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Original Article

# Chemical and microbiological properties of Lake Aygır in Turkey and usage of drinking, fisheries, and irrigation

## Propriedades químicas e microbiológicas do lago Aygır na Turquia e uso de bebidas, pescarias e irrigação

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**Abstract**

Since water is one of the essentials for life, the presence and quality of water in the habitat is extremely important. Therefore, water quality change and management of Lake Aygır was investigated in this study. For this, water samples collected from the lake and the irrigation pool between May 2015 and May 2016 were analyzed monthly. Spectrophotometric, titrimetric and microbiological methods were used to determine the water quality. According to some water quality regulations, $HCO_3$, $NH_4$, Cu, Mo, Br, fecal coliform and total suspended solid (TSS) values were found above the limit values. The other 29 parameters comply with Turkish national and international legislations. Lake Aygır was negatively affected by the surrounding settlements and agricultural activities. It is thought that the water resource should be monitored periodically and remedial studies should be done to prevent parameters exceeding the limits. However, Lake Aygır was generally suitable for drinking, use, fishing and irrigation.

**Keywords:** heavy metal, lake Aygır, water quality, water pollution, water resources.

**Resumo**

Como a água é um dos elementos essenciais para a vida, a presença e a qualidade da água no habitat são extremamente importantes. Portanto, a mudança da qualidade da água e a gestão do lago Aygır foram investigadas neste estudo. Para isso, amostras de água coletadas no lago e na piscina de irrigação entre maio de 2015 e maio de 2016 foram analisadas mensalmente. Métodos espectrofotométricos, titulométricos e microbiológicos foram usados para determinar a qualidade da água. De acordo com alguns regulamentos de qualidade da água, os valores de $HCO_3$, $NH_4$, Cu, Mo, Br, coliformes fecais e total sólido suspenso (TSS) foram encontrados acima dos valores limite. Os outros 29 parâmetros estão em conformidade com as legislações nacionais e internacionais turcas. O lago Aygır foi afetado negativamente pelos assentamentos e atividades agrícolas ao redor. Pensa-se que o recurso hídrico deve ser monitorado periodicamente e estudos corretivos devem ser feitos para evitar que os parâmetros ultrapassem os limites. No entanto, o lago Aygır era geralmente adequado para beber, usar, pescar e irrigar.

**Palavras-chave:** metal pesado, lago Aygır, qualidade da água, poluição da água, recursos hídricos.

## 1. Introduction

Water is a fundamental necessity and critical component for the socio-economic growth of any country. Because water is mainly used in drinking water, agricultural activities, fishing activities, energy production, tourism, navigation and recreation. However, the disproportionate amount of some water quality parameters and microorganisms can harm water quality as well as cause problems for the health of fauna, flora and human beings (Çetinkaya, 2003; Achieng et al., 2014; Nagamani et al., 2015). Besides, water scarcity has become an unpleasant reality in many parts of the world (Taloor et al., 2020). In Turkey, annual per capita water amount is 1519 $m^3$/year. It is estimated that water problems will be difficult to solve after 25-30 years if necessary measures are not taken such as preserving the current state of water resources, preventing their pollution and ensuring the best use of them (Akin and Akin, 2007; Turkey, 2017; Birici et al., 2017; Şen, 2017). Today, the world's waters are at risk of pollution and destruction. Domestic, agricultural, industrial and tourism wastes, climate changes resulting from global warming and drought trigger this result. As a result of these negative factors, clean water resources are rapidly decreasing (Küçük, 2007). The rapid consumption of fresh water resources, the change of quality and the pollution have attracted attention to the water. In order to ensure a wide range of the usable of quality and clean water resources, the water resources should be managed very well (Girgin et al., 2004). In order for a water resource to

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be used for its intended purposes, it should be monitored periodically. A monitoring program managed to fully evaluate the data provides very useful information for environmental management (Ünlü et al., 2008).

Lake Aygır is supplied to Aydınlar Town as drinking water, to farmer as aquaculture and irrigation water (Çavuş and Şen, 2020a, b). Furthermore, Lake Aygır is a natural beauty and touristic attraction center in itself (Köşker, 2001). The lake is suitable for swimming, water sports, angling, camping and picnics (Köşker and Kahyaoğlu, 2015). In this study, the water quality of Lake Aygır, which is used for drinking and utility water, animal drinking water, agricultural irrigation, fishing and recreation purposes, was investigated.

## 2. Material and Methods

Lake Aygır is a maar lake located on the southern slopes of Suphan Mountain, which is the third highest mountain in Anatolia. Lake Aygır, connected to Adilcevaz district of Bitlis, is at an altitude of 1938 m and has an area of 1.4 km$^2$ (Özgülbaş, 2011; Çavuş, 2018). The sampling points in the Lake Aygır were shown in Figure 1 and Table 1.

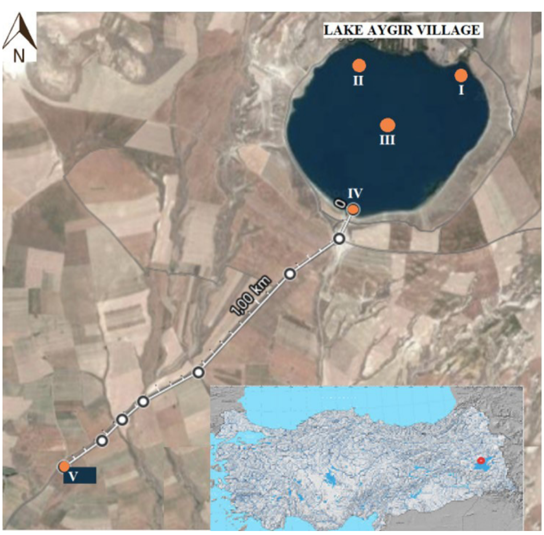


**Figure 1.** Sample stations; I: Near trout cages, II: Across to village, III: Center of the lake, IV: Drainage of the lake, V: Irrigation pond.

Studies were carried out in monthly between May 2015 and May 2016. A boat and a gasoline engine were used in transportation to sampling points. Water samples were taken from the surface (0 m), 15 m depth and lake bottom with a Nansen bottle. The water in the Nansen bottle was filled and stored in sample bottles. The bottles were filled with sampling water several times and were tightly closed in an airtight manner. The bottles were brought in thermos containers in order not to break the cold chain. They were stored at +4 ° C refrigerator conditions in Van YYÜ Faculty of Fisheries Water Pollution and Quality Laboratory.

To determine the quality of water samples, Cl and salinity by Mohr-Knudsen method, Ca, Mg, total hardness by EDTA method, $CO_3$, $HCO_3$, total alkalinity by HCI titration method were analyzed with titrimetric analysis solutions (Greenberg et al., 1992). TSS, Al, Cr, CN, $NH_4$, $NH_3$, $NH_3$–N, $NO_2$, $NO_2$–N, $NO_3$, $NO_3$–N, $SO_4$, o-$PO_4$, K, Zn, Cu, F, Mn, Ag, B, Ni, Co, Br, I, Mo, Fe, Si, $SiO_2$, COD parameters were analyzed with a UV spectrophotometer. Biological oxygen demand (BOD) were analyzed for 5 days at 20 °C. Chemical oxygen demand (COD) were analyzed using a thermoreactor and the UV spectrophotometer (HACH, 2010). The water was transferred to the ICP-OES spectrometer for As and Cd analysis; ICP-MS spectrometer for B analysis; AAS spectrometer for Na analysis (Morales-Rubio and De la Guardia, 1999; Hill et al., 1995; Kmiecik et al., 2016; Thompson and Wood, 1982). Fecal coliform were determined using a membrane filter set (TSE, 2014; Tekbaş and Oğur, 2005; Sartonet, 2015).

The data obtained at the end of the study were compared with the regulations and standards as Greenberg et al. (1992), FR (Turkey, 1995), TS 266 (TSE, 1997), WHO, UK, EEC (Tebbutt, 1998), USEPA (1999), Çetinkaya (2003), WPCR (Turkey, 2004), WHCR (Turkey, 2005), Egemen (2006), Emre and Kürüm (2007). They were analyzed from the perspectives of fishing, drinking, use and irrigation. Mean values and standard errors were made using Microsoft Excel 2007 program (Yildiz et al., 2011).

Formulas of magnesium hazard (MH), sodium percentage (Na%), sodium absorption ratio (SAR), residual sodium carbonate (RSC), permeability index (PI) were also used in the evaluation of water quality (Eaton, 1950; Richards, 1954; Prasanth et al., 2012; Domenico and Schwartz, 1990). For this Ca, Mg, CO3, HCO3, Na and K ion species were expressed in meq.L$^{-1}$.

**Table 1.** Sampling points information geographically.

| | Coordinates | | Depth | Distances from shore | Vertical sampling | Explanation |
|---|---|---|---|---|---|---|
| | North | East | | | | |
| I. station | 38° 50′ 18.00″ | 42° 49′ 29.7″ | 30 m | ≈~61 m | Surface, pelagic, bottom | Near trout cages |
| II. station | 38° 50′ 28.56″ | 42° 49′ 14.82″ | 30 m | 145 m | Surface, bottom | Across to village |
| III. station | 38° 50′ 6.66″ | 42° 50′ 22.92″ | 40 m | 500 m | Surface, pelagic, bottom | Center of the lake |
| IV. station | 38° 49′ 54.36″ | 42° 49′ 10.98″ | 3-7 m | 40 m | Surface, bottom | Drainage of the lake |
| V. station | 38° 49′ 18.12″ | 42° 50′ 11.7″ | - | 2910 m | Surface | Irrigation pond |

## 3. Results

The alkalinity of water is calculated by determining the amount of $CO_3$, $HCO_3$ and hydroxide anions (Çetinkaya, 2003; Gray, 2015a). In the measurements made in Lake Aygır, the average $CO_3$ value was 9.8 ± 0.9 mg.L$^{-1}$, the $HCO_3$ value was 256.9 ± 5.0 mg.L$^{-1}$ and the total alkalinity value was 235.1 ± 2.9 mg.L$^{-1}$ (Table 2).

$NH_3$, which is formed by the degradation of organic substances by microbiological activities, enters the body of aquatic creatures and has a toxic effect (Çetinkaya, 2003; Atabey, 2015). The values of $NH_4$, $NH_3$, and $NH_3$-N were determined as 0.06 ± 0.00 mg.L$^{-1}$, 0.52 ± 0.05 mg.L$^{-1}$ and 0.44 ± 0.05 mg.L $^{-1}$, respectively, in this study (Table 2).

Cu plays a role in immune system, red blood cell production, hair color gain, metabolic activities, and functions as a cofactor in many enzymes. Cu mixes with various water resources through agriculture and industry and poses a threat to the living creatures in these areas (Atabey, 2015). The average Cu value in Lake Aygır was determined as 3.72 ± 0.22 µg.L$^{-1}$ (Table 2).

Mo, which is naturally found in nature and is one of the essential elements, creates toxic effects when 100 mg.kg$^{-1}$ is taken into the body, and it can cause anemia, diarrhea and uric acid accumulation in the blood (Gray, 2015b). The average Mo value in Lake Aygır was determined as 1.69 ± 0.04 mg.L$^{-1}$ (Table 3).

Br has many side effects. These can be listed as psychiatric illnesses, difficulty speaking, feeling weak and over-sleeping (Atabey, 2018). Br, which is present in trace amounts in natural waters, is found at higher levels in salty waters and thermal waters (Güneş, 2016). The average Br value of Lake Aygır was 97.2 µg.L$^{-1}$ (Table 3).

Determining whether water resources are exposed to fecal contamination indicates whether the water is hygienically safe (Sartonet, 2015). The highest number of fecal coliforms belonging to Lake Aygır was 8 cfu.100 mL$^{-1}$ in the IV. station were determined (Table 3).

TSS adversely affects the sensory organs of fish and damages the mucus layer. TSS causes the death of benthic creatures living in the bottom, the development of fish eggs and larvae, the reproduction of fish, and prevents the plants from performing photosynthesis by reducing their light transmittance (Göksu, 2003). The average TSS value in Lake Aygır had been determined as 3.8 ± 0.5 mg.L$^{-1}$ (Table 3).

A magnesium ratio of more than 50 meq.L$^{-1}$ is considered to be harmful; therefore, such waters are unsuitable for drinking and irrigation purposes. In this study, MH ranged between 0.47 and 0.61. Water from sampling points had not MH values greater than 50 meq.L$^{-1}$ therefore suitable for agricultural practices. Also, suitability for irrigation based on Na% had excellent with mean 16.77. Lake Aygır was included in $C_2$-$S_1$ class from the graph of irrigation water classification with SAR 0.5736 and electrical conductivity 353.1 µS/cm (Çavuş and Şen, 2020a). Lake Aygır as an irrigation water was in the class of medium salty waters ($C_2$), and in the class of waters with less sodium ($S_1$) damages.

The RSC value is positive (+) means that there is still some carbonate + bicarbonate in the environment except ($CO_3^{=}$+$HCO_3^{-}$) which is combined with ($Ca^{+2}$+$Mg^{+2}$). These ions can combine with $Na^+$ to form sodium bicarbonate ($NaHCO_3$). In other words, there is a potential carbonate and bicarbonate ion in the environment that can cause sodium damage. If the equation is negative (-), it means that there is no possibility of sodium damage in the environment (Eaton, 1950; Richards, 1954). In this study, RSC values between -2.3 and -0.8 meq.L$^{-1}$ show that the lake water is suitable for irrigation. Besides, the water of Lake Aygır were categorized as good (Class II) for irrigation with 45% permeability index (Doneen, 1964).

## 4. Discussion

$HCO_3$ value was found above the value recommended in WHO (Tebbutt, 1998). While the alkalinity, which has a buffering effect in the waters, was required to be between 10-400 mg.L$^{-1}$ in trout farming, it was below the limit value in our study (Table 2; TSE, 1997; Emre and Kürüm, 2007). The $HCO_3$ values in the studies carried out in the Lake Van basin and other basins is given in Table 4.

According to Turkish standards and WHO standards, $NH_4$ values are suitable. While the water samples were in A2 class according to EEC in terms of average $NH_4$, they were slightly above the limit value given in UK (0.5 mg.L $^{-1}$) (Turkey, 2004, 2005; TSE, 1997; Tebbutt 1998; Emre and Kürüm, 2007). The $NH_4$ values in the studies carried out in the Lake Van basin and other basins is given in Table 4.

Cu values comply with both Turkish and international standards. Only according to WHCR, it was above the limit value (TSE, 1997; Turkey, 2004, 2005; Tebbutt 1998).

According to WHO, Mo and Br exceeded the limit value (Tebbutt 1998). The Mo values in the studies carried out in the Lake Van basin and other basins is given in Table 4. The Br values were parallel to a study conducted in Lake Nazik (Güneş, 2016).

Lake Aygır water samples are in the I. water quality class in WPCR in point of FC (Turkey, 2004). WHCR was slightly above the limit values given in WHO and UK (0 cfu.100 mL$^{-1}$) (Tebbutt, 1998; Turkey, 2005). It is thought that the surrounding settlements or herds of animals grazing around the lake are effective in finding fecal coliforms. The fecal coliform numbers in the studies carried out in the Lake Van basin and other basins is given in Table 4.

TSS was suitable according to TS 266 (TSE, 1997). TSS value has been found to comply with the standards in A3 class according to EEC (Tebbutt, 1998). Bayram (2011) stated that the TSS limit values for natural protection areas and recreation and various uses are 5 and 15 mg.L$^{-1}$, Birtwell (1999) stated that very low risk occurs at TSS levels below 25 mg.L$^{-1}$ for aquatic organisms, 25-100 mg.L$^{-1}$ SSM low risk, 100-200 mg.L$^{-1}$ TSS acceptable risk, 200-400 mg.L$^{-1}$ SSM high risk and 400 mg.L$^{-1}$ ' reported that there is an unacceptable risk in TSS above. The TSS values in the studies carried out in the Lake Van basin and other basins is given in Table 4.

The average MEI value, lake fishing yield, was 10.3 ± 0.2 mg/L/m (Table 3). Acara (1992) measured the MEI values as 0.77, 1.08, 8.20, and 1.02 mg/L/m in the north, south, west and whole of the Kootenay Lake (Canada), respectively. MEI was reported in Şen (2001) as 16.92 mg/L/m, in Çevlik

**Table 2.** According to the sampling months, data from titrimetric and spektrophotometric laboratory analysis in Lake Aygır ($mg.L^{-1}$).

| Sampling | Cl | Salinity | Ca | Mg | $CaCO_3$ | $CO_3$ | $HCO_3$ | Alkalinity | $NO_3$ | $NO_3^-$-N | $NO_2$ | $NO_2$-N | $NH_4$ | $NH_3$ | $NH_3$-N | $PO_4$ | $SO_4$ | K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **months** | **$mg.L^{-1}$** | **(‰)** | **$mg.L^{-1}$** | **$mg.L^{-1}$** | **$mg.L^{-1}$** | **$mg.L^{-1}$** | **$mg.L^{-1}$** | **$mg.L^{-1}$** | **$mg.L^{-1}$** | **$mg.L^{-1}$** | **$\mu g.L^{-1}$** | **$\mu g.L^{-1}$** | **$\mu g.L^{-1}$** | **$\mu g.L^{-1}$** | **$\mu g.L^{-1}$** | **$\mu g.L^{-1}$** | **$mg.L^{-1}$** | **$mg.L^{-1}$** |
| **May 15** | 18.1 | 0.23 | 56.3 | 36.5 | 290.7 | 12.7 | 218.2 | 210.6 | 1.5 | 35.6 | 17.2 | 5.7 | 66.7 | 63.3 | 46.0 | 10.2 | 10.5 | 1.60 |
| **June 15** | 19.7 | 0.21 | 49.2 | 41.5 | 293.7 | 10.8 | 241.6 | 225.0 | 1.6 | 38.0 | 24.3 | 8.1 | 66.0 | 61.0 | 49.0 | 10.6 | 12.4 | 1.77 |
| **July 15** | 19.1 | 0.21 | 55.7 | 41.6 | 310.3 | 16.8 | 202.5 | 208.0 | 1.2 | 26.0 | 21.4 | 7.1 | 62.0 | 58.0 | 48.0 | 16.3 | 12.3 | 1.73 |
| **Aug. 15** | 18.6 | 0.21 | 55.4 | 40.7 | 306.0 | 13.2 | 263.5 | 249.0 | 0.9 | 20.0 | 13.9 | 4.6 | 65.0 | 53.0 | 25.0 | 22.8 | 11.2 | 1.54 |
| **Sept. 15** | 18.6 | 0.21 | 57.2 | 37.9 | 298.8 | 12.0 | 234.0 | 221.8 | 1.4 | 31.8 | 14.4 | 4.8 | 69.1 | 64.5 | 50.9 | 16.6 | 13.6 | 1.75 |
| **Oct. 15** | 14.8 | 0.19 | 61.1 | 33.2 | 289.6 | 10.7 | 256.9 | 237.2 | 1.9 | 42.2 | 17.1 | 5.7 | 66.7 | 61.1 | 41.1 | 18.3 | 12.9 | 1.71 |
| **Nov.15** | 16.5 | 0.22 | 57.0 | 41.0 | 311.1 | 9.3 | 246.7 | 225.6 | 1.0 | 23.3 | 14.7 | 4.9 | 60.0 | 55.6 | 44.4 | 13.6 | 12.5 | 1.78 |
| **Dec. 15** | 16.7 | 0.21 | 50.0 | 40.8 | 292.7 | 13.8 | 253.8 | 242.5 | 0.2 | 6.0 | 11.9 | 4.0 | 56.0 | 38.0 | 32.0 | 24.6 | 13.5 | 1.74 |
| **Jan. 16** | 18.1 | 0.20 | 45.4 | 39.1 | 274.3 | 10.8 | 255.0 | 236.0 | 1.2 | 25.0 | 15.9 | 5.3 | 25.0 | 23.0 | 21.0 | 14.2 | 12.9 | 1.74 |
| **Feb. 16** | 16.9 | 0.21 | 52.1 | 49.2 | 332.7 | 3.6 | 298.9 | 254.0 | 1.1 | 26.0 | 13.9 | 4.6 | 44.0 | 41.0 | 34.0 | 17.4 | 12.8 | 1.73 |
| **Mar. 16** | 15.5 | 0.22 | 58.8 | 42.6 | 322.0 | 2.4 | 331.8 | 278.0 | 2.1 | 48.0 | 14.9 | 5.0 | 26.0 | 24.0 | 19.0 | 9.3 | 9.1 | 1.73 |
| **Apr. 16** | 16.6 | 0.17 | 57.0 | 41.8 | 314.7 | 10.2 | 226.9 | 211.5 | 0.9 | 21.0 | 36.5 | 12.2 | 49.0 | 44.0 | 28.0 | 12.7 | 11.2 | 1.74 |
| **May 16** | 15.3 | 0.22 | 51.4 | 40.9 | 296.7 | 1.2 | 307.4 | 255.0 | 0.6 | 14.0 | 14.6 | 4.9 | 63.0 | 59.0 | 40.0 | 94.1 | 7.2 | 1.75 |
| **Mean** | **17.3 ± 0.4** | **0.21 ± 0.00** | **54.3 ± 1.7** | **40.6 ± 1.0** | **302.7 ± 4.8** | **9.8 ± 1.3** | **256.9 ± 5.0** | **234.9 ± 5.7** | **1.2 ± 0.1** | **27.5 ± 2.1** | **17.8 ± 2.0** | **5.91 ± 0.6** | **55.3 ± 6.6** | **49.7 ± 6.1** | **36.8 ± 3.7** | **21.6 ± 6.2** | **11.7 ± 0.5** | **1.72 ± 0.07** |

**Table 3.** According to the sampling months, data from spektrophotometric and microbiological laboratory analysis in Lake Aygır.

| **Sampling** | **Cu** | **$Al^{+3}$** | **Zn** | **Mn** | **Mo** | **Ag** | **As** | **Cd** | **Si** | **$SiO_2$** | **Br** | **I** | **Na** | **CN** | **F** | **TSS** | **MEI** | **FC** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **months** | $\mu g.L^{-1}$ | $\mu g.L^{-1}$ | $\mu g.L^{-1}$ | $\mu g.L^{-1}$ | $mg.L^{-1}$ | $\mu g.L^{-1}$ | $\mu g.L^{-1}$ | $\mu g.L^{-1}$ | $mg.L^{-1}$ | $mg.L^{-1}$ | $\mu g.L^{-1}$ | $\mu g.L^{-1}$ | $mg.L^{-1}$ | $mg.L^{-1}$ | $\mu g.L^{-1}$ | $mg.L^{-1}$ | $mg.L^{-1}$ | cfu. $100ml^{-1}$ |
| **May 15** | 4.4 | 1.1 | 0.19 | 2.4 | 1.50 | 0.26 | 0.75 | 1.3 | 5.50 | 24.8 | 366.7 | 268.9 | 26.3 | 1.65 | 487.8 | 6.7 | 10.0 | 0.3 |
| **June 15** | 4.4 | 0.6 | 0.21 | 1.9 | 1.78 | 0.17 | 1.42 | 1.0 | 5.35 | 24.2 | 66.0 | 518.0 | 26.2 | 1.61 | 568.9 | 5.2 | 10.0 | 0.5 |
| **July 15** | 2.3 | 1.9 | 0.21 | 2.8 | 1.99 | 0.48 | 1.17 | 1.2 | 5.75 | 23.4 | 81.0 | 127.0 | 29.0 | 0.87 | 552.0 | 4.0 | 10.1 | 1.0 |
| **Aug. 15** | 4.3 | 2.4 | 0.23 | 4.6 | 1.59 | 0.24 | 0.65 | 1.3 | 5.40 | 23.5 | 83.0 | 122.0 | 33.4 | 0.91 | 537.0 | 3.1 | 10.2 | 0.8 |
| **Sept. 15** | 4.0 | 0.6 | 0.23 | 3.4 | 1.70 | 0.00 | 1.46 | 1.1 | 5.60 | 23.5 | 93.6 | 150.9 | 25.3 | 1.56 | 525.5 | 3.8 | 10.8 | 0.0 |
| **Oct. 15** | 3.7 | 0.0 | 0.19 | 2.8 | 1.57 | 0.00 | 1.31 | 1.2 | 5.80 | 25.8 | 114.4 | 193.3 | 22.9 | 0.89 | 495.6 | 4.8 | 10.2 | 2.0 |
| **Nov.15** | 3.9 | 0.0 | 0.24 | 3.0 | 1.73 | 0.00 | 1.34 | 0.6 | 5.95 | 25.4 | 104.4 | 171.1 | 26.7 | 1.07 | 570.0 | 4.4 | 10.7 | 0.0 |
| **Dec. 15** | 3.2 | 1.1 | 0.14 | 4.0 | 1.52 | 0.30 | 1.17 | 1.3 | 5.76 | 22.0 | 77.0 | 116.0 | 23.9 | 1.39 | 587.0 | 3.2 | 10.2 | 0.0 |
| **Jan. 16** | 2.4 | 0.9 | 0.26 | 2.2 | 1.64 | 0.09 | 1.43 | 0.8 | 6.00 | 24.5 | 61.3 | 99.0 | 27.1 | 0.97 | 679.0 | 2.8 | 9.8 | 0.0 |
| **Feb. 16** | 3.0 | 0.2 | 0.19 | 2.6 | 1.76 | 0.44 | 1.44 | 0.7 | 6.09 | 25.4 | 51.1 | 98.9 | 26.5 | 1.19 | 587.0 | 3.9 | 10.5 | 0.0 |
| **Mar. 16** | 3.9 | 3.9 | 0.26 | 3.7 | 1.67 | 0.00 | 1.37 | 0.7 | 5.95 | 24.8 | 42.0 | 60.0 | 31.0 | 1.19 | 589.0 | 2.6 | 10.8 | 0.0 |
| **Apr. 16** | 4.7 | 0.2 | 0.29 | 4.0 | 1.65 | 0.00 | 2.01 | 1.6 | 5.87 | 25.3 | 48.0 | 74.0 | 27.3 | 0.91 | 620.0 | 3.0 | 10.3 | 0.5 |
| **May 16** | 4.3 | 1.7 | 0.23 | 4.6 | 1.88 | 0.15 | 5.06 | 1.1 | 5.55 | 23.3 | 74.4 | 263.0 | 25.9 | 1.21 | 519.0 | 2.2 | 10.5 | 1.0 |
| **Mean** | **3.7 ± 0.2** | **1.1 ± 0.3** | **0.22 ± 0.01** | **3.2 ± 0.2** | **1.69 ± 0.04** | **0.15 ± 0.17** | **1.58 ± 0.30** | **1.1 ± 0.2** | **5.74 ± 0.07** | **24.3 ± 0.3** | **97.2 ± 23.5** | **174.0 ± 64.9** | **27.0 ± 2.8** | **1.19 ± 0.08** | **562.9 ± 51.4** | **3.8 ± 0.5** | **10.3 ± 0.2** | **0.5 ± 0.5** |

**Table 4.** Similar studies in the Lake Van Basin and others about some of the criteries.

| Studies in Lake Van Basin | Site | $HCO_3$ mg.L-1 | $NH_4$mg.L-1 | Cu µg.L-1 | Mo mg.L-1 | FC cfu.100 mL-1 | TSS mg.L-1 |
|---|---|---|---|---|---|---|---|
| Şen (1995) | Van | 528.67 | - | - | - | - | - |
| Atasoy et al. (2011) | Van | - | - | - | - | - | - |
| Kahraman et al. (2012) | Bitlis | - | - | - | - | - | - |
| Bulum (2015) | Van | 651.60 | 0.06 | 8.5 | - | - | - |
| Bayram (2016) | Van | 457.9 | 0.07 | 0.0 | - | - | - |
| Atici et al. (2016) | Van | 171.7 | - | 0.39 | - | - | 0.33 |
| Seyhan (2016) | Van | 171.05 | 0.10 | 7.77 | - | - | - |
| Çavuş et al. (2017) | Van | 280 | - | 1.18 | 0.279 | 0 | - |
| Kaptanoğlu and Bakir (2017) | Van | - | - | - | - | - | - |
| Atici et al. (2018) | Van | 457.9 | 0.49 | 0.2 | 1.9 | 538.3 | 212.5 |
| Aydin (2019) | Van | 356.6 | 0.38 | 0.0 | 0.2 | 36-* | 11.8 |
| Demir (2019) | Van | - | 0.204-0.224 | - | - | - | 15.96-18.11 |
| Sanaç (2019) | Van | 709.6 | 0.05 | - | - | - | - |
| Şen and Şekerci (2019) | Van | 452.2 | 0.41 | - | - | - | - |
| Atici (2020) | Van | 305.0 | - | - | 225.0 | - | 44.8 |
| Sepil (2020) | Bitlis | 283.0 | 0.10 | 3.2 | 0.3 | | 0.0074 |
| **Others** | | | | | | | |
| Kumbur et al. (2008) | Mersin | - | - | - | 1.17-2.05 | - | - |
| Sönmez et al. (2012) | Karasu Stream | - | - | - | - | - | - |
| Akar (2015) | Armağanköy Dam | - | - | - | 0.000183-4.493 | - | - |
| Şen and Aksoy (2015) | Bulakbaşı Stream | 365.94 | - | 0.0 | - | - | - |
| Pehlivan (2016) | Sarma Stream | - | - | - | - | - | 70 |
| Subka (2017) | Zuwarah-Libya | - | - | - | - | 1300-2000 | - |
| Megessa (2017) | Lake Basaka-Ethiopia | 580 | - | - | - | - | - |
| Chebet et al. (2020) | River Molo-Kenya | 54-384 | - | - | - | - | - |

*Too much that can not be counted.

(2013) as 38, 49, 70 and 2.25 mg/L/m (in different dams). According to these results, Aygır Lake is similar to Kootnay Lake and Nazik Lake in terms of fishing efficiency.

Cl, Ca, Mg, total hardness, $CO_3$, $HCO_3$, Al, Cr, CN, $NO_2$, $NO_2$ – N, $NO_3$, $NO_3$ – N, $SO_4$, o-$PO_4$, K, Zn, F, Mn, Ag, B, Ni, Co, I, Fe, Si, $SiO_2$, COD, BOD, As, Cd, B, Na, were found suitable for Turkey, EU, WHO legislations and some literatures (TSE, 1997; Turkey, 1995, 2004, 2005; Tebbutt, 1998; Türkman et al., 1999; USEPA, 1999; Emre and Kürüm, 2007). At the same time, Çavuş and Şen (2020b) applied to CCME-

WQI to this data set because of assessing drinking water quality. Under Turkish national legislations CCME-WQI values were good quality with 83.30 points. They stated that the lake could not reach the excellent quality due to its geological structure, a village on the shore, cage fishing.

Based on the results of this study, the quality of the lake is generally suitable for drinking, utility, fisheries and irrigation water. As drinking water with a small-scale treatment system; It can continue to be used as agricultural irrigation water without treatment. There is no information about the organic pollution load that trout cages release into the lake. Organic accumulation resulting from mesh cages can be simulated using various computer programs. As a result, the priority order should be determined while benefiting from Lake Aygır as a water resource. Right to benefit and use water resources; It should be established by considering the quantity, quality of the water, the characteristics of its location, essential needs and conditions.

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