the bacteriology of the coliform group: their suitability as markers of microbial water safety". *Annual Review of Microbiology* 55 (2001): 201-234.

10. APHA-AWWA-WEF. "Standard Methods for the Examination of Water and Wastewater". 21st edition, American Public Health Association, Washington (2005).

11. Aslan-Yılmaz A., *et al*. "Bacteriological indicators of anthropogenic impact prior to and during the recovery of water quality in an extremely polluted estuary, Golden Horn, Turkey". *Marine Pollution Bulletin* 49.11-12 (2004): 951-958.

12. Metcalf and Eddy. "Wastewater Engineering". 2nd edition, Revised By G Tchobanoglous, Mcgraw-Hill Book Company New York (1991).

13. Mancini JL. "Numerical Estimates of Coliform Mortality Rates Under Various Conditions". *Journal of the Water Pollution Control Federation* 50.11 (1978): 2477-2480.

Volume 8 Issue 10 October 2019