Int. J. Pure Appl. Sci. 8(1);61-70 (2022)

IJPAS
ijpas@munzur.edu.tr
ISSN: 2149-0910

Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

Evaluation of the Microbiological Quality and Public Health Risks of Urban Beaches on the Munzur and Pülümür Streams in Tunceli Province

Banu Kutlu[1]*, Serdar Çetindağ[2]
[1] *Munzur University, Faculty of Fisheries, Tunceli, Turkey*
[2] *Tunceli Provincial Health Directorate Tunceli, Turkey*
**banukutlu@munzur.edu.tr, serdarcetindag@gmail.com*
Received date:16.09.2021, Accepted date: 29.12.2021

Abstract

The study is aimed to evaluate the microbiological quality of water samples obtained from the beaches of the Munzur and Pülümür streams in Tunceli province, during the summer season of 2019. The samples were analyzed for the fecal indicator bacteria to reveal the bathing water quality of these beaches. The samples were collected from 10 sampling points in the study region between June and September 2019. Fecal streptococci, total coliform, fecal coliform bacteria were determined the highest in August and the lowest in May and July according to the analysis. The data were evaluated according to the bathing water quality directive. The bathing water quality was identified as class B for all the sample points on the beaches. It was found that there was no data exceeded the mandatory value, as per the bathing water directive. This has been applied for the first time for inland waters. Esinti, Halbori, Kavacik, Kutu Stream, and Anahita beaches were found to be most suitable for swimming. According to the results obtained, it was determined that Tunceli city beaches are not polluted in terms of microbial parameters. However, in this study, it is recommended to carry out regular monitoring and evaluation by using appropriate methods to reduce the microbial load in the Munzur Stream and Pülümür Stream basins.

Keywords: Fecal indicator, microbial assessment, Tunceli Beaches

Tunceli İli Munzur ve Pülümür Çayı Kent Plajlarının Mikrobiyolojik Kalitesinin Değerlendirilmesi ve Halk Sağlığı Riskleri

Öz

Tunceli ili Munzur ve Pülümür çayı üzerindeki plajlarının 2019 yılı yaz sezonu boyunca çay suların numunelerinin mikrobiyolojik analiz sonuçları fekal indikakatör bakteri açısından uygunluğu değerlendirilmesi ve bu plajların yüzme suyu kalitesinin ortaya konulması amaçlanmıştır. Çalışma 2019 yılında Haziran- Eylül ayları arasında Tunceli ili Pülümür ve Munzur Çayları üzerinde 10 numune alma noktasından numunelerinin mikrobiyolojik sonuçları dâhil edilerek veriler yüzme suyu kalitesi yönetmeliğine göre değerlendirilmiştir. Fekal streptokok, toplam koliform, fekal koliform bakteri analize göre en yüksek Ağustos ayı, en düşük ise Mayıs, Temmuz ayında tespit edilmiştir. Pülümür ve Munzur Çayı üzerindeki plajlardan alınan tüm numune noktalarındaki yüzme suyu kalite sınıfının B sınıfı olduğu belirlenmiştir. İlk defa iç sularda uygulanan yüzme suyu ilgili yönetmenliğim zorunlu değeri aşan veri olmadığı tespit edilmiştir. Esinti, Halbori, Kavacık, Kutu deresi, Anahita plajları yüzme için en tüm zamanlarda elverişli yüzme alanlarıdır. Elde edilen sonuçlara göre Tunceli kent plajları mikrobiyal parametreler açısından kirli olmadığı belirlenmiştir. Fakat bu çalışmada Munzur Çayı ve Pülümür çayı havzasındaki mikrobiyal yükü azaltmak için uygun yöntemler kullanılarak düzenli izleme ve değerlendirme yapılması önerilmektedir.

Anahtar Kelimeler: Fekal indikatör, mikrobiyal değerlendirme, Tunceli Plajları

INTRODUCTION

Many water resources worldwide are affected by intense anthropogenic activities (Hering et al., 2015). These pollution sources can be either point-based or can spread with the flow regime. However, in recent years, the construction of dams has caused interruptions in the natural flow of the rivers and disruption of the organic matter cycle and river flow activity (Boehm et al., 2009). The physicochemical

ijpas@munzur.edu.tr
ISSN: 2149-0910
Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

properties of a river play an important role in the ecological processes of aquatic ecosystems by having a direct or indirect effect on the entire physical habitat (Tamer and Çolaker, 2020; Verep et al., 2019; Wu et al., 2014). In addition, the pollution load from domestic and agricultural land constitutes an important factor in river pollution (Hilton et al., 2006; Mutlu and Verep, 2018). Treatment facilities for the prevention of this pollution are very costly and cause a decrease in biological diversity, leading to the dominance of single species (Binzer et al., 2016).

In recent years, there has been a gradual increase in recreational water activities around the world. Water-based recreational activities such as swimming, rafting, underwater diving, jet-skiing water skiing, and canoeing are becoming increasingly common in countries like Turkey, which is rich in water resources. However, these anthropogenic activities are also affecting freshwater resources (Hering et al., 2006). The lotic ecosystems present in the freshwater bodies are most vulnerable to pollution due to transportation of industrial and municipal wastewater and agricultural runoff (Ammar et al., 2015; Baran et al., 2016). In addition, the residential settlements around rivers and streams directly affect the quality of water. Many environmental factors like the discharge of mine waste leachate, agricultural irrigation, sewage, and other wastes lead to heavy metal pollution in water bodies. Studies have shown that swimming and recreational activities in polluted waters can increase the likelihood of eye and ear infections, gastrointestinal and respiratory tract diseases (Yaşar, 2019; Wade et al., 2006; Wiedenmann et al., 2006; Whitmann et al., 2014). Many countries have imposed legal regulations for recreational activities to protect public health. In this context, the "Bathing Water Directive" was published in Turkey in the official gazette number 26048 (76/160/EU) on 9th January 2006. This directive aims at determining the water quality for swimming and recreational purposes and preventing water contamination from microbiological pollutants. According to the directive, regular samples are collected from the bathing water by the Ministry of Health to analyze the chemical and fecal indicator bacteria levels, and to determine the quality classification of the bathing water (Bonilla et al., 2007).

The present study aims to determine the conformity of the microbiological analysis of the beach water samples collected during the summer season of 2019–2020 in Tunceli province. To evaluate the bathing water quality of these beaches, the samples were tested in terms of fecal indicator bacteria (FIB) levels.

MATERIAL and METHODS

The Munzur Stream, originates from the Munzur Mountains and flows rapidly southward through deep and narrow valleys in the Ovacık district. It collects water from other streams such as Havaçor, Şamuşağı, Mamusağı, Kabusağı, Nanikuşağı, Haçılı, Mercan, Merho, Sarıtaş, Laç, Kalan and İksor. It then merges with the Pülümür Stream in the center of Tunceli and flows southward into the Uzunçayır Reservoir and then into Keban Reservoir (URL-1, 2016).

This station selection should represent the microbiological quality of the site. This means that the entire area is represented in exposure to potential contaminants that are homogeneous. Monitoring point:It should be as easily accessible as possible (easy to monitor and find) for the personnel taking the sample. This means that it must be several meters from the Beach (includes waves or swimmers having an effect on the precipitation of suspensions). Must be in water at least 1 meter deep. Samples should be taken from the same spot at regular intervals and at regular times, and should be monitored in a statistically representative manner. According to the regulation, these samples should be taken twice a month, that is, once every 15 days. It can be taken 3 days before or 3 days after this 15 day period. Samples should be taken at a depth of 0.3 m from the water surface. The sample should be taken from a depth of at least 1 m and 30 cm below the water surface to be as representative of swimming conditions as possible. The sample to be taken from the river should be taken from the front of the stream. Sampling requires excellent hygienic conditions to avoid any external contamination. For this reason, hands should be washed before sampling and tools and equipment that will come into contact with water should be cleaned before use. Tools and equipment must be purposeful. Robust and lightweight containers should be used to make tools and equipment easier to transport and keep clean. Except for the bottles, the instrument equipment

IJPAS
ijpas@munzur.edu.tr
ISSN: 2149-0910

Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

does not need to be subjected to a complete sterilization process (hand contact with the bottle mouths should be avoided). It is recommended that the sampling container be opened and closed directly in water whenever possibleIn this study, water samples were collected from six stations on Munzur Stream (Dersim 1 st, Esinti 2 st, Kemerbel 3 st, Miskişah 4 st, Halbori 5 st, Anahita 6 st) and four stations on Pülümür Stream (Marçik 7st, kavacık 8 st, Sinan 9 st, Kutuderesi 10 st) (Figure 1). Tunceli province is the only place in Turkey that has a swimming area in the rivers. In 2019, ninety microbiological samples were collected from 10 sampling points in Munzur and Pülümür Streams from June to September. The data were evaluated according to the "Bathing Water Directive" (Table 1). The quality classification of beach water is shown in Table 2 (Anonymous, 2006; Anonymous, 2008).

Microbiological analyzes were carried out in the laboratory of Erzurum provincial health directorate. For microbiological examination, the samples were brought to the laboratory by cold chain within 24 hours and analyzes were carried out at room temperature. In the examination of the samples; Membrane Filter Method, which is accepted and recommended all over the world, and which is frequently applied in our country, is used. Filtration was carried out using 0.45 μm filters in the Millipore membrane filter assembly. Membrane filters, on which the sample was passed, were placed on the appropriate media used to distinguish each microorganism after the filtration process. Finally, the petri dishes were closed and placed in the oven upside down. After the petri dishes placed in the oven for each microorganism species were incubated at the required temperatures (35-37-41-44.5 ^{0}C), the colonies were counted. The media were obtained from Sigma-Aldrich/Merck KGaA in accordance with microbiological analysis standards. Lauryl tryptose broth-Brilliant green lactose broth, mFC (m-Fecal Coliform) agar, Slanetz-Bartley ready-made media were used to determine the total coliform, Fecal coliform, Fecal streptococcus and Salmonella numbers, respectively. Total coliform, fecal coliform and streptococcus were analyzed in accordance with SM 9221 B, SM 9222 D, SM 9230 C standards (APHA-AWWA-WEF 2005) . One way anova was applied in the sample data MINITAB program.

RESULT

The microbiological analysis of the sampling point on Dersim Beach showed the lowest value for Total coliform (200 cfu100 ml^{-1}) in the first week of July. The highest value of 3500 cfu100 mL^{-1} was observed in the first week of August (Figure 2). In the fecal coliform bacteria analysis, the highest value was observed as 1250 cfu100 mL^{-1} in the first week of August. The lowest fecal coliform value was found to be 200 cfu 100 ml^{-1}in July first week (Figure 3). In the fecal Streptococcus bacteria analysis of Dersim Beach samples, the highest value was found to be 280 cfu 100 ml^{-1}in the last week of August. The lowest value was observed as 110 cfu 100 ml^{-1}in May (Figure 4).

The microbiological analysis of samples from Esinti Beach showed the lowest value of 100 cfu 100 ml^{-1}for TC in September last week. The highest value of 2400 cfu 100 ml^{-1}was measured in the last week of August (Figure 2). The FC analysis depicted the highest value as 400 cfu 100 ml^{-1}in the last week of August. The lowest FC value was found to be 100 cfu 100 ml^{-1}in September last week (Figure 3). As per the analysis of FS bacteria on Esinti Beach samples, the highest value was determined as 240 cfu 100 ml^{-1}in the last week of August. The lowest value was determined as 25 cfu 100 ml^{-1}in September last week (Figure 4).

Analysis of samples from Halbori Beach indicated the lowest TC (10 cfu 100 ml^{-1}) value in the first week of August. The highest TC value (3000 cfu100 ml^{-1}) was observed in the first week of July (Figure 2). The FC analysis showed the highest value as 450 cfu 100 ml^{-1}in the first week of July, and the lowest value (100 cfu100 ml^{-1}) in September last week (Figure 3). Analysis on FS bacteria Halbori Beach samples showed the highest bacterial value (450 cfu100 ml$^{-1)}$ in the first week of July. On the contrary, the lowest value was found to be 10 cfu 100 ml^{-1}in the last week of September (Figure 4).

In the case of samples collected from Kavacık Restaurant Beach, the lowest TC value (200 cfu 100 ml^{-1}) was observed in the first week of August and the highest value (3100 cfu 100 ml^{-1}) was measured in May (Figure 2). According to the FC analysis, the highest value was determined as 390 cfu 100 ml^{-1}in July last week and the lowest value (60 cfu100 ml^{-1}) in August last week (Figure 3). The highest FS bacteria value was determined as 450 cfu 100 ml^{-1}in

Int. J. Pure Appl. Sci. 8(1);61-70 (2022)
IJPAS
ijpas@munzur.edu.tr
ISSN: 2149-0910
Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

the first week of July and the lowest (10 cfu/100 mL) in the last week of September (Figure 4).

With Sinan Beach samples, the lowest TC (150 cfu100 ml^{-1}) was measured in July last week, and the highest value (3500 cfu100 ml^{-1}) was found in May (Figure 2). The results of FC analysis showed the highest value of 430 cfu 100 ml^{-1}in the last week of July. The lowest FC value was found to be 50 cfu 100 ml^{-1}in the first week of August (Figure 3). The FS analysis of Kavacık Restaurant Beach samples indicated the highest value of 250 cfu 100 ml^{-1}and lowest value of 30 cfu 100 ml^{-1}in the last week of July (Figure 4).

Kemerbel Beach samples depicted the lowest TC value of 170 cfu 100 ml^{-1}in September and the highest value of 2600 cfu 100 ml^{-1}in August last week (Figure 2). As per the FC analysis, the highest value was determined as 430 cfu 100 ml^{-1}and the lowest value as 90 cfu 100 ml^{-1}in the last week of July (Figure 3). The highest FS value was determined as 260 cfu 100 ml^{-1}in July last week; whereas the lowest FS value was found to be 26 cfu 100 ml^{-}1September last week (Figure 4).

From the analysis of Kutuderesi Beach samples, the lowest TC value was found to be 320 cfu 100 ml^{-1}in the first week of September. The highest value of 3200 cfu 100 ml^{-1}was measured in May (Figure 2). According to the analysis of FC bacteria, the highest value was observed as 490 cfu 100 ml^{-1}in June and the lowest value of 80 cfu 100 ml^{-1}in July last week(Figure 3). The highest value of FS bacteria (490 cfu100 ml^{-1}) was observed in July last week, and the lowest value (19 cfu100 ml^{-1}) in September last week (Figure 4).

Samples from Marcik Beach showed the lowest TC value of 180 cfu 100 ml^{-1}in the last week of July. The highest TC value was measured as 3300 cfu 100 ml^{-1}in May (Figure 2). The FS analysis revealed the highest value as 400 cfu 100 ml^{-1}in May and the lowest value as 70 cfu 100 ml^{-1}in the last week of July (Figure 3). The FS value was found to be highest in May (230 cfu100 ml^{-1}) and lowest (32 cfu100 ml^{-1}) in the first week of August (Figure 4).

For Miskişah Beach samples, the TC value was lowest in the last week of July (27 cfu/100 ml) and highest (2500 cfu100 ml^{-1}) in the last week of August (Figure 2). The highest FC value was noted as 420 cfu 100 ml^{-1}in the last week of August. The lowest FC value was found to be 27 cfu 100 ml^{-1}in the last week of July (Figure 3). The FS values were found to be highest (250 cfu100 ml^{-1}) in August last week and lowest (30 cfu100 ml^{-1}) in July last week (Figure 4).

The samples from Anahita Beach exhibited the lowest TC value of 20 cfu 100 ml^{-1}in June first week and the highest value 3500 cfu100 ml^{-1}) in the last week (Figure 2). The FC value was determined as highest (870 cfu100 ml^{-1}) in the last week of August and lowest (20 cfu100 ml^{-1}) in the first week of June (Figure 3). The highest FS value was observed as 480 cfu 100 ml^{-1}in the last week of August, whereas the lowest value was determined as 20 cfu 100 ml^{-1}in May (Figure 4).

The analysis was carried out on each microorganism at ten different sampling points. The values were averaged for May, June, July, August, and September (2019) (Table 3).

According to the monitoring results obtained in 2019, ten swimming areas were categorized as Class B (100%). There were no swimming areas classified as A, C, or D in 2019 (Tablo 4).

DISCUSSIONS

The province of Tunceli is among the provinces where wastes are considered a problem with priority (T.E.I.P.R, 2017). Coliform bacteria are commonly used bacterial markers to measure water pollution. Although this type of bacteria does not directly cause diseases, some types of microorganisms can have negative effects on human health.

In underdeveloped countries, high levels of pathogens are found in freshwater basins due to sewage discharge and livestock enterprises (Çelebi, 2018).

Proper management, protection, and correct use of freshwater are important for life on earth. In this context, various organizations worldwide need to follow some legal regulations to protect water. With the Water Framework Directive (WFD), the European Union aims to adopt a sustainable water policy to bring water resources to a good ecological condition and have a better understanding of water use. The main purpose of this directive is to protect the basin-based surface and groundwater to have a good ecological status by 2015 (Gabriele et al., 2016). According to WFD, the ecological status can be attained by examining the structure of the aquatic ecosystem, analyzing the function of surface waters based on their classification, and determining their quality (Fleisher et al., 1998).

Int. J. Pure Appl. Sci. 8(1);61-70 (2022)

IJPAS
ijpas@munzur.edu.tr
ISSN: 2149-0910

Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

In the present study, the highest number of coliform groups was recorded in August-September. Temperature limits affect the development and distribution of microorganisms in water (Sponza, 2009; Güven and Zorba, 2013). The coliforms, a mesophilic (20–45 ^{0}C) microorganism, were found numerically high in the measurements performed in July. This can be attributed to the fact that warming of the surface waters takes place in the summer months. In addition, the feces of animals grazing around the canal get mixed in the water, leading to a high coliform number in these months.

Since streams reflect the condition and quality of the surrounding habitat, stream evaluation programs should determine the relationships between water quality and quantity, groundwater and surface water, and the aquatic organisms that depend on them. Considering these complex interactions, the biological assessment is the direct and most effective method in determining the status of the streams.

CONCLUSIONS

In the present study, the bacteriological analysis of samples collected from the Tunceli swimming areas was evaluated in 2019. The data used for the study were obtained by using the "Bathing Water Monitoring System", published regularly on the website of the Ministry of Health. In this study, samples belonging to ten sampling points on the coast of Pülümür and Ovacık districts of Tunceli province were collected for the microbiological analysis. The selected stations are in serious danger due to the uncontrolled mixing of domestic and animal wastes into the water. The most important tourism time in our country is considered to be summer. During the tourism period in the region, an increase in bacteria has been observed in parallel with the population density. Necessary measures should be taken to prevent risk to public health in the future.

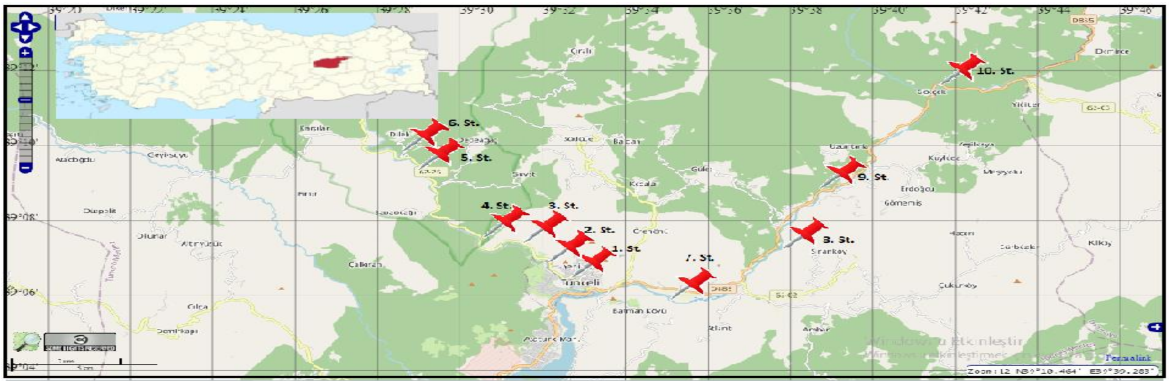

Figure 1. Study area

Int. J. Pure Appl. Sci. 8(1);61-70 (2022)

ijpas@munzur.edu.tr
ISSN: 2149-0910

Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

Table 1. Criteria for fecal indicator bacteria according to the Bathing Water Quality Regulation

Parameters	Guide Values (kob/100 ml)	Mandatory values (kob/100
Total Coliform (TC)	500 (2015 year)	10000
Fecal Coliform (FC)	100 (2015 year)	2000
Fecal Streptokok (FS)	100	1000

Table 2. Bathing water quality classification

Cl	Quality	
A	Excellent	At least 80% of the results for TC and FC are below the guideline value
B	Good	At least 95% of results below the mandatory value for TK, FK, and FS
C	Bad	5% to 33% of results are above the required value
D	Forbidden	More than 33% of results are above the required value

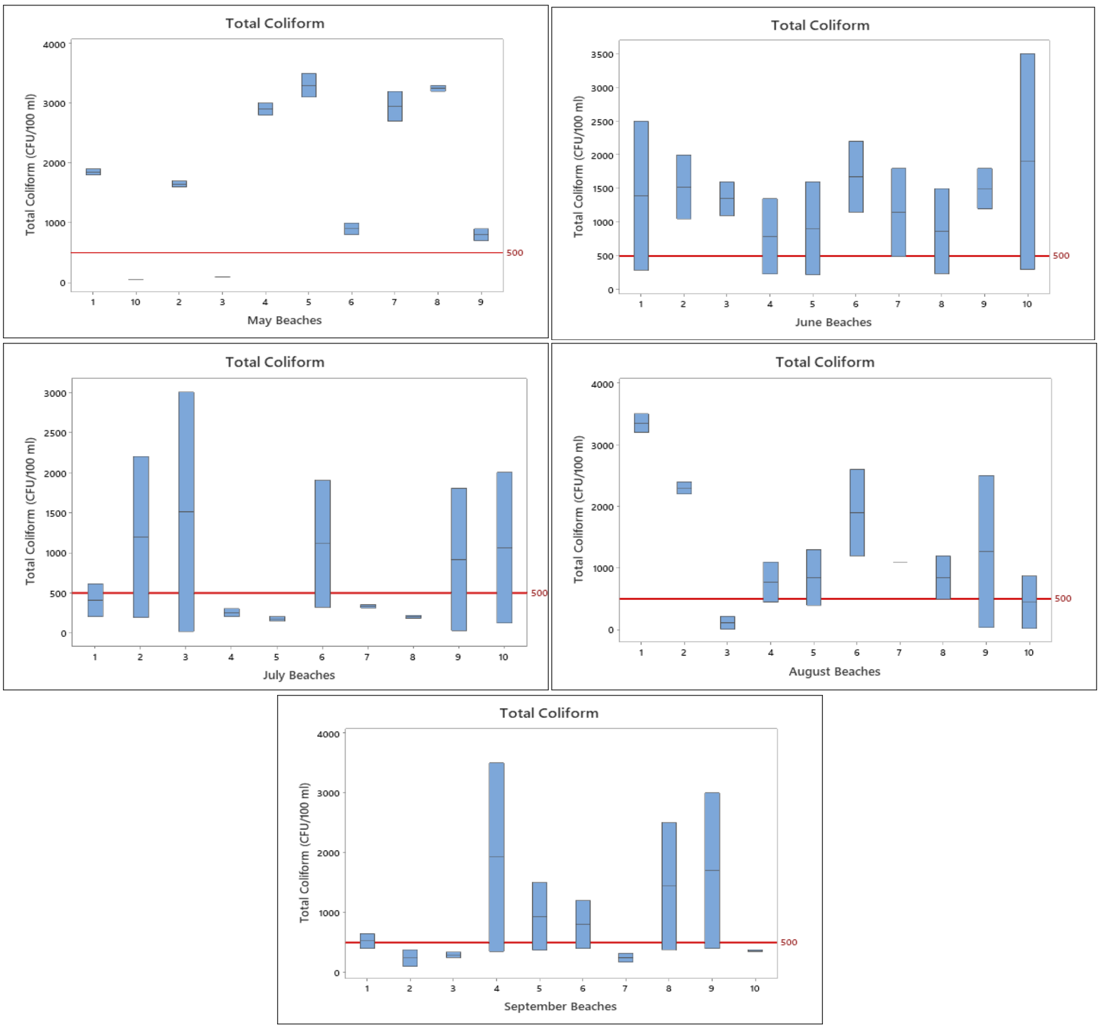

Figure 2 Monthly distribution of total coliform bacteria levels at sampling points in 2019

Int. J. Pure Appl. Sci. 8(1);61-70 (2022)

IJPAS
ijpas@munzur.edu.tr
ISSN: 2149-0910

Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

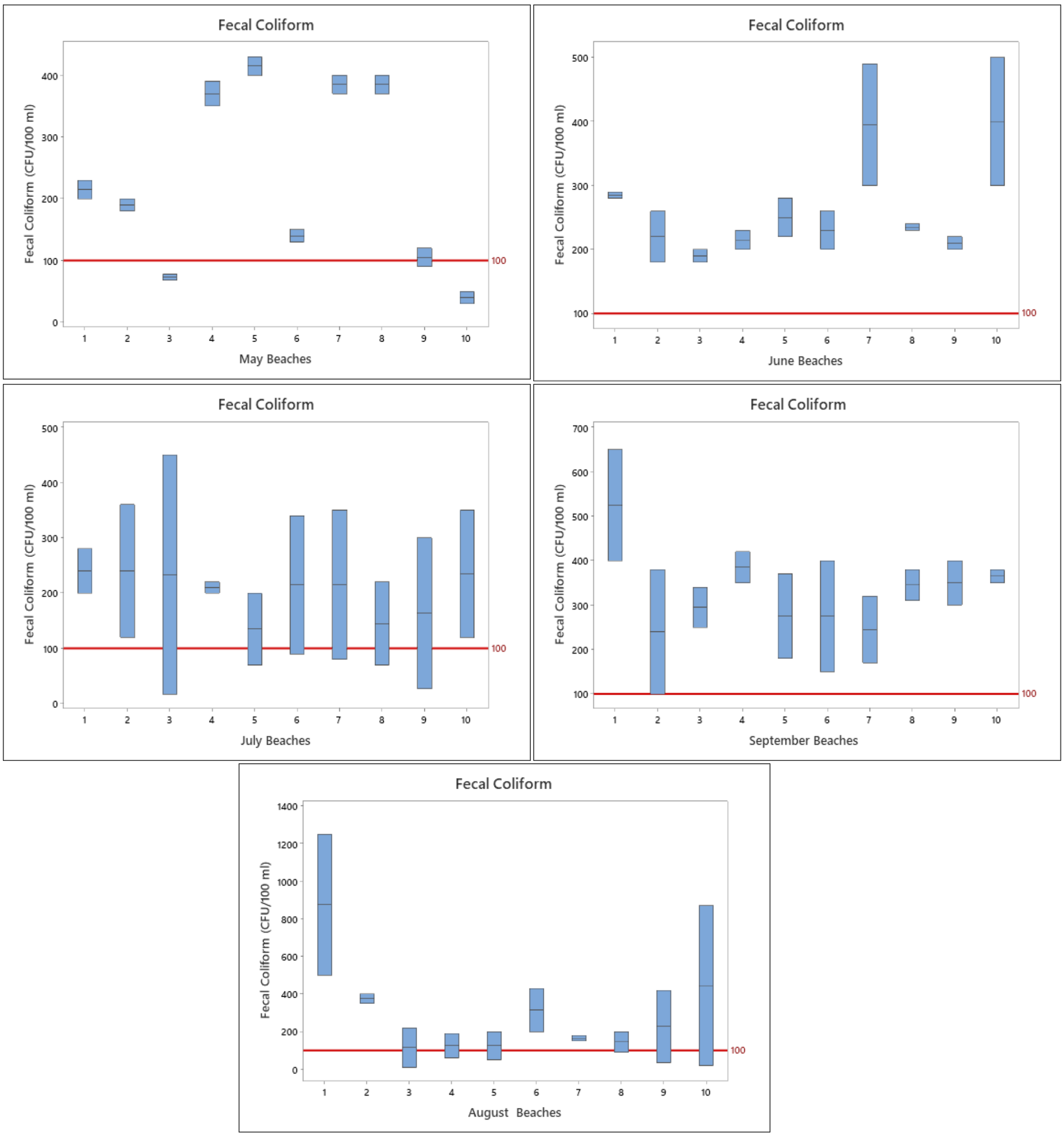

Figure 3 Monthly distribution of fecal coliform bacteria levels at sampling points in 2019

Int. J. Pure Appl. Sci. 8(1);61-70 (2022)

IJPAS
ijpas@munzur.edu.tr
ISSN: 2149-0910

Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

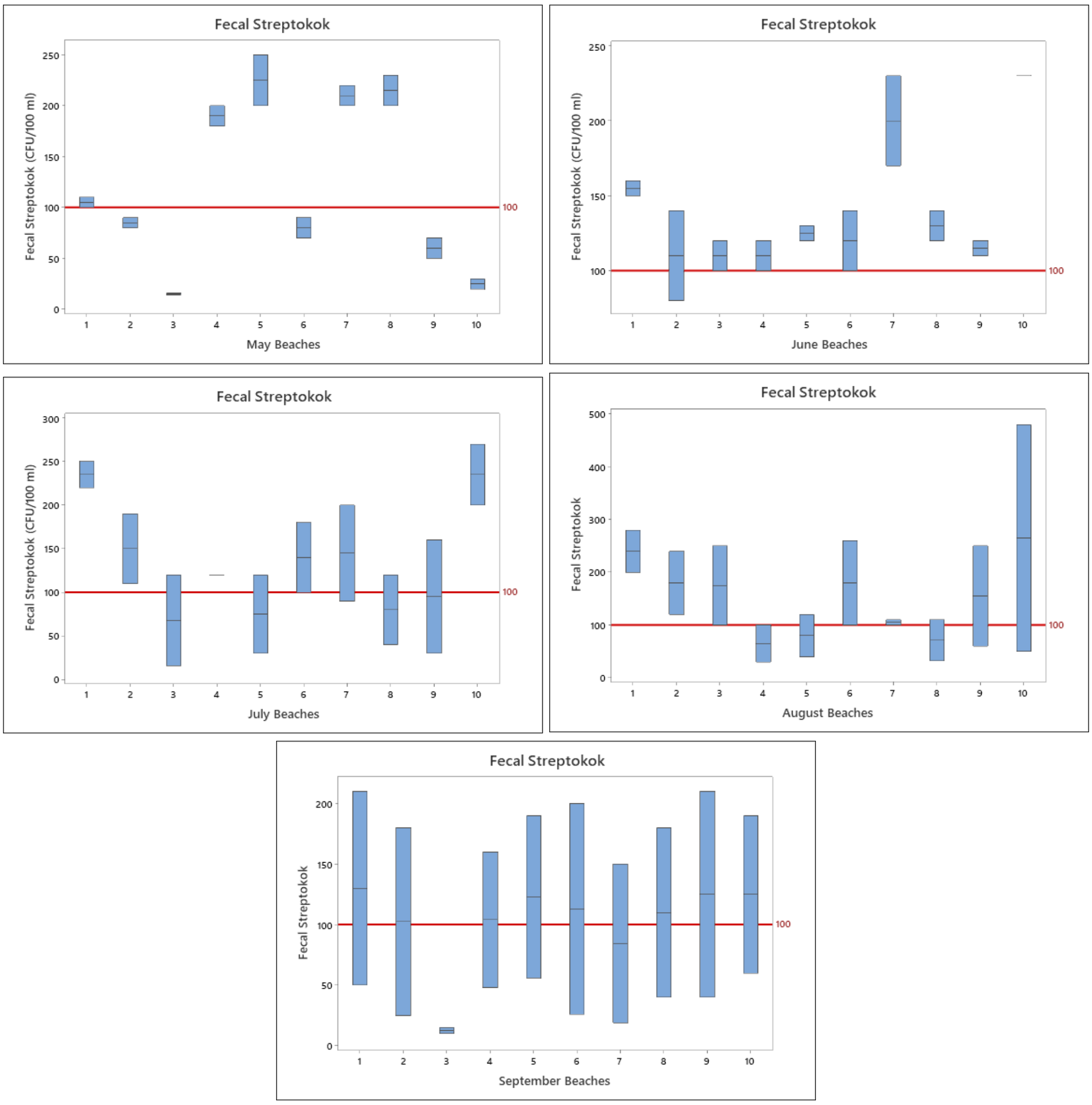

Figure 4 Monthly distribution of fecal streptococcal bacteria levels at sampling points in 2019

ijpas@munzur.edu.tr
ISSN: 2149-0910

Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

Table 3. *Monthly distribution of bacteriological analysis of beach water at Tunceli in 2019*

Months	Total Coliform (TC)*	Fecal Coliform (FC)*	Fecal Streptococci (FS)*
May	1895.78.5(50 –3500)	244.8 (50–430)	130.6 (16–250)
June	1336.2(220–3500)	273.1(180–500)	140(80–230)
July	746(17–3000)	207.5(17–450)	128.6(15–270)
August	1295.2(10–3500)	291.2(10–1250)	140.6(10–480)
September	847(100–3500)	330(100–650)	114.2(19–210)
Total	1125.5(10–3500)	270.3(10–1250)	131.3(10–480)

Table 4. *Annual Classification Report of 2019*

			Total			**Total**		**Total**		**Total**		**Total**	
Year	**Monitored**	**Total**	TC	FC	FS	n	%	n	%	n	%	n	%
2019	**Tunceli**	**10**	90	90	90	0	0	10	100	0	0	0	0

CONFLICT OF INTEREST

The Author report no conflict of interest relevant to this article.

RESEARCH AND PUBLICATION ETHICS STATEMENT

The author declares that this study complies with research and publication ethics.

REFERENCES

Akkan, T., Çolaker, F., 2020. Determining bacteriological pollution level in Gelevera creek, Giresun. Jornal of anatolian environmenatl and animal sciences,5(4):691-695.

Ammar, R., Kazpard V., Wazne, M., El Samrani, A.G., Amacha, N., Saad, Z., Chou L., 2015. Reservoir sediments: a sink or source of chemicals at the surface water-groundwater interface. Environmental Monitoring and Assessment, 187: 579–582.

Anonymous, 2006. Official Gazette, Swimming Water Quality Regulation. (76/160/EU), 2006.

Anonymous, 2006. Swimming Water Tracking System. Access address: http://yuzme.saglik.gov.tr/.(Accessed date:on 25.04.2018).

Anonymous, 2008. Strengthening the Ministry of Health in Harmonization and Implementation of the Legislation in the Field of Water for the Protection of Public Health project.TR04-IBEN-04, Ankara, 2008.

APHA-AWWA-WEF, 2005. Standard Methods for the Examination of Water and Wastewater, 21st edition. American Public Health Association American Water Works Association, Water Environment Federation, Washington DC, USA.

Baran, A., Tarnawsk, M., Koniarz, M., 2016. Spatial distribution of trace elements and ecotoxicity of bottom sediments in Rybnik reservoir, Silesian-Poland. Environmental Science and Pollution Research, 23:17255–17268.

Binzer, A., Guill, C., Rall, B., Brose, U.,2016. Interactive efefcts of warming, eutrophication and size structure:impacts on biodiversity and food-web structure. Global Change Biology,22,220-227.

Boehm, A.B., Ashbolt, N.J., Colford, J.M., Dunbar, L.E., Fleming, L.E., Gold, M.A., 2009. A sea change ahead for recreational water quality criteria. J Water Health, 2009;7 (1): 9–20.

Bonilla, T.D., Nowosielski, K., Cuvelier, M., Hartz, A., Green, M., Esiobu, N., 2007. Prevalence and distribution of fecal indicator organisms in South Florida beach sand and preliminary assessment of health effects associated with beach sand exposure. Mar Pollut Bull, 54:1472–82.

Çelebi,H., 2018.Exploring specific types microorganisms living in the water Karasu channel. J. Eng Sci Des, 6(2),182-189.

European Environmental Agency, 2020. European bathing water quality in 2019. https://www.eea.europa.eu/publications/european-bathing-water-quality-in-2019.

Fleisher, J.M., Kay, D., Wyer, M.D., Godfree, A.F.,1998. Estimates of the severity of illnesses associated with bathing in marine recreational waters contaminated with domestic sewage. Int J Epidemiol, 1998; 27: 722–6.

Fleisher, J.M., Kay, D., Wyer, M.D., Godfree, A.F.,1998. Estimates of the severity of illnesses associated with

Int. J. Pure Appl. Sci. 8(1);61-70 (2022)
ijpas@munzur.edu.tr
ISSN: 2149-0910
Research article/Araştırma makalesi
DOI:10.29132/ijpas.996531

bathing in marine recreational waters contaminated with domestic sewage. Int J Epidemiol, 1998; 27: 722–6.

Hering, D. et al.,2015. Managing aquatic ecosystems and water resources under multiple stress–An introduction to the MARS project.Sci Tot Envir, 503–504.

Hering, D., Johnson, R.K., Kramm, S., Schmutz, S., Szoszkiewicz, K., Verdonschot, P.F.M., 2006. Assessment of European streams with diatoms, macrophytes, macroinvertebrates and fish: a comparative metric-based analysis of organism response to stress. Fresh w. Biol. 51, 1757–1785.

Hilton, J., O'Hare, M., Bowes, M.J., Iwan Jones, J.,2006. How green is my river? A new paradigm of eutrophication in rivers. Sci. Total Environ.365,66–83

Mutlu, T., Verep, B., 2018. Water quality of streams flowing into South Eastern Black Sea coasts in terms of physico-chemical properties. Fresen. Environ. Bull. 27(5a), 3752-3758.

URL-1 2016. Tunceli provincial environmental status report. Tunceli Governorship Provincial Directorate of Environment and Urbanization. 1-101.1 June 2016.

Soller, J.A., Schoen, M.E., Varghese, A., Ichida, A.M., Boehm, A.B., Eftim, S., Ashbolt, N.J., 2014. Human health risk implications of multiple sources of faecal indicator bacteria in a recreational water body. Water Res, 66: 254–64.

Solo-Gabriele, H.M., Harwood, V.J., Kay, D., Fujioka, R.S., Sadowsky, M.J., Whitman, R.L., 2016. Beach sand and the potential for infectious disease transmission: observations and recommendations. J Mar Biol Assoc, 96, 101–20.

Verep, B., Ölmez, T.B., Mutlu, T.,2019. Investigation of physico-chemical water quality of Salarha basin streams, J Ana Environ Anim Sci, 188-200.

Wade, T.J., Calderon, R.l., Sams, E., Beach, M., Brenner, K.P., Williams, A.H., 2006. Rapidly measured indicators of recreational water quality are predictive of swimming-associated gastrointestinal illness. Environ Health Perspect, 114:24–8.

Whitmann, R.l., Harwood, V.J., Thomas, A.E., Nevers, M.B., Byappanahalli, M., Vijayavel, K., 2014. Microbes in beach sands: integrating environment, ecology and public health. Rev Environ Sci Biotechnol, 13: 329–68.

Wiedenmann, A., Krüger, P., Dietz K, López–Pla, J.M., Szewzyk, R., Botzenhart, K. A., 2006. Randomized controlled trial assessing infectious disease risks from bathing in fresh recreational waters in relation to the concentration of Escherichia coli, intestinal enterococci, Clostridium perfringens, and somatic coliphages. Environ Health Perspect, 114: 228–36.

World Health Organisation., 2003. Guidelines for safe recreational water environments. Volume 1: Coastal and fresh waters. Geneva World Health Organisation Geneva, 2003.

Wu, N., Huang, J., Schmalz, B., Fohrer, N., 2014. Modeling daily chlorophyll chlorophyll-a dynamics in a German lowland river using artificial neural networks and multiple linear regression approaches. Limnology 15 (1), 47–56.

Yaşar, B.A.,2019. Evaluation of total and fecal coliform measurements in İstanbul public beaches, Hacettepe University, Department of Environmental Engineering.