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The Presence and Population Status of Medicinal Leeches in the Some Wetlands in the Susurluk Basin

Mustafa ERGÜN[1*], Mehmet PAZAR[1], Cafer BULUT[1]

[1]Fisheries Research Institute, 32500 Eğirdir/Isparta-Türkiye

ABSTRACT

In this study, the population status of the wetlands in the Susurluk Basin (except Uluabat and Manyas Lakes) in terms of medicinal leeches and the stock status of the existing areas were investigated. Between March and October 2022 and 2023, studies were carried out in a total of 108 areas, including 26 wetlands in Kütahya, 49 wetlands in Bursa and 33 wetlands in Balıkesir. Medicinal leech population and stock studies were carried out in the wetlands located in Keles Epçeler in Bursa, Balıkesir İvrindi Çelimler and Balıkesir Dursunbey Aşağımusalar regions. A total of 378 medicinal leeches (0.02-5.19 g weight and 10.48-153.92 mm) were sampled from the study areas. The catchable amount of medicinal leeches was determined as 4.956 g for Epçeler, 218 g for Çelimler and 44 g for Aşağımusalar. When the population status and stock amounts of medicinal leeches obtained from wetlands and their habitats were analysed, it was determined that there was a decrease in medicinal leeches as a result of hunting pressure and habitat change and loss. This situation has shown that breeding systems should be increased and the pressure on nature should be reduced against the increasing demand for medicinal leeches in recent years.

Keywords: Medicinal leeches, Susurluk Basin, Kütahya, Bursa, Balıkesir

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**** CORRESPONDING AUTHOR***

mustafaergun126@gmail.com
Phone : +90 246 313 34 60
Fax : +90 246 313 34 63

Susurluk Havzasında Yer Alan Bazı Sulak Alanların Tıbbi Sülük Varlığı ve Popülasyon Durumları

Öz: Bu çalışmada Susurluk Havzası'nda bulunan sulak alanların (Uluabat ve Manyas Gölleri hariç) tıbbi sülükler açısından popülasyon durumlarının tespiti ve mevcut alanların stok durumları araştırılmıştır. 2022 ve 2023 yıllarında Mart ve Ekim ayları arasında Kütahya'da 26, Bursa'da 49 ve Balıkesir'de 33 sulak alan olmak üzere toplam 108 alanda çalışmalar yürütülmüştür. Bursa'da Keles Epçeler; Balıkesir İvrindi Çelimler ve Balıkesir Dursunbey Aşağımusalar bölgelerinde yer alan sulak alanlarda tıbbi sülük popülasyon ve stok çalışmaları gerçekleştirilmiştir. Çalışma yapılan alanlardan toplam 378 adet tıbbi sülükte örneklenmiştir (0,02-5,19 g ağırlık ve 10,48-153,92 mm). Sulak alanlardan elde edilen tıbbi sülük popülasyon durumu ve stok miktarları ile habitatları incelendiğinde gerek av baskısı gerekse habitat değişimi ve kaybı sonucu tıbbi sülüklerde azalma olduğu tespit edilmiştir. Bu durum son yıllarda artan tıbbi sülük talebine karşı yetiştiricilik sistemlerinin artırılması ve doğa üzerindeki baskının azaltılması gerektiğini göstermiştir.

Anahtar kelimeler: Tıbbi sülükler, Susurluk Havzası, Kütahya, Bursa, Balıkesir

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Introduction

Leeches are a group of creatures in the Hirudinea class of the Annelida branch, which feed on blood and predators and have more than 800 species (Sağlam 2019; Ünal et al. 2023). Leeches are widely distributed all over the world in a variety of habitats (Zhang et al. 2008) and are also found in different ecosystems such as seas, deserts and oases, especially in fresh waters (Graf et al. 2006).

The leech species of the genus Hirudo are generally reported as Hirudo medicinalis, including in Türkiye, but as a result of detailed species diagnoses and molecular genetic studies, there are 6 species in this genus (*Hirudo medicinalis, Hirudo verbana, Hirudo orientalis, Hirudo troctina, Hirudo nipponia and Hirudo sulukii*) (Figure 1). The H. verbana species, which is also found in Türkiye, is widespread in the geography extending from Switzerland-Italy to Anatolia and Uzbekistan

(Siddall et al. 2007; Utevsky et al. 2010). *Hirudo verbana* and *Hirudo sulukii* species, which have been reported in species level studies in Turkey so far, are medicinally and economically important. However, recent genetic studies have indicated that the species *Hirudo medicinalis*, which documented in scientific literature in Türkiye, is distributed in Europe and is absent in Türkiye. The species found in Türkiye has been identified as *Hirudo verbana* (Utevsky et al. 2010; Trontelj and Utevsky 2012; Sağlam et al. 2016) (Figure 1).

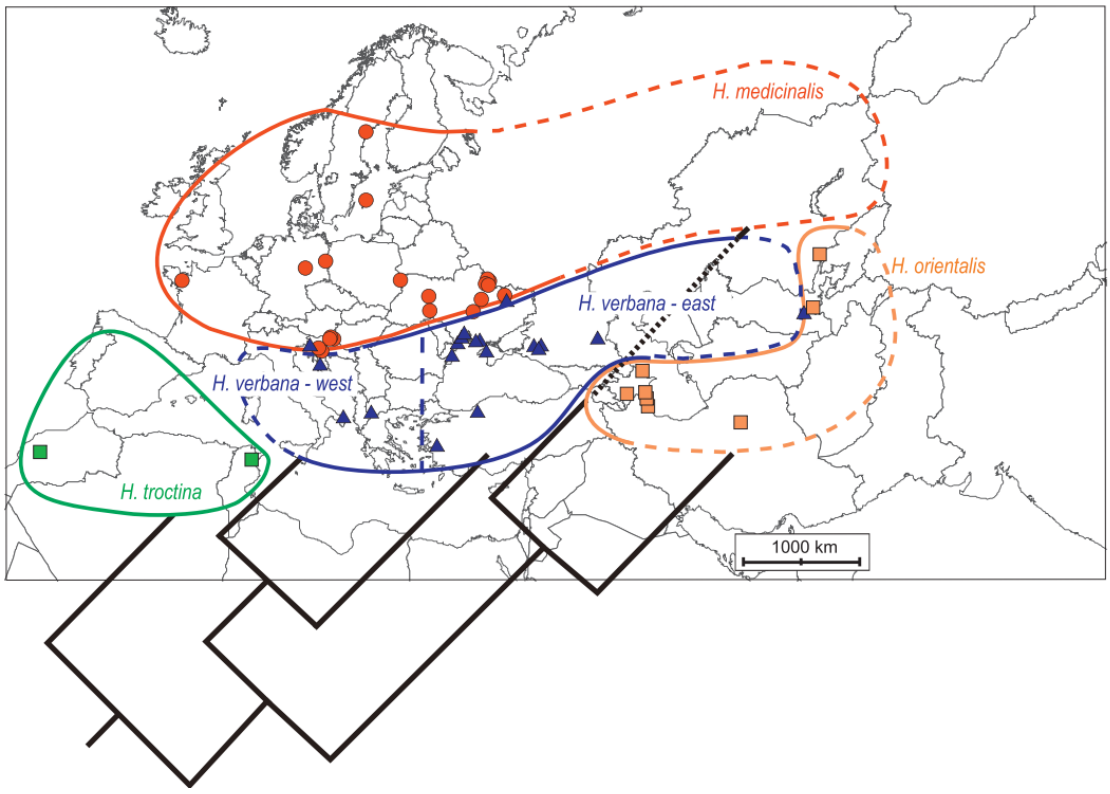

Figure 1. Distribution map of Hirudo species (Trontelj and Utevsky 2012)

They have been used for therapeutic purposes in human health since ancient times (Papavramidou et al. 2009; Gödekmerdan et al. 2011). In this context, the use of medicinal leeches has officially entered into force within the framework of the Traditional and Complementary Medicine Regulation issued by the Ministry of Health in 2014 (Anonymous 2014). Medicinal leeches, which have been used for such a long time and officially approved for use, are collected in Türkiye and exported abroad at an average price of 500 to 750 €/kg (Gödekmerdan et al. 2011). However, it is seen that higher amounts of sales are made especially abroad. For example, in Germany, medicinal leeches are sold for around 9.0-10.0 € each (Hirucult 2024), while in the USA, depending on their size, they are sold up to $ 18.15 per piece (Leeches USA 2024).

Leeches collected for medicinal purposes have experienced a dramatic decline in their populations in recent years as a result of hunting pressure, loss of general wetland habitats and pollution. In this direction, with the decline of medicinal leech species, it was added to the Red List of Threatened Species by the International Union for the Conservation of Nature and Natural Resources (IUCN) as a result of the efforts of international organizations (Trontelj et al. 2004)

The authority to manage the process related to the trade of medicinal leeches in Türkiye belongs to the Ministry of Agriculture and Forestry. As a result of this decrease in leech populations in recent years, the medicinal leech quota was applied as 8.000 kg in 2003 and 3.000 kg in 2013 (Anonymous 2002; Anonymous 2012a). Only 26.68% (1.601 kg) of the quota (6.000 kg) given by the Ministry of Agriculture and Forestry in 2010 could be exported. Accordingly, it is seen that even the quota cannot be filled and the amount exported decreases every year (Sağlam 2011). Currently, one of the most important leech exporting countries in the world is Türkiye. Türkiye is in a crucial position in the world in terms of leech exports. 86.54% of world trade is carried out from Türkiye. Under CITES, a quota is imposed by the Ministry of Agriculture and Forestry on the export of medicinal leeches from Türkiye. Since 2014, it has been applied as 2.000 kg. In 2023, it was determined

as 1.500 kg again (Anonymous 2012b and BSGM 2023).

Susurluk Basin is located in western Türkiye, between 39°-40° north latitude and 27°-30° east longitude (Anonymous 2018). Since the investigation of the medicinal leech species (*Hirudo verbana*) in the basin will contribute to both the international conservation status and the conservation and sustainable management of the relevant species, it is important to determine the population status, economic importance and to determine the level of fishable stock. In this study, the wetlands in the Susurluk Basin were screened in terms of medicinal leech Hirudo verbana populations, and the areas with medicinal leech and population status were analyzed economically and ecologically.

Material and Method

Study Area

The Susurluk Basin covers approximately 3.11% of Türkiye in terms of area and its total area is approximately 2.434.909 ha. In the basin, where the mountain system extends in the east-west direction is seen, there is Uludağ, the highest mountain belonging to the Marmara Region (Figure 2). The basin lies between the Mediterranean and the Black Sea climate. Throughout the West, summers are dry and hot, and winters are rainy and warm. As you go inland, the continental climate manifests itself. Especially in winters, these regions are cold and the coastal regions are mild in summers due to the effect of the Black Sea climate (Anonymous 2018). In the Susurluk Basin, which covers an area of more than 2 million hectares, there are many dam lakes, small lakes and ponds.

Figure 2. Susurluk Basin map (Anonymous 2018)

The study was conducted between March and October 2022 and 2023. In the study, wetland and aquatic areas (lake, dam lake, pond, etc.) located in the basin were examined. Wetlands were screened for medicinal leech population presence and economic level, and studies were conducted on population sizes, density conditions, and the amount of catchable stock (Figure 3)(Table 1).

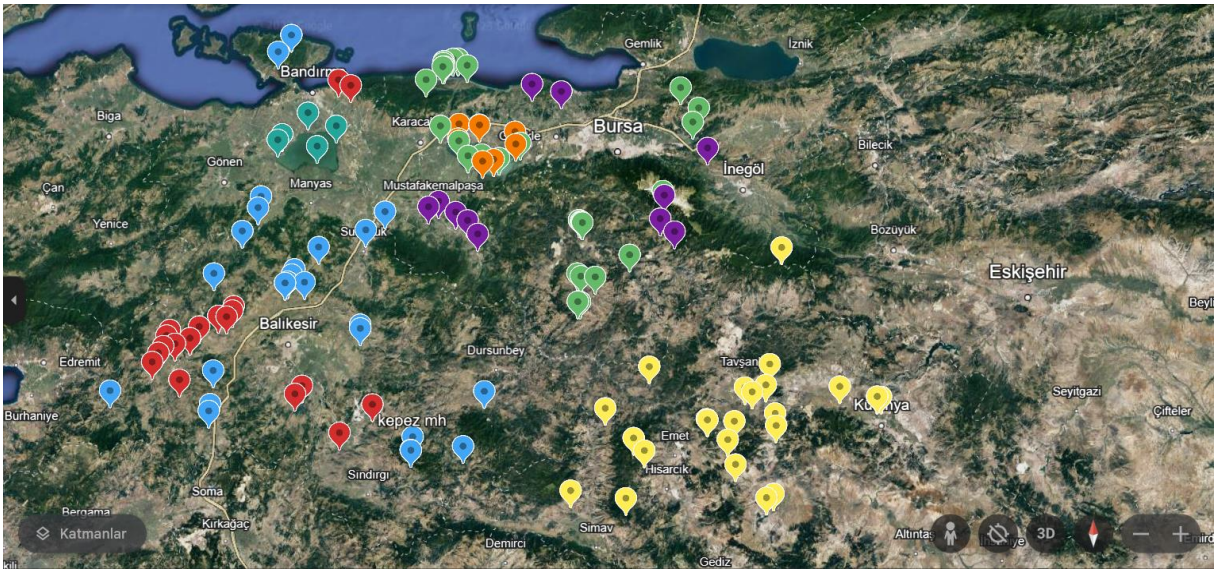

Figure 3. Medicinal leech sampling areas

Table 1. Study area sampling points and locations

No	Sampling point	Coordinate-1	Coordinate-2
	Bursa		
1	Bayramdere Pond	40°20'06.24"K	28°22'48.26"D
2	Longoz-1	40°22'40.80"K	28°25'15.74"D
3	Longoz-2	40°22'49.05"K	28°25'40.87"D
4	Longoz-3	40°22'29.64"K	28°26'32.99"D
5	Longoz-4	40°22'26.66"K	28°26'44.33"D
6	Longoz-5	40°22'17.64"K	28°26'19.01"D
7	Longoz-6	40°22'11.87"K	28°26'43.11"D
8	Dalyan Lake-1	40°23'30.27"K	28°28'18.52"D
9	Dalyan Lake-2	40°23'25.21"K	28°29'07.71"D
10	Dalyan Lake-3	40°23'33.11"K	28°29'35.48"D
11	Arapçiftliği Lake	40°22'24.69"K	28°31'21.28"D
12	Çapraz Creek	40°12'25.43"K	28°25'52.96"D
13	Karaoğlan	40°07'16.60"K	28°31'55.69"D
14	Fadıllı-1	40°08'00.51"K	28°40'24.41"D
15	Fadıllı-2	40°09'36.75"K	28°42'56.60"D
16	Akçalar	40°10'33.52"K	28°43'22.02"D
17	Kumkadı	40°10'00.49"K	28°29'51.56"D
18	Eskikaraağaç	40°12'40.72"K	28°33'58.44"D
19	Gürsu Ericek Pond	40°18'40.34"K	29°17'19.41"D
20	Kestel Nüzhetiye Gölcük Pond	40°15'26.83"K	29°21'11.45"D
21	Kestel Gölbaşı Lake	40°12'54.31"K	29°19'57.23"D
22	Keles Epçeler	40°00'30.92"K	29°13'16.49"D
23	Orhaneli Akçabük-1	39°56'38.73"K	28°55'25.61"D
24	Orhaneli Akçabük-2	39°56'29.74"K	28°55'52.63"D
25	Orhaneli Akçabük-3	39°56'21.94"K	28°56'00.75"D
26	Orhaneli Akçabük-4	39°56'15.98"K	28°56'08.10"D
27	Orhaneli Ağaçhisar	39°50'53.81"K	29°06'06.52"D
28	Büyükorhan Ciga Stream	39°47'14.81"K	28°58'45.90"D
29	Büyükorhan Cuma Stream	39°47'50.58"K	28°54'59.05"D
30	Büyükorhan Dam	39°47'21.30"K	28°55'42.64"D
31	Büyükorhan Kınık-1	39°43'08.36"K	28°55'30.01"D
32	Büyükorhan Kınık-2	39°43'09.67"K	28°55'02.66"D
33	Kestel Babasultan Dam	40°19'58.39"K	28°03'56.57"D
34	Ömerli	40°08'24.04"K	29°22'40.49"D
35	Kocaavşar-1	39°40'49.25"K	27°39'26.60"D
36	Kocaavşar-2	39°40'20.36"K	27°40'27.81"D
37	Narlı	39°41'32.17"K	27°41'4351"D

Table 1. Continue

38	Alidemirci Pond	39°42'29.65"K	27°41'57.21"D
39	Özgören Dam	39°26'00.31"K	28°11'44.00"D
40	Yörücekler Dam	39°21'33.12"K	28°04'26.97"D
41	Kemer	39°32'48.77"K	27°24'49.04"D
42	Susuzyayla	39°29'52.07"K	27°30'35.41"D
43	Yalıntaş Pond-M.K.Paşa	39°58'57.23"K	28°23'19.49"D
44	Behram	39°59'54.12"K	28°25'30.00"D
45	Hasköy	40°18'06.17"K	28°51'47.80"D
46	Çınarlı-Mudanya	40°19'21.81"K	28°45'30.39"D
47	Epçeler	40°00'30.92"K	29°13'16.49"D
48	Gököz-Keles	39°56'50.33"K	29°12'38.34"D
49	Keles Göl Kamp	39°54'41.26"K	29°15'39.30"D
	Balıkesir		
1	Erdek Yukarıyapıcı Pond	40°27'29.09"K	27°53'51.60"D
2	Erdek Pond	40°24'43.86"K	27°51'02.85"D
3	Erdek Strait	40°22'42.96"K	27°53'26.68"D
4	Manyas Necip	40° 0'33.94"K	27°47'35.68"D
5	Manyas Dam	39°58'42.61"K	27°46'58.69"D
6	Karacahisar Kocaçay	39°54'47.26"K	27°43'40.12"D
7	Balya Kocaçay	39°47'56.48"K	27°37'51.81"D
8	Susurluk	39°55'07.36"K	28°09'56.73"D
9	Susurluk Karapürçek Pond	39°58'10.65"K	28°14'05.93"D
10	Susurluk Reşadiye	39°52'14.55"K	27°59'59.23"D
11	Karesi Halkapınar	39°48'27.73"K	27°54'55.90"D
12	Karesi Karacaören	39°47'35.89"K	27°54'24.31"D
13	Karesi Karakolköy-1	39°46'23.72"K	27°53'30.88"D
14	Karesi Karakolköy-2	39°46'11.40"K	27°52'53.81"D
15	Karesi Davutlar	39°46'14.80"K	27°56'58.80"D
16	Kepsut Şerametler Kille Creek	39°38'48.66"K	28°08'54.47"D
17	Kepsut Şerametler-2	39°39'19.40"K	28°08'52.23"D
18	Savaştepe Çavlı	39°31'24.71"K	27°37'37.22"D
19	Savaştepe Sarıbeyler Dam-1	39°25'59.93"K	27°37'08.14"D
20	Savaştepe Sarıbeyler Dam-2	39°24'58.66"K	27°37'05.64"D
21	İvrindi Çelimler	39°27'57.23"K	27°15'54.08"D
22	Dursunbey Aşağımusalar	39°28'17.68"K	28°35'10.96"D
23	Sındırgı Karagöl	39°19'12.19"K	28°30'43.05"D
24	Sındırgı Kepez-1	39°18'33.90"K	28°19'36.77"D
25	Sındırgı Kepez-2	39°18'29.59"K	28°19'42.93"D
26	Sındırgı Kepez-3	39°18'21.33"K	28°19'53.59"D
27	Sındırgı Okçular-1	39°20'44.93"K	28°20'04.71"D
28	Bandırma Yeniziraatli Pond	40°19'08.11"K	28°06'40.21"D
29	İkizcetepeler Dam	39°29'05.38"K	27°56'34.53"D
30	Kocaçay	39°36'52.62"K	27°32'42.31"D
31	İvrindi Karaçepiş Pond	39°34'22.16"K	27°26'01.61"D
32	İvrindi Susuzyayla	39°29'53.59"K	27°30'34.85"D
33	İvrindi Saklıgöl	39°37'15.93"K	27°27'43.95"D
	Kütahya		
1	Domaniç Topuk Plateau	39°51'51.12"K	29°38'13.78"D
2	Kütahya Yedigöller Şehzadeler Park-1	39°26'42.59"K	29°59'10.74"D
3	Kütahya Yedigöller Şehzadeler Park-2	39°26'45.96"K	29°58'30.71"D
4	Kütahya Yedigöller Şehzadeler Park-3	39°26'41.97"K	29°58'28.22"D
5	Kütahya Yedigöller Şehzadeler Park-4	39°26'32.55"K	29°58'46.90"D
6	Kütahya İnköy Stream	39°26'42.52"K	29°59'38.07"D
7	Kütahya Enne Dam	39°28'33.26"K	29°50'31.59"D
8	Tavşanlı Devekayası	39°32'35.92"K	29°36'09.43"D
9	Tavşanlı Yağmurlu Orhaneli Creek	39°29'03.29"K	29°34'39.54"D
10	Tavşanlı Kayaboğazı Dam-1	39°24'14.81"K	29°36'42.84"D
11	Tavşanlı Kayaboğazı Dam-2	39°22'10.94"K	29°36'51.30"D
12	Tavşanlı Karacakaş	39°27'49.99"K	29°31'36.75"D
13	Tavşanlı Dağboğazı	39°28'38.46"K	29°30'20.49"D

Table 1. Continue

14	Tavşanlı Kayı Dam	39°23'04.17"K	29°27'59.42"D
15	Emet Konuş Pond	39°20'00.52"K	29°26'33.52"D
16	Emet İkibaşlı-1	39°23'20.81"K	29°22'17.92"D
17	Emet İkibaşlı-2	39°23'28.90"K	29°22'09.55"D
18	Tavşanlı Doğanlar Pond	39°32'14.29"K	29°10'10.02"D
19	Simav Toklar	39°25'25.08"K	29°00'44.91"D
20	Emet Yenice Pond	39°18'29.90"K	29°08'46.69"D
21	Emet Krater Lake	39°20'28.39"K	29°00'38.34"D
22	Simav Akdağ Örenli	39°11'40.54"K	28°53'24.86"D
23	Simav Gölcük Plateau Krater Lake	39°10'12.06"K	29°04'56.04"D
24	Emet Çerte Pond	39°15'43.54"K	29°28'02.10"D
25	Çavdarhisar Dam	39°10'12.24"K	29°34'42.59"D
26	Çavdarhisar	39°10'49.86"K	29°36'11.84"D

Medicinal Treatment and Evaluation Procedures

In the sampling of medicinal leeches, the study was carried out at water temperatures of 19 ºC and above, where they are actively present in the water (Figure 4) (Elliott and Tullett 1986). In this context; medicinal leeches were sampled with 1-hour operations in designated areas where leeches are likely to be found. In the study, firstly, the aquatic environment in which the medicinal leeches were found was walked and stirred manually and in the water environment. Thus, their activation was ensured. The floating leeches were collected with the help of a ladle or hand and placed in jars and biometric measurements were made with precision balances and digital calipers (Figure 5 and Figure 6) (Elliott 2008; Ceylan 2016).

Figure 4. Images from the sampling areas (a: Bursa Bayramdere Longoz; b: Bursa Keles Epçeler; c: Balıkesir Dursunbey Aşağımusalar; d: Kütahya Simav Toklar; e: Balıkesir İvrindi Çelimler; f: Bursa Orhaneli Akçabük)

Figure 5. Images from the sampling studies (a: Balıkesir Sındırgı Kepez; b: Balıkesir İvrindi Çelimler; c: Bursa Bayramdere)

Figure 6. Medicinal leeches measured with digital callipers

Determination of the Density of Medicinal Leeches:

In determining the densities of leeches, the method used by Sağlam (2011), Sağlam and Dörücü (2002) was applied and accordingly, the surface area (m^2) where the leeches were sampled was determined and the density of the leeches (pcs/m^2) was calculated by dividing the number of leeches sampled (pieces) by the surface area.

Estimating the Stock Status of Medicinal Leeches:

The "Area Scanning" method was used to estimate the stock amount of medicinal leeches (Sparre and Venema 1998; Avşar 2005). In this method, the approach based on determining the catchable stock amount by reflecting/proportioning the biomass value obtained in the sub-areas determined in the relevant wetland to the whole area was used. For this purpose, data on leech density per unit area, average weight of populations and the surface area where medicinal leeches can live were used. The number of leeches in each sample area was determined by multiplying the predicted surface area (m^2) where medicinal leeches can live by the density of medicinal leeches in the relevant sample area (pcs/m^2). Then, this value was multiplied by the average weight (g) of the relevant populations determined by individual weighing to estimate the catchable stock of medicinal leeches in the wetland (kg) (Ceylan 2016).

Determination of Water Quality Parameters

Each wetland was sampled and water samples were taken. For this purpose, water temperature (°C), dissolved oxygen (DO) (mg/L) concentration and oxygen saturation (OD) (%), pH, electrical conductivity (EC) (µS/cm (25°C)), total dissolved solids (TDS) (mg/L), salinity (ppt) parameters were determined in the field with WTW 3620i multiparameter meter. Ammonium nitrogen (NH_4-N) (mg/L), nitrite nitrogen (NO_2-N) (mg/L), nitrate nitrogen (NO_3-N) (mg/L), Ortho-phosphate (PO_4-P) (mg/L), sulfate (SO_4) (mg/L), hardness (mg/L

$CaCO_3$), turbidity (NTU), organic matter as $KMnO_4$ consumption (mg/L) were analyzed in the laboratory. For the analysis of the parameters, 1 L water samples were taken from each sampling locations and transported to the chemistry laboratory of Eğirdir Fisheries Research Institute Directorate. SO_4, organic matter and hardness were analyzed by titrimetric analysis, turbidity by turbidimeter, NH_4-N, NO_2-N, NO_3-N and PO_4-P by spectrophotometer in the laboratory (APHA 1971; APHA 1995; TSE 1996; Egemen and Ünlü 1996; WTW 2015).

Calculation of the Condition Factor

The condition factor is the formula that best controls the morphological structure in living organisms. It is one of the criteria for nutrition and development. In general, it is desired that the condition factor is close to 1. The condition factor is calculated by the following formula (Martinez and Vasquez 2001).

$$K = \frac{\text{(Medicinal leech weight (g))}}{\text{(Medicinal leech length (mm))}^3} \times 100$$

Regression Analysis

The length-weight relationship was calculated region by region for individuals and the whole population and the length-weight relationship curves were drawn. The equation is as follows.

$W=a*L^b$ (Bagenal and Tesch 1978)

was used to calculate length-weight relationships. In this equation; W= weight of medicinal leech (g), a and b are relationship constants, L= total length (mm). The parameters of the length-weight relationship were determined by linear regression transformation of the relation as below.

$LogW = Loga + b\ LogL$

Statistical Analysis

The data obtained as a result of the research were evaluated with the help of the SPSS 25.0 package program and Microsoft Excel 2021. The importance level was accepted as α=0.05 in all statistical tests (Özdamar 2011).

Results

During the study period, sampling was carried out in 49 areas excluding Uluabat Lake in Bursa province, 33 areas excluding Manyas Lake in Balıkesir province and 26 areas in Kütahya province (Figure 6). In the study, areas with the presence of medicinal leeches and areas where their presence was previously reported but could not be detected were determined. Medicinal leech sampling was carried out in Keles Epçeler in Bursa, İvrindi Çelimler and Dursunbey Aşağımusalar in Balıkesir (Figure 7). Although the presence of medicinal leeches was previously reported in Bayramdere Longoz and Orhaneli Akçabük in Bursa province; Manyas Necip and İvrindi Susuzyayla in Balıkesir province; and Simav Örenli and Toklar in Kütahya province, no samples were detected in the study. Only 2 medicinal leeches were obtained in Balıkesir Sındırgı Karagöl and were not evaluated statistically since sufficient samples could not be obtained (Figure 8). In other areas, no medicinal leech presence was found. The data of the medicinal leeches obtained in the study are given in Table 2, length-weight distribution regression graph is given in Figure 9, weight distribution histogram graph is given in Figure 10 and length distribution histogram graph is given in Figure 11.

Table 2. The lowest, highest and average data of the samples obtained from the areas with medicinal leeches in Bursa (Epçeler) and Balıkesir (Çelimler and Aşağımusalar) province

Bursa Keles Epçeler			
Number of samples		**226**	
	Minimum	**Maximum**	**Average**
Weight (g)	0.07	5.19	0.92±0.94
Length (mm)	10.48	153.92	81.24±0.94
Condition factor	0.05	0.45	0.14±0.05
Balıkesir Ivrindi Celimler			
Number of samples		**139**	
	Minimum	**Maximum**	**Average**
Weight (g)	0.02	1.92	0.15±0.26
Length (mm)	30.57	104.07	52.11±12.50
Condition factor	0.03	0.27	0.08±0.04
Balıkesir Dursunbey Aşağımusalar			
Number of samples		**13**	
	Minimum	**Maximum**	**Average**
Weight (g)	0.34	1.84	0.97±0.42
Length (mm)	74.20	119.95	93.95±14.29
Condition factor	0.08	0.17	0.11±0.02

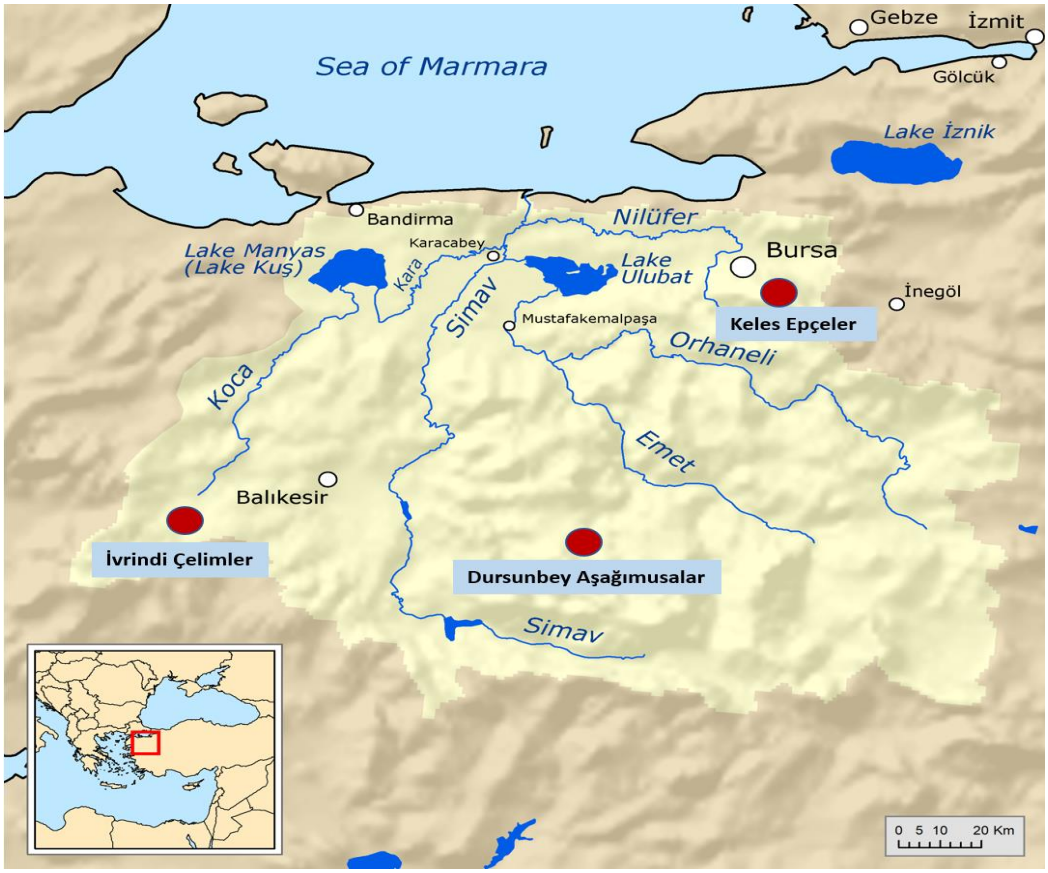

Figure 7. Map of medicinal leech sampling areas

Figure 8. Map of areas where the presence of medicinal leeches was previously reported but not found in the sampling study

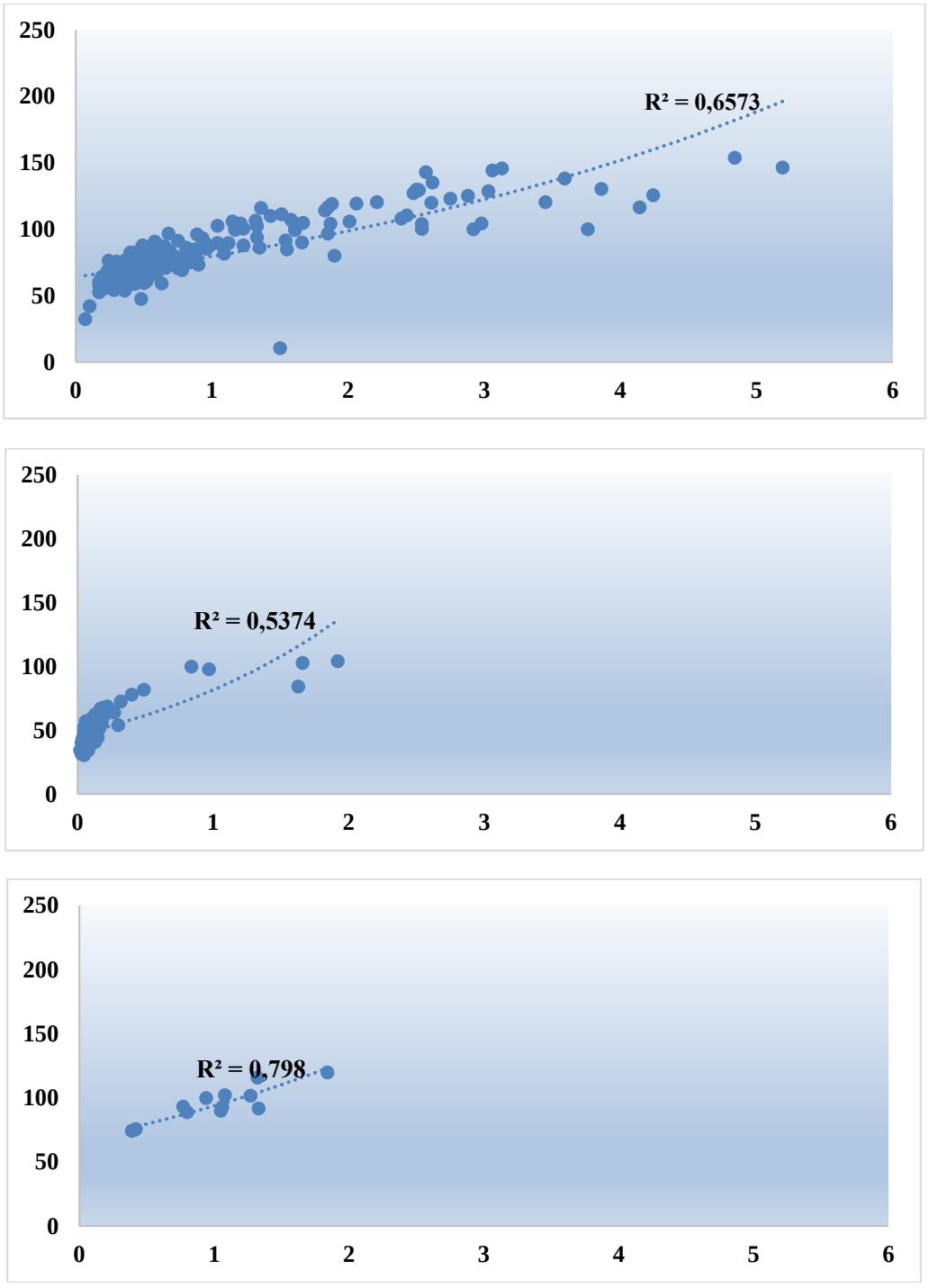

Figure 9. Epçeler (Bursa), Çelimler and Aşağımusalar (Balıkesir) medicinal leech length-weight distribution regression graph

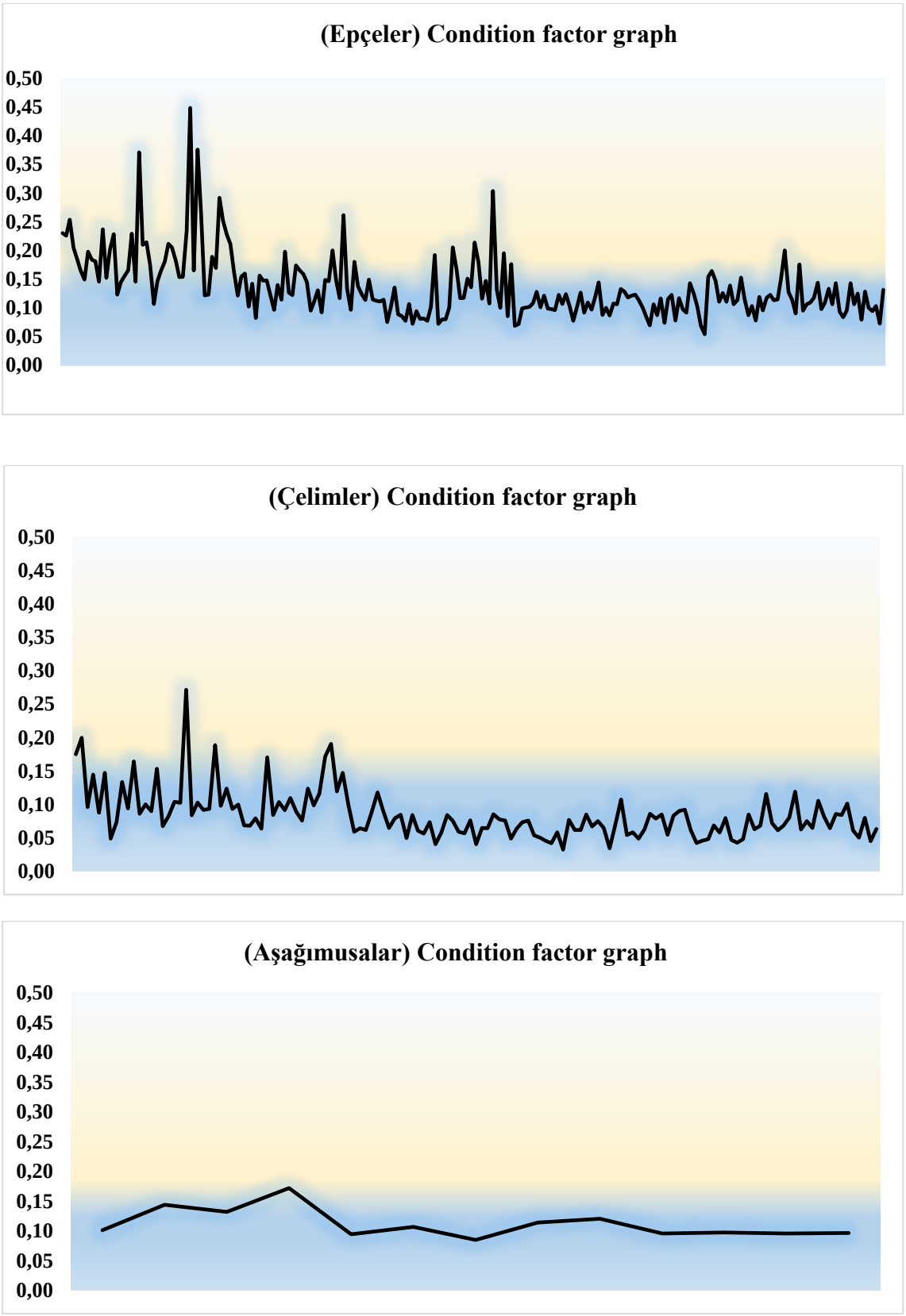

Figure 10. Epçeler (Bursa), Çelimler and Aşağımusalar (Balıkesir) medicinal leech condition factor graph

Densities and catchable stocks of medicinal leeches obtained from Bursa Keles Epçeler, Balıkesir İvrindi Çelimler and Dursunbey Aşağımusalar are given in Figure 11.

	**Bursa Keles Epçeler**
Medicinal Leech Density	3.77 pieces/m^2
Catchable Medicinal Leech Amount	4.956 g
	**Balıkesir İvrindi Çelimler**
Medicinal Leech Density	0.46 pieces/m^2
Catchable Medicinal Leech Amount	218 g
	**Balıkesir Dursunbey Aşağımusalar**
Medicinal Leech Density	0.04 pieces/m^2
Catchable Medicinal Leech Amount	44 g

Figure 11. Epçeler (Bursa) and Çelimler, Aşağımusalar (Balıkesir) densities of medicinal leeches and catchable leeches

The water quality results of the areas where medicinal leeches were obtained are given in Table 3. When the water quality data obtained from the wetlands where medicinal leeches are obtained are examined, it is seen that there is relatively nitrogen and phosphorus content, however, it contains conductivity values with an average range of 400-600 µS/cm and salinity values with a range of 0.0-0.2. It is also seen that the total alkalinity content is around 200 mg/L and the total hardness level is around 345 mg/L. This situation shows that medicinal leeches are organisms with high tolerance levels in terms of water quality, however, they are more effective especially in freshwater environment and prefer relatively clean waters.

Table 3. Water quality data of areas with medicinal leeches

	Bursa Keles Epçeler	Balıkesir İvrindi Çelimler	Balıkesir Dursunbey Aşağımusalar
Sampling time:	June 2022	July 2022	July 2022
Water temperature (^{o}C):	22.3	24.6	23.6
Dissolved oxygen (mg/L):	8.03	10.1	10.4
O_2 saturation (%):	93.2	112.1	113.1
pH:	9.01	8.56	8.65
Conductivity (µS/cm):	456	501	643
Total dissolved solids (mg/L):	0.342	0.377	0.498
Salinity (%):	0,2	0,2	0.2
Turbidity (NTU):	2,4	3.1	2.2
Total alkalinity(mg/L):	231.32	198.65	212.45
Total hardness (mg/L):	337	352	348
Ammonium (mg/L):	0.199	0.157	0.117
Nitrite (mg/L):	0.043	0.055	0.054
Nitrate (mg/L):	2.32	1.76	1.09
Ortho-phosphate (mg/L):	0.084	0.071	0.096

Discussion

In the study investigating the presence of medicinal leech populations and the size-weight distribution and stock amount of leeches in the areas where leeches were found, a total of 108 areas, including 26 wetlands in Kütahya, 49 wetlands in Bursa and 33 wetlands in Balıkesir, were surveyed in 2022 and 2023.

Kasparek et al. (2000), determined the presence of medicinal leeches in 42 of 65 wetlands surveyed in Türkiye using semi-quantitative method. The strongest populations were found in the Kızılırmak Delta, Yeşil Irmak Delta and Karagöl wetlands. Susurluk Basin is also one of the important wetlands of Türkiye in terms of the presence and population of medicinal leeches. Medicinal leeches have been identified in the wetlands of the basin, especially in Uluabat and Manyas Lakes, and have formed populations in certain areas.

Elliott (2008) used reduction-based "Maximum Likelihood" (Zippin 1956) and "Regression" (Leslie and Davis, 1939) methods to estimate *Hirudo medicinalis* population size at Jenny Dam. It was determined that the leech population ranged between 248-288 individuals over the years (1986-1992). It was found that the least represented group in the population was over 5 g with approximately 1% and the most represented group was the immature group (between 0.4-3.4 g). In this study, samples between 0.15 g and 0.97 g were obtained on average. Medicinal leeches collected in Çelimler region were found to be lower in weight compared to other regions.

Sağlam et al. (2008), reported that *Hirudo medicinalis* was found in 22 of 87 wetlands in the Eastern Anatolia Region. Ekman bucket and modified leech frame were used to capture leeches, and time-based collection method was preferred to determine leech density. It was reported that the average weight of leeches collected from the relevant wetlands was 1.90 g. With the genetic identification studies carried out in recent years, it has been determined that the species previously reported as *H. medicinalis* in Türkiye is actually *H. verbana*. When the data obtained in this study are evaluated with this study, it is concluded that medicinal leeches show that they grow well in areas with intense hunting pressure and low habitat destruction.

Ceylan (2023), in his study in Sındırgı Karagöl, reported that the number of medicinal leeches, which they found 12 in 2012, was 2 in 2022. In our study in the same wetland, 2 medicinal leeches were obtained.

Ceylan (2016) investigated the ecology, population size and hunting efficiency of medicinal leech *Hirudo verbana* populations in the wetlands around Lake Eğirdir and estimated the amount of medicinal leeches that can be hunted in the wetlands around Lake Eğirdir as 1,988,700 (593 kg). Ceylan et al. (2017) reported that they sampled leeches from 232 different habitats in wetlands within the borders of Afyonkarahisar, Burdur, Denizli, Isparta and Konya within the scope of the project "Investigation of the Leech Fauna and Economic Importance of the Lakes Region" carried out by TAGEM between

2011-2014, and as a result of the study, leeches were detected in 119 habitats. In their study carried out in the wetlands of the Lakes Region indicated a presence of a catchable stock of 142.46 kg (1.166.000 leeches) of medicinal leeches in the region. In the research Lake Eğirdir with 481.05 kg, Lake Gavur with 226.34 kg and Lake Karamık with 82.78 kg were determined as the habitats with the highest amount of catchable medicinal leeches. However, in recent years, wetlands in provinces such as Afyonkarahisar, Konya, Isparta, Denizli, especially in Lake Eğirdir, have seen serious population declines due to both the intense effects of local climate change, intense hunting pressure against medicinal leech populations and habitat change. In this context, it is significant to switch to sterile medicinal leech production as soon as possible due to excessive demand.

As a result, the use and popularity of medicinal leeches have increased in recent years and their stock amounts have been decreasing considerably due to hunting pressure and habitat loss in nature. Türkiye, which ranks first in exports in the world, has reduced the quota from 10 tonnes to 2 tonnes due to these problems. In this context, the cultivation of medicinal leeches should be started as soon as possible and hunting from nature.

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Conflict of Interest Declaration

The authors declare that there are no financial interests or personal relationships that may have influenced this work.

Ethical Approval Statement

Since experimental animals were not used in this study, Local Ethics Committee Approval was not obtained.

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