JAES

Journal of Anatolian Environmental and Animal Sciences
(*Anadolu Çevre ve Hayvancılık Bilimleri Dergisi*)
DOI: https://doi.org/10.35229/jaes.1419710

Year: 9, No: 1, 2024 (74-81)

AÇEH

Yıl: 9, Sayı: 1, 2024 (74-81)

ARAŞTIRMA MAKALESİ RESEARCH PAPER

Analysis the Metal Composition of Fish Samples Collected from Karacaören II Dam Lake

Oğuz Kağan KÖKSAL[1,6*] **Gokhan APAYDIN**[2,6] **Erhan CENGIZ**[3,6] **Murat SİRİN**[4,6]
Hasan BALTAS[4,6] **Eyüp ÇAKMAK**[5] **Engin TIRASOGLU**[2,6]

[1]*Department of Electrical and Electronics Engineering, Department of Engineering, Adıyaman University, 02040, Adıyaman, Türkiye*
[2]*Department of Physics, Faculty of Sciences, Karadeniz Technical University, 61080, Trabzon, Türkiye*
[3]*Department of Basic Engineering Science, Faculty of Rafet Kayis Engineering, Alanya Alaadin Keykubat University,07450, Antalya, Türkiye*
[4]*Department of Physics, Faculty of Science and Literature, Rize Recep Tayyip Erdoğan University, 53100, Rize, Türkiye*
[5]*Fisheries Central Research Institute, 61250, Trabzon, Türkiye*
[6]*Gamma and X-Ray Applications Research Group (GXARG), Department of Physics, Faculty of Science, Karadeniz Technical University, 61080, Trabzon, Türkiye*

Received: *14.01.2024* ***Accepted:*** *05.02.2024* ***Puplished:*** *19.03.2024*

How to cite: **Koksal, O.K., Apaydin, G., Cengiz, E., Sirin, M., Baltas, H., Çakmak, E. & Tirasoglu, E. (2024).** Analysis the Metal Composition of Fish Samples Collected from Karacaören II Dam Lake. *J. Anatolian Env. and Anim. Sciences,* ***9***(1), 74-81. https://doi.org/10.35229/jaes.1419710

Atıf yapmak için: **Koksal, O.K., Apaydin, G., Cengiz, E., Sirin, M., Baltas, H., Çakmak, E. & Tirasoglu, E. (2024).** Karacaören II Dam Gölü'nden toplanan balık örneklerinin metal bileşimi analizi. *Anadolu Çev. ve Hay. Dergisi*, **9**(1), 74-81. https://doi.org/10.35229/jaes.1419710

*: https://orcid.org/0000-0003-2671-6683
: https://orcid.org/0000-0002-4647-344X
: https://orcid.org/0000-0002-4094-5784
: https://orcid.org/0000-0001-6864-752X
: https://orcid.org/0000-0002-1939-8253
: https://orcid.org/0000-0003-3075-9862
: https://orcid.org/0000-0001-7953-5638

***Corresponding author's:**
Oğuz Kağan KÖKSAL
Department of Electrical and Electronics Engineering, Department of Engineering, Adıyaman University, 02040, Adıyaman, Türkiye
: okoksal@adiyaman.edu.tr

Abstract: The objective of this study was to analyze the metal content in the organs of *Oncorhynchus mykiss,* commonly known as rainbow trout, at 12 different locations within the cages located in Karacaören II Dam Lake. The metal contents in fish samples were analyzed using a PANalytical Epsilon5 energy dispersive X-ray fluorescence (EDXRF) spectrometer. We will analyze the findings by displaying the fluctuating metal concentrations in various internal organs over the seasons.

Keywords: *Karacaören II Dam lake, fish, metal, EDXRF*.

Karacaören II Dam Gölü'nden toplanan balık örneklerinin metal bileşimi analizi

***Sorumlu yazar:**
Oğuz Kağan KÖKSAL
Adıyaman Üniversitesi, Elektrik-Elektronik Mühendisliği Bölümü, Mühendislik Bölümü, 02040, Adıyaman, Türkiye
: okoksal@adiyaman.edu.tr

Öz: Bu çalışmanın amacı, *Oncorhynchus mykiss*'in organlarının metal içeriğini, Karacaören II Dam Gölü'nde bulunan 12 farklı kafeste , rainbow trout olarak bilinen organları analiz etmektir. Balık örneklerinde bulunan metal içeriği, PANalytical Epsilon5 enerji dağılımı X-ray fluorescence (EDXRF) spektrometresi kullanılarak analiz edildi. Sonuçları, çeşitli iç organlarda mevsimsel olarak değişen metal konsantrasyonlarını göstererek analiz edildi.

Anahtar kelimeler: *Karacaören II dam gölü, balık, metal, EDXRF.*

INTRODUCTION

Environmental pollution is commonly discussed in relation to the contamination of the air, water, and soil. Undoubtedly, groundwater is the most susceptible and rapid to being polluted. Water is typically the last destination for pollution, as water is commonly used to cleanse and purify things that are unclean. Over time, when pollution in the air, soil, and groundwater is replenished, it gradually infiltrates the water (URLs 1, 2). Gradually, this pollution might potentially affect the aquatic organisms residing in the water, particularly the fish. The global issue of heavy metal contamination in the natural environment persists due to the inability to completely eradicate heavy metals. Living organisms become harmful when the concentration of metal beyond a specific threshold. Due to their resistance to self-treatment, heavy metals hold significant ecological importance as they cannot be effectively eliminated from water. These noxious metals accumulate in reservoirs and enter the food web. The primary factor contributing to the rise in metal levels in reservoirs is the presence of elevated metal concentrations in bottom sediments (Ghrefat & Yusuf, 2006). The concentration of heavy metal in the sediment is influenced by the quantity of sediment particles settled at the bottom, the dimensions of the particles, and the existence of organic substances within the silt. Sediment experiences substantial rates of heavy metal accumulation. Consequently, it is employed to evaluate metal contamination in aquatic environments (Salomons, De Rooij, Kerdijk, & Bril, 1987). The ability for copper absorption was determined in the Mediterranean mussel (Mytilus galloprovincialis) (Baltas et al., 2016). An analysis of trace elements was conducted on the water, sediment, and freshwater fish species found in Rize Iyidere Stream (Bulent Verep, Mutlu, Apaydin, & Cevik, 2012). An investigation was conducted to measure the levels of radioactivity and concentrations of heavy metals in the sea water, sediment, and anchovies (Engraulis encrasicolus) at Rize, located in the Black Sea (Baltas, Kiris, & Sirin, 2017). An assessment was conducted on the trace elements present in rainbow trout (*Oncorhynchus mykiss*) that were bred in cages located in saltwater along the Black Sea coast (Bülent Verep et al., 2007).

Our prior research (APAYDIN et al., 2019; APAYDIN et al., 2023) involved assessing the concentrations of metal pollutants and natural radiation in the sediments of the Karacaören II dam. Furthermore, our study team assessed naturally occurring radiation levels in fish living in the Karacaören II dam, as well as the extent of metal contamination in the water (Guliev & Mavruk; MADANI & SEENIVASAN). Metals may accumulate in organisms either directly or indirectly through their nutrition. Direct fish health assessments may be performed by utilizing organisms in studies. This study aims to assess the seasonal variation in metal contamination levels in different organs of fish.

MATERIAL AND METHOD

Sampling Points: The Karacaören II Dam, built between 1988 and 1993 for hydropower and agricultural reasons, has since been repurposed to provide drinking water to the province of Antalya (URLs-3,4,5,6). Upon further examination, it is seen that the lake is situated adjacent to the Isparta-Antalya (D-685) highway, which traverses the western part and is in close proximity to the lake. Conversely, the eastern section consists entirely of trails, village roads, hills, and hilly areas. The primary sources of sustenance for the inhabitants of the communities north of the lake (Karacaören and Amlk villages) are greenhouse cultivation and animal husbandry. Additionally, agricultural land extends all the way to the lake's shoreline. A little settlement called Kargı was noted to be located in the southernmost part of the area. At the periphery of the lake, there exist three recreational amenities. There are five separate areas along the lake where trout farms are currently in operation. Recreational coastal fishing and hunting are commonly conducted with small watercraft. Tourist organizations frequently organize lake excursions throughout the summer season (Figure 1).

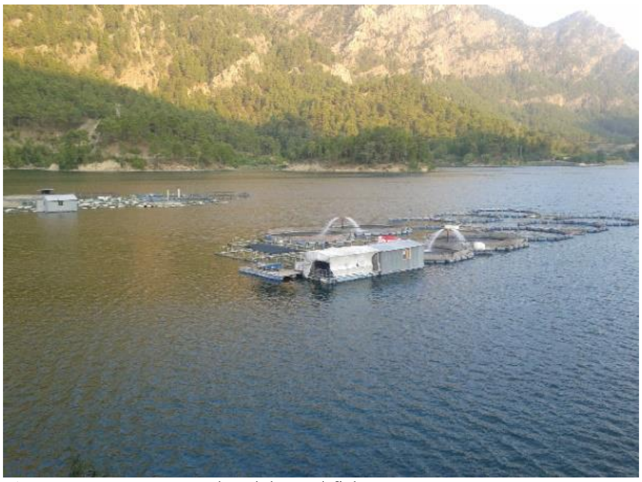

Figure 1. Karacaören II dam lake and fish cages.

As to the geological research conducted by the MTA website, the Burdur/Bucak district is known for its abundance of marble, granite, and limestone industries. Furthermore, the proximity (URL-7) has revealed the existence of copper (Cu), lead (Pb), and zinc (Zn).

The Collection of Fish Samples: A total of four sets of samples were collected, corresponding to each of the four seasons: May 2016, August 2016, November 2016, and February 2017. The samples consist of fish obtained from the fish farms located at the five specific sites indicated in Figure 1. To gather fish samples from the lake, we solicited the assistance of avid lake-fishing enthusiasts and experienced fisherman. Fish were procured from fisherman employing nets in an attempt to trap escaping fish from the cages, although this endeavor proved futile. Efforts were made to get it from fish farms. There are around five distinct areas surrounding the lake that include cages. To gather samples from each cage, a total of 20 trout groups were formed, with five groups for each of the four seasons. The samples were transferred to Trabzon and kept there until usage, utilizing the cold chain.

Preparation of Fish Samples for Elemental Analysis: The rainbow trout (*Oncorhynchus mykiss*) is a notable species of trout found in North America. It is commonly obtained via fish sample cages. The cultural characteristics were generated and spread over other continents. The arrival of this item in Europe occurred around in 1880, while its introduction in the United States took place in 1970. Subspecies have the ability to enter the water. It is absent in the United States by default.

Nevertheless, aquaculture enterprises in our country produce it in substantial amounts. Initially, the fish specimens delivered to the laboratory were subjected to measurements of their weights, ranging from 239.8 to 310.2 grams, and lengths, ranging from 27.5 to 31.3 cm. The fish samples were dissected into their gills, livers, kidneys, and muscles in order to examine the metal content (Figure 3). The gills, kidneys, liver, and muscles were desiccated by subjecting them to a 105 °C oven for a duration of 96 hours (Baltas et al., 2016). The materials were further pulverized using an agate grinding mill and a 37-mm screen to mitigate the influence of particle size (Figure 4). Appropriate sample sizes are provided for elemental analysis.

Table 1. Sampling quantities of fish samples.

	Length (cm) (min-max)	Weight (g) (min-max)	Gill (g) (min-max)	Liver (g) (min-max)	Kidney (g) (min-max)	Muscle (g) (min-max)
Rainbow Trout	27.5-31.3	239.8-310.2	4.8-10.8	2-4.6	1.8-3.4	94.4-130.8
Average	29.66	263.87	8.08	3.2	2.73	122.16

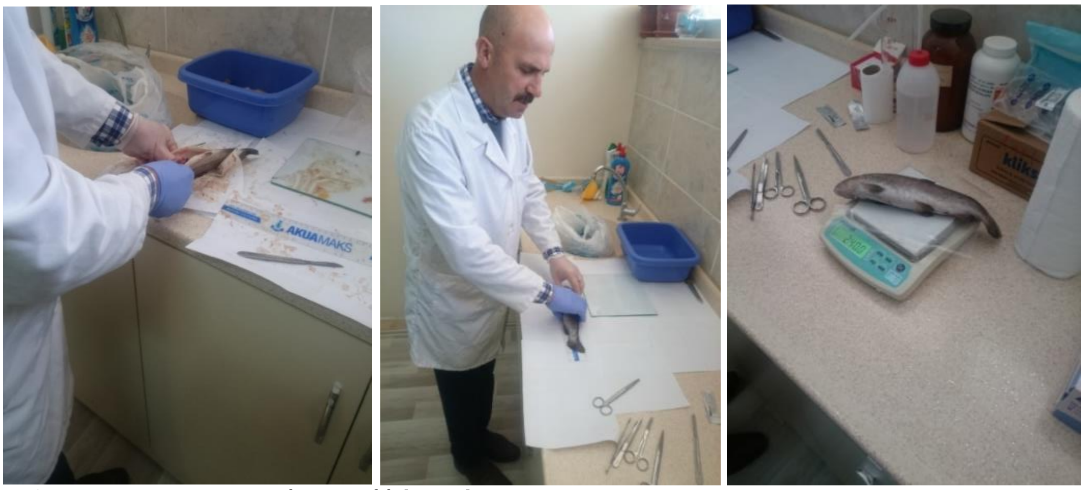

Figure 2. Separation process of organs of fish samples.

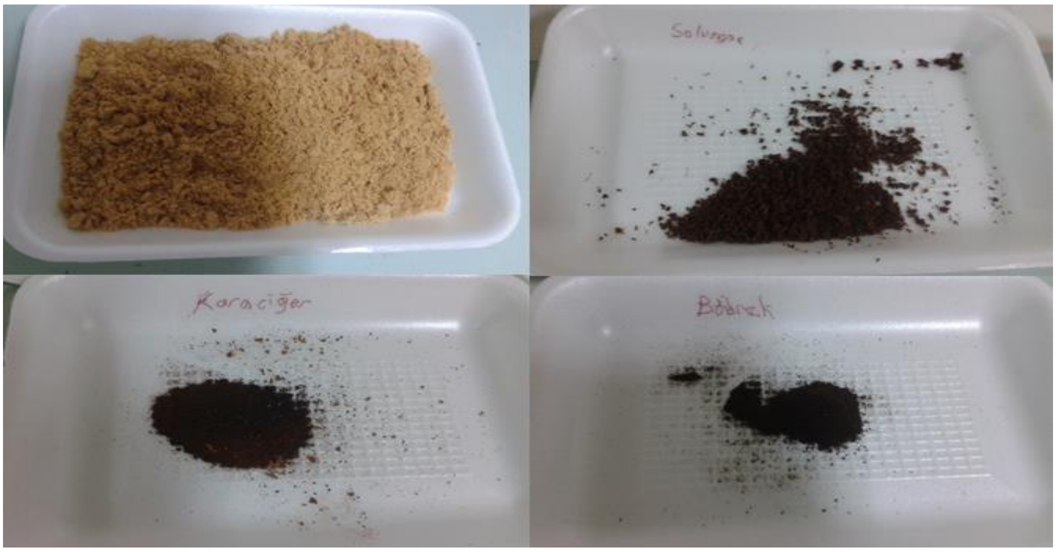

Figure 3. Drying and grinding the separated parts of fish samples

Experimental Set-up:

ED-XRF Measurement System: The energy dispersive X-ray fluorescence spectrometer (EDXRF) is often used to quantitatively and qualitatively analyze unique X-rays and scattering photons generated by photon-matter interaction. The EDXRF technique utilizes the energy of the X-rays obtained from the material being tested to identify the elements present. Additionally, it quantifies the amount of elements by tallying the incoming rays. It is highly important in technical and scientific research because of its speed and sensitivity, ease of usage, and non-destructive nature. This device is capable of detecting heavy metal concentrations in the Na-U element range in samples of many forms, including solid (such as minerals, metals, and polymers), liquid (such as water, oil, and petroleum products), thin film, or pressed powder. It can measure the concentrations in both percentage and parts per million (ppm) units, without requiring a reference sample set. Due to it, we are able to conduct semi-quantitative analysis. Although this approach does not yield precise quantitative data, it is highly useful for determining the structure of the sample and guiding further inquiry. Accurate quantitative analysis may be conducted across a wide range of concentrations, from parts per million (ppm) to percentages, by utilizing appropriate reference materials. The experiment employed Epsilon-5, an EDXRF instrument manufactured by PANalytical (Figure 4).

The efficiency of the device is dependent on the duration of net measurement time, which imposes limitations on its detection capabilities;

$$DL = \frac{3C}{N_p}\sqrt{\frac{N_b}{t}} \qquad (1)$$

The abbreviations in the equation represent the detection limit (DL), concentration (C), net peak count (NPC), background count rate (BCR), and time (t), respectively (Mahommed & Makundi, 2002). Table 2 displays the detection restrictions based on the measurement time.

Figure 4. **PANalytical brand EDXRF system**

Statistical Calculation: The fish samples were analyzed for metal contents using dry weight values, and the results were reported as microgram per gram (µg/g). The aggregated data were imported into the SPSS environment, namely IBM SPSS Statistics 23. The obtaşned data were analyzed on a seasonal basis. All statistical analyses were conducted using the SPSS software in a computer environment.

Table 2. Limits on detection dependent on time.

Element	Aluminium	Sulphur	Chromium	Manganese	Iron	Nickel	Copper	Zinc	Arsenic	Mercury	Lead
Detection Limit (parts per million) (1500s)	2.36	1.10	0.93	0.39	0.43	0.47	0.52	0.20	0.34	0.98	1.37

RESULTS

Metal Values in Fish Samples: The accompanying tables (Tables 3-6) present the periodic variations in the muscle, gill, kidney, and liver constituents of the fish samples after analysis using the EDXRF equipment. Figure 6 depicts the mean concentrations of manganese, iron, zinc, copper and lead during different seasons.

Table 3. Elemental analysis (µg/g) in the gills of fish samples.

NO	Al	S	Cr	Mn	Fe	Ni	Cu	Zn	As	Pb
May 2016										
1	6250	25920	ND	40.89	239	ND	37.95	847.44	ND	12.57
2	6325	25830	ND	41.16	238	ND	37.89	846.84	ND	12.63
3	6400	25740	ND	41.42	238	ND	37.82	847.55	ND	12.69
4	6475	25650	ND	41.69	237	ND	37.75	847.61	ND	12.75
5	6550	25560	ND	41.96	236	ND	37.68	847.66	ND	12.81
Ave.	**6400**	**25740**	-	**41.42**	**238**	-	**37.88**	**847.42**	-	**12.69**
August 2016										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	6625	27475	ND	46.21	509	ND	80.83	1805.00	ND	13.95
2	6767	26347	ND	41.98	382	ND	83.15	1863.10	ND	12.63
3	6784	27284	ND	54.26	402	ND	79.42	1779.90	ND	11.42
4	6993	27702	ND	45.44	313	ND	88.15	1788.50	ND	12.62
5	6943	27349	ND	58.74	262	ND	79.13	1780.10	ND	12.43
Ave.	**6823**	**27231**	-	**49.32**	**374**	-	**84.94**	**1803.60**		**12.61**
November 2016										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	7960	32990	ND	60.18	1766	ND	243.60	2510	ND	14.51
2	7810	33210	ND	61.14	1740	ND	245.70	2537	ND	14.18
3	7290	33590	ND	59.23	1792	ND	250.80	2560	ND	14.74
4	7650	33370	ND	60.82	1814	ND	238.50	2490	ND	14.63
5	7582	33980	ND	61.01	1748	ND	236.30	2508	ND	14.32
Ave.	**7658**	**33428**	-	**60.48**	**1772**	-	**243.00**	**2521**	-	**14.48**
February 2017										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	7355	28701	ND	52.36	1536	ND	148.60	2130	ND	14.01
2	7355	22915	ND	45.24	1288	ND	152.40	2269	ND	14.08
3	7355	31575	ND	57.45	1738	ND	168.10	2436	ND	13.34
4	7355	29366	ND	53.52	1596	ND	140.70	2297	ND	14.13
5	7355	32961	ND	59.18	1696	ND	148.90	2032	ND	12.32
Ave.	**7627**	**29103**	-	**53.55**	**1570**	-	**151.70**	**2233**	-	**13.58**

Table 4. Elemental analysis (µg/g) in the muscles of fish samples.

NO	Al	S	Cr	Mn	Fe	Ni	Cu	Zn	As	Pb
May 2016										
1	5880	46680	ND	ND	243	ND	62.75	235.19	ND	13.22
2	6365	46850	ND	ND	245	ND	62.80	235.87	ND	12.41
3	4910	46350	ND	ND	241	ND	62.65	233.84	ND	13.22
4	6042	46740	ND	ND	244	ND	62.71	234.42	ND	12.20
5	6850	47020	ND	ND	246	ND	62.84	236.55	ND	11.61
Ave.	**6009**	**46728**			**244**		**62.75**	**235.17**		**12.53**
August 2016										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	5196	41023	ND	ND	343	ND	72.71	245.22	ND	14.01
2	5963	42369	ND	ND	298	ND	70.63	245.87	ND	12.99
3	6023	44423	ND	ND	321	ND	69.65	243.11	ND	13.17
4	6042	40231	ND	ND	294	ND	68.77	244.72	ND	13.60
5	6250	40326	ND	ND	327	ND	72.13	246.54	ND	12.96
Ave.	**5895**	**41674**	-	-	**317**	-	**70.78**	**245.09**	-	**13.34**
November 2016										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	6470	38870	ND	ND	741	ND	88.26	316.76	ND	15.59
2	6380	38560	ND	ND	733	ND	88.11	314.43	ND	14.81
3	6480	39350	ND	ND	745	ND	90.46	321.07	ND	14.45
4	6440	38950	ND	ND	740	ND	89.00	317.51	ND	14.95
5	6560	39660	ND	ND	754	ND	90.61	323.36	ND	15.23
Ave.	**6466**	**39078**	-	-	**743**	-	**89.29**	**318.63**	-	**15.01**
February 2017										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	6082	41870	ND	ND	644	ND	80.96	313.59	ND	15.43
2	6111	40560	ND	ND	655	ND	78.11	308.14	ND	14.51
3	6039	40353	ND	ND	695	ND	83.78	282.54	ND	12.72
4	6445	42363	ND	ND	720	ND	81.80	260.36	ND	12.26
5	6156	39956	ND	ND	723	ND	91.36	294.26	ND	13.86
Ave.	**6167**	**41020**	-	-	**688**	-	**83.20**	**291.78**	-	**13.76**

Table 5. Elemental analysis (µg/g) in livers of fish samples.

NO	Al	S	Cr	Mn	Fe	Ni	Cu	Zn	As	Pb
May 2016										
1	5290	59080	34.61	44.73	6960	ND	43.50	1588.10	5.61	11.30
2	5230	59140	33.85	44.26	6830	ND	42.90	1532.70	5.54	10.70
3	5150	59260	33.72	45.97	7020	ND	44.00	1604.90	6.02	10.58
4	5340	58320	35.20	42.84	6870	ND	43.80	1625.20	5.32	11.06
5	5430	58900	35.50	43.48	6900	ND	43.10	1571.30	5.21	11.30
Ort.	**5288**	**58940**	**34.58**	**44.26**	**6916**	-	**43.46**	**1584.40**	**5.54**	**10.99**
August 2016										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	5449	56126	35.64	46.07	6612	ND	44.80	1508.70	5.33	11.64
2	5335	55000	34.52	45.15	6352	ND	43.75	1425.40	5.15	10.91
3	5356	53927	35.06	47.81	6388	ND	45.76	1460.50	5.48	11.01
4	5981	50155	39.42	47.98	5908	ND	49.05	1397.70	4.58	12.39
5	6082	56721	35.85	43.91	6645	ND	43.53	1513.20	5.02	11.41
Ave.	**5640**	**54386**	**36.10**	**46.18**	**6381**	-	**45.38**	**1461.10**	**5.11**	**11.47**
November 2016										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	5960	52630	54.85	52.06	5360	ND	47.30	1384.50	5.71	11.52
2	5570	50520	53.64	50.65	5180	ND	46.10	1335.20	4.64	13.10
3	5670	51690	55.90	52.52	5350	ND	47.80	1372.50	3.87	15.54
4	5740	51520	54.70	51.85	5270	ND	47.10	1364.30	4.74	13.38
5	5896	52890	56.15	53.02	5420	ND	48.20	1397.80	4.86	13.72
Ave.	**5767**	**51850**	**55.05**	**52.02**	**5316**	-	**47.30**	**1370.90**	**4.76**	**13.45**

Table 6. Elemental analysis (µg/g) in livers of fish samples (continued).

February 2017										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	5662	49999	52.11	53.62	5521	ND	48.71	1315.30	5.42	11.87
2	5180	46984	49.89	51.66	5284	ND	47.22	1241.70	4.32	13.36
3	5160	47038	50.87	57.77	5885	ND	52.58	1249.00	3.52	17.09
4	4936	44307	47.04	58.59	5955	ND	53.22	1173.30	4.08	15.12
5	5678	50933	54.07	53.55	5474	ND	48.68	1346.10	4.68	13.86
Ave.	**5323**	**47852**	**50.79**	**55.03**	**5624**	**-**	**50.04**	**1265.10**	**4.40**	**14.25**

Table 7. Elemental analysis (µg/g) in kidneys of fish samples.

May 2016										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	5950	36690	65.32	36.54	6601	11.04	107.69	1077.80	3.40	15.06
2	5620	36580	66.40	35.26	6592	10.69	107.28	1066.00	5.20	12.61
3	5440	35970	64.58	35.93	6500	10.54	106.25	1045.80	5.13	14.26
4	5615	35750	64.24	34.81	6474	11.24	105.32	1032.60	4.91	13.84
5	5280	36470	67.47	33.99	6581	10.33	106.87	1054.10	6.41	12.61
Ave.	**5581**	**36292**	**65.60**	**35.31**	**6549**	**10.77**	**106.68**	**1055.30**	**5.01**	**13.68**
August 2016										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	6129	34856	67.28	37.64	6271	11.37	110.90	1023.90	3.23	15.51
2	5732	34019	67.73	35.97	6131	10.90	109.40	991.38	4.84	12.86
3	6202	32733	73.62	40.96	5915	12.02	121.10	951.68	4.67	16.26
4	6289	30745	71.95	38.99	5568	12.59	118.00	888.04	4.22	15.50
5	6082	35121	68.35	34.43	6338	10.46	108.30	1015.10	6.17	12.77
Ave.	**6087**	**33494**	**69.78**	**37.59**	**6040**	**11.46**	**113.50**	**974.10**	**4.62**	**14.58**
November 2016										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	6160	39610	82.17	60.98	8100	16.53	160.50	920.13	4.21	14.53
2	6050	37860	80.24	57.92	7840	17.95	163.70	862.81	5.84	13.75
3	5920	39550	79.85	57.26	7960	17.32	167.00	902.32	6.09	14.39
4	5840	38420	81.45	59.58	7730	18.12	164.40	895.45	4.89	13.92
5	5970	38940	79.51	58.27	7910	16.85	161.10	887.88	5.07	14.05
Ave.	**5988**	**38876**	**80.64**	**58.80**	**7908**	**17.35**	**163.30**	**893.72**	**5.22**	**14.13**
February 2017										
NO	**Al**	**S**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Pb**
1	5852	37630	78.06	62.81	8343	15.70	152.5	874.12	4.01	14.97
2	5627	35210	74.62	59.08	7997	16.69	152.2	802.41	5.43	14.03
3	5387	35991	72.66	62.99	8756	15.76	152.00	821.11	5.54	15.83
4	5022	33041	70.05	67.33	7344	15.58	141.4	770.09	4.21	15.73
5	5749	37499	76.57	58.85	7989	16.23	155.1	855.03	4.88	14.19
Ave.	**5527**	**37874**	**74.39**	**62.21**	**8085**	**15.99**	**150.6**	**824.55**	**4.81**	**14.95**

The fish samples' muscle, gill, kidney, and liver sections were measured using the EDXRF equipment. Tables 3-6 provide the results for all time periods. Figure 6 illustrates the mean concentrations of Mn, Fe, Zn, Cu, and Pb during different seasons. The fish samples from all areas and time periods included significant levels of the elements Aluminum (Al), Sulfur (S), Iron (Fe), Copper (Cu), Zinc (Zn), and Lead (Pb). Cr and As were not present in the gills and muscles, however they were detected in the liver and kidneys. The presence of the Ni element was exclusively seen in renal tissue samples. Manganese (Mn) was detectable in the gills, liver, and kidneys, but remained below the detection limit in the muscles. The overall assessment of metals revealed that metal buildup was more pronounced in the kidneys and livers compared to the gills and muscle tissue. Seasonal analysis of the elemental accumulations of Al, S, Cu, and Zn reveals that concentrations are greater during the period from August to November compared to the period from May to February. Based on the limit values set by international organizations for different fish samples, the following values have been determined for the element Cu: 120 mg/g (USEPA, 1999), 30 mg/kg (FAO, 1983), and 20 mg/kg (Organization, 2008). The mean results of all the samples in the investigation reveal that the substance is found in the gills at a concentration of 130 mg/g, in the muscles at 77 mg/g, in the liver at 47 mg/g, and in the kidneys at 134 mg/g. In our investigation, we discovered that the element Pb was present in the gills at a concentration of 13 mg/g, in the muscles at a concentration of 14 mg/g, in the liver at a concentration of 13 mg/g, and in the kidneys at a concentration of 14 mg/g. These results are much higher compared to the reference value of 2 mg/kg (Organization, 2008), 0.5 mg/kg (FAO, 1983), and 4.0 mg/g (USEPA, 1999). Based on the Australian and New Zealand food standards as well as the EPA requirements, the recommended quantity of ase was determined to be 2 mg/g (Waheed, Malik, & Jahan, 2013) in the study on quantity, and 1.3 mg/g in the research on quantity. By employing these values as a reference, Waheed et al. A research was undertaken to ascertain the concentration of Arsenic (As) in different species of fish. It was observed that the concentration of As varied across different organs, with the highest concentration finding in the liver, followed by the muscle, and the lowest concentration in the gill. The amounts in the Muscle and Liver exceeded the criteria set by WHO, FAO, and EPA. In our investigation, the quantities of the substance were detected in the liver (4.96 mg/g) and kidneys (4.92 mg/g). However, they were not detectable in the muscles and gills. The TGK communiqué, issued by the Ministry of Agriculture, aims to determine the highest allowable levels of certain pollutants found in fish samples. However, the elements Hg and Cd were not detectable since they fell below the threshold of detection. The levels of Pb were found to exceed the claimed threshold of 0.30 mg/kg mentioned in the communiqué. The ICP technique was used to analyze heavy metals in various tissues and organs of samples collected from the dam lake (Cyprinus carpio L., 1758). Results showed that Fe and Zn were present in all tissues across all seasons. Cu was only detected in the liver during spring 2016, while Pb was found in the liver and gills during the same season. Manganese (Mn), aluminum (Al), and strontium (Sr) contents were found to be below the analytical limit in muscle, liver, and liver tissue only during the summer of 2016, fall of 2016, and winter of 2017, respectively. They asserted that Cr, Cd, and Hg were absent from all tissues and organs, irrespective of the season. Research in the field of literature indicates that there is a gradual accumulation of metal, especially in the liver tissues. Firstly, the activities of the liver, an organ that is very active in metabolism, are addressed. This characteristic enables it to accommodate a significant quantity of metallic substances that have the potential to be harmful to the human body. Conversely, the presence of gills may be attributed to their role as the initial organs to encounter the aquatic environment and sediment. Due to its limited presence in muscular tissues, it is not considered an actively functioning organ.

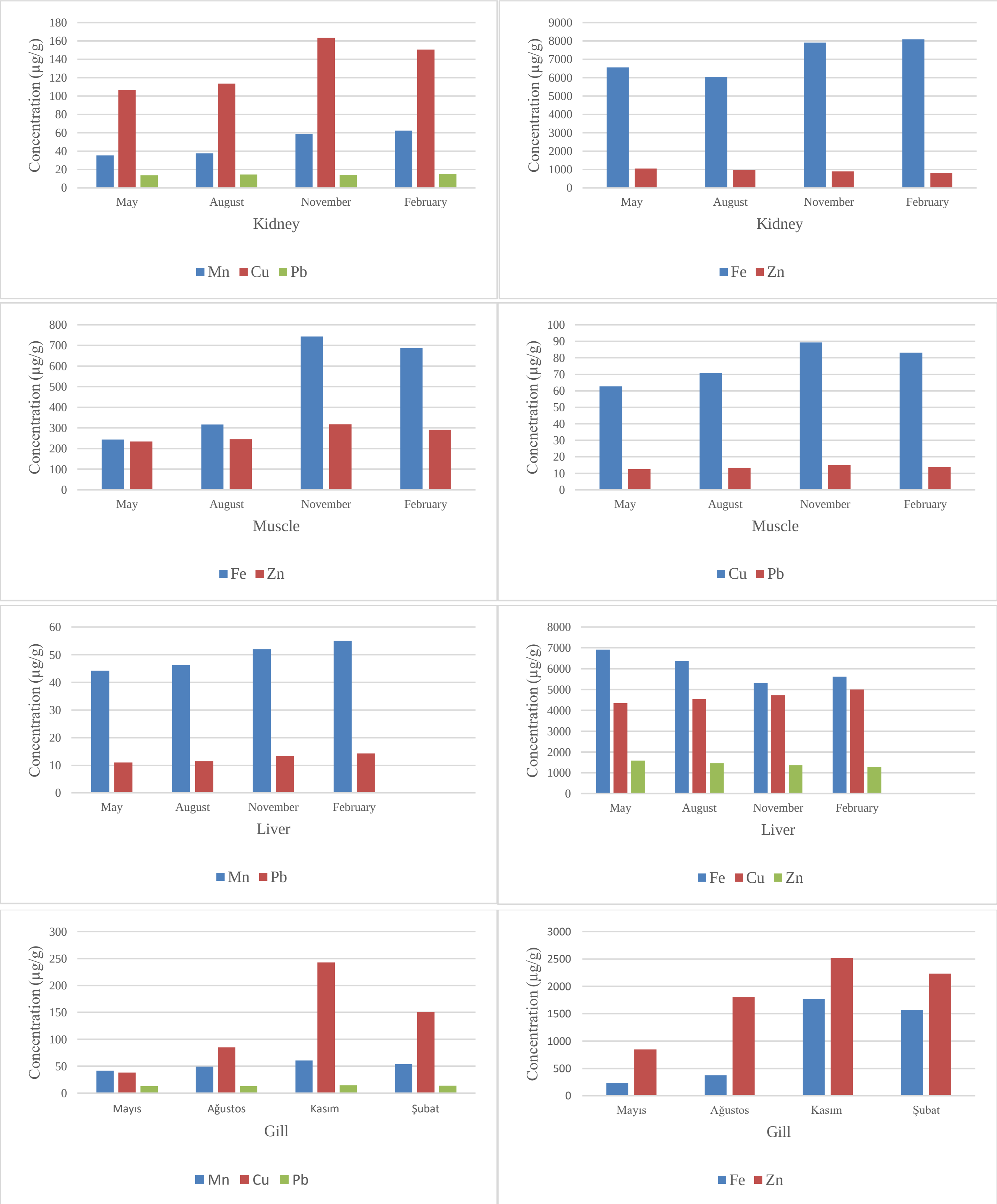

Figure 5. Variation of seasonal average of some elements (manganese, iron, zinc, copper and lead) in fish samples. a) kidney, b) muscle, c) liver, d) gill.

CONCLUSION

As a result, elements were evaluated after the muscle, gill, kidney, and liver portions of the fish samples were separated. The analysis identified the chemical components Aluminum (Al), Sulfur (S), Chromium (Cr), Manganese (Mn), Iron (Fe), Nickel (Ni), Copper (Cu), Zinc (Zn), Arsenic (As), and Lead (Pb). The findings indicate that the liver exhibits the greatest metal buildup, albeit it remains within the established constraints, particularly in muscle tissues. The conducted investigations demonstrate that the project successfully achieved the targeted advantages to a significant degree. Sharing the data with the relevant individuals and obtaining their viewpoints, particularly at the introductory meeting arranged for the Isparta DSI 18th Regional Directorate, our important stakeholder throughout the project, proved to be beneficial. The high concentration of Pb in the water samples is believed to be caused by the construction of the dam lake basin on the site of a former settlement, the ongoing cage fishery and its environmental effects, the high traffic volume on the Isparta-Antalya highway, especially during the summer, and various activities taking place near the lakeside. In order to save the aquatic fauna from water pollution, it may be imperative to implement preventive measures in the future.The findings were evaluated seasonally. When examining the comprehensive results of the study, it is thought that they offer first insights into the utilization of water for drinking purposes in the province of Antalya. Prior to utilizing any water, it is imperative to thoroughly assess the conditions of the activities taking place in and around the lake. The investigations should prioritize assessing the contamination levels of the Isparta Stream, which flows into the lake. The decision to utilize the water should be followed by awareness-raising initiatives to urge people of communities surrounding the lake to keep all domestic wastes and possible contaminants, notably agricultural runoff, away from the lake. Accredited groups should evaluate farms operating within the lake. Prior to use, it is important to thoroughly cleanse all water samples for chemical analysis through the application of diverse spectroscopic methods.

ACKNOWLEDGEMENTS

The financing of this study was provided by the Turkish Science and Technology Research Council within the scope of TÜBİTAK Project No 115Y768. The authors express their gratitude to the relevant institution for its assistance.

CONFLICT of INTEREST

The authors explicitly declared the absence of any conflicts of interest.

REFERENCES

Apaydin, G., Koksal, O. K., Cengiz, E., Tirasoglu, E., Baltaş, H., Karabulut, K. & Söğüt, Ö. (2019). Assessment of natural radioactivity and radiological risk of sediment samples in Karacaören II dam Lake, Isparta/Turkey. *ALKÜ Fen Bilimleri Dergisi*, 28-35.

Apaydin, G., Köksal, O. K., Cengiz, E., ŞİRİN, M., Baltas, H. & Tiraşoğlu, E. (2023). Exploration of Seasonal Metal Pollution in Karacaören II Dam Lake Sediment Samples using X-ray Fluorescence Method. *Cumhuriyet Science Journal*, ***44***(3), 567-582.

Baltas, H., Dalgic, G., Bayrak, E., Sirin, M., Cevik, U. & Apaydin, G. (2016). Experimental study on copper uptake capacity in the Mediterranean mussel (*Mytilus galloprovincialis*). *Environmental Science and Pollution Research*, ***23***, 10983-10989.

Baltas, H., Kiris, E. & Sirin, M. (2017). Determination of radioactivity levels and heavy metal concentrations in seawater, sediment and anchovy (Engraulis encrasicolus) from the Black Sea in Rize, Turkey. *Marine Pollution Bulletin*, ***116***(1-2), 528-533.

FAO, F. (1983). Fishery Circular No. 464, 5-100. *Compilation of legal limits for hazardous substances in fish and fishery products. Food and Agriculture Organization of the United Nations, Rome*.

Ghrefat, H. & Yusuf, N. (2006). Assessing Mn, Fe, Cu, Zn, and Cd pollution in bottom sediments of Wadi Al-Arab Dam, Jordan. *Chemosphere, 65*(11), 2114-2121.

Guliev, R., & Mavruk, C. (2023). 5. International Antalya Scientific Research and Innovative Studies Congress.

Madani, K. & Seenivasan, M. (2023). 4th international acharaka congress on life, engineering, and applied sciences.

Mahommed, N., & Makundi, I. (2002). Optimization of EDXRF for the study of heavy metal pollution of Lake Victoria. *Tanzania Journal of Science, 28*(1), 7-24.

Organization, W.H. (2008). *Guidelines for drinking-water quality: second addendum. Vol. 1, Recommendations*: World Health Organization.

Salomons, W., De Rooij, N., Kerdijk, H., & Bril, J. (1987). Sediments as a source for contaminants? *Hydrobiologia*, ***149***(1), 13-30.

USEPA. (1999). National Recommended Water Quality Criteria–Correction. EPA 822-Z-99–001.

Verep, B., Akin, S., Mutlu, C., Ertugral, B., Apaydin, G. & Cevik, U. (2007). Assesment of trace elements in rainbow trout (Oncorhynchus mykiss) cultured in the marine aquaculture cages on the black sea coast. *Fresenius Environmental Bulletin*, ***16***(9A), 1005.

Verep, B., Mutlu, C., Apaydin, G. & Cevik, U. (2012). The trace element analysis in freshwater fish species, water and sediment in Iyidere stream (Rize-Turkey). *Pakistan Journal of Biological Sciences: PJBS*, ***15***(14), 658-665.

Waheed, S., Malik, R. N., & Jahan, S. (2013). Health risk from As contaminated fish consumption by population living around River Chenab, Pakistan. *Environmental Toxicology and Pharmacology*, ***36***(2), 579-587.

URL-1. Milli Eğitim Bakanlığı."Su Kirliliği". http://yazarlikyazilimi.meb.gov.tr/Materyal/afyon/afyon2/cevrekirliligi/SU%20K%C4%B0RL%

C4%B0L%C4%B0%C4%9E%C4%B0.html Son Erişim Tarihi: 24.03.2014

URL-2. Hakkında Bilgi İnternet Sitesi.”Su Kirliliği ve Nedenleri”. http://www.hakkinda-bilgi-nedir.com/su-kirliligi-ve-nedenleri-nedir+su-kirliligi-ve-nedenleri-hakkinda-bilgi Son Erişim Tarihi: 24.03.2014.

URL-3. Özgür, T. ”Karacaören 2 Barajı Antalya'nın Su Sorunu Çözecek”. Haberciniz.biz. http://haberciniz.biz/karacaoren-2-baraji-antalyanin-su-sorunu-cozecek-2656514h.htm Son Erişim Tarihi : 24.03.2014

URL-4. İnternet gazete, http://www.torosgazete.com/m/TR/Haberler/Ekonomi/yeterlı-su-varsa-neden-kırlı-barajdan-su-getırıyorsun-----/ Son Erişim Tarihi : 20.05.2016

URL-5. Hürriyet Gazetesi, http://www.hurriyet.com.tr/alabalik-yetistiricileri-karacaoren-de-yasaklarin-askiya-alinmasi-istiyor-37135904 Son Erişim Tarihi : 20.06.2016

URL-6. Antalya Kent Konseyi, http://antalyakentkonseyi.org.tr/tr/genhaber.aspx?kod=2463 Son Erişim Tarihi : 12.07.2016

URL-7. Maden Teknik Arama genel Müdürlüğü http://www.mta.gov.tr/v3.0/hizmetler/il-maden-haritalari Son Erişim Tarihi: 26.02.2017