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Physiochemical Parameters and Fish diversity of Zameer Gul Dam of Kohat District Khyber Pakhtunkhwa Pakistan

Owais Rehman[1], Amir Sohail[2], Hira Rehman[3], Shafiullah Gul[4], Habib Ullah[5], Zulqurnain[6], Umair Ali[7], Uzma Ayaz[8], Asif Ali[9], Javeria Umber[10].

[1-4] Department of Zoology, Government Post Graduate College, Karak, KP, Pakistan
[5] Department of Zoology, Abdul Wali Khan University, Mardan, KP, Pakistan
[6] Department of Zoology, Government College University Faisalabad, Punjab Pakistan
[7] School of Biological and Medical Physics Moscow Institute of Physics and Technology Moscow Russia
[8] Department of Plant Breeding & Molecular Genetics University of Poonch Rawalkot Azad Jammu & Kashmir Pakistan
[9] Department of Zoology, University of PMAS Arid and Agriculture Rawalpindi.
[10]Department of Bioinformatics and Biotechnology Government College University Faisalabad.

Abstract
The present investigation was carried out to observe the biodiversity of fish fauna and to analyze the physiochemical parameters of water and soil in Zameer Gul dam of Kohat District, Khyber Pakhtunkhwa province of Pakistan. The collection was done from April 2019 to September 2019. A total of nine species were identified, which were belonging to one orders, one family and nine genera. The physiochemical properties like color, taste, odor, electrical conductivity, pH, temperature, elasticity and, TDS of water and soil samples collected from three different sites (start, mid, and end) of the dams were analyzed. Therefore, from the results of our present study, it was concluded that the Zameer Gul dam of Kohat district has favorable condition to support more diversity of fish fauna. In conclusion present study provide useful information about the diversity of fish fauna and physiochemical parameter of Zameer Gul dam that can of interest in the fields of systematics, fisheries management and conservation.

Keywords: parameters, investigation, biodiversity, Physiochemical

Introduction
Ichthyo diversity means number of fishes in fish population, alleles or genotypic form or variety of species and their distribution within a particular area [1]. Fish are limbless, cold-blooded, vertebrate animals with gills and fins fully adapted to the aquatic way of life. Beginning with the primary Chinese, Egyptian and Greek eras, fish are believed to have been reared and studied for centuries [2]. Fishes are not only a valuable resource for marine ecosystem but also for humans. Being an integral part of aquatic ecosystems, they play a key role in energy flow, nutrient cycling and environmental balance maintenance [3]. A significant source of food is the fish, provided mainly from the wild and farmed system. It provides nutritional sources such as protein, omega-3 fatty acids, vitamin D, calcium, vitamins B, vitamin A, iron, zinc and lysine [4]. Most fish live in warmer waters with relatively stable conditions [5]. Freshwater fish, including ponds, streams, canals, lakes, dams, and other land-locked waters, are found in various locations. Fish lives in aquatic habitat and varies greatly in morphological characteristics due to biological adaptations [4]. About 32,500 fish species have been reported so far globally [6]. While in pakistan total of 193 freshwater fish species have been reported to date which are found either in costal water or fresh water depending upon water quality [7].
Water quality generally means the portion of water that must be present for optimal aquatic organism growth [8]. Maintaining a healthy aquatic ecosystem depends on the physio-chemical properties and biodiversity [9]. The properties of water quality depend on the amount of dissolved oxygen (DO), biochemical demand for oxygen (BOD), organic content, chemical demand for oxygen (COD), pH value temperature, infectious agents, toxic substances and minerals [10]. A place's soil properties have a vigorous function in marine organism survival and development. The soil functions as a biological filter by collecting fish excretions, organic residues of feed and algal metabolites and also regulates the salinity of aquaculture systems not to increase, its solidity or rigidity and its pH [11]. Ecological balance sustainability of an aquaculture system is also dependent on its soil properties. It is therefore necessary to determine the physiochemical parameter analysis to analyze the quality of an ecosystem's water and soil that provides adequate information on favorable and unfavorable conditions in an ecosystem and their effects on aquatic organisms that live in such ecosystems [12].
The current research was therefore planned to explore the diversity of fish and to study the physiochemical characteristics of water and the soil of the dam to determine the relation of such condition with fish fauna and to analyze its importance in fisheries management policies. This study will be useful also in the future to ensure the safety of the aquatic ecosystem and the climate for healthy fish development.

Material and Method
Study area and study period
The Zameer Gul dam is situated some 71 km away from

Kohat on Nizampur Road at Ziarat Sheik Allahdad Kpk Pakistan. The study was carried out from the month of April 2019 to September 2019.

Fishes Collection

Based on local fishing activities and sampling sites were selected where fishing was productive. The fish were collected using various nets, i.e. cast nets, hand nets, gill nets, hook and dragon nets. Fish were euthanized after collection and placed in 10% formalin solution. Larger fish were injected with formalin in their abdomen and other parts of the body to avoid bacterial contamination. The same species were placed in a container and was labelled with collection time. The fishes after collection were brought to the laboratory of department of Zoology, Government Post Graduate Collage Karak for further analysis.

Identification of the fishes

Fish harvested from the study area were classified on the basis of morphometric and meristic according to the methods of Bhuiyan (1964), Rahman (1989), Talwar and Jhingran (1991). After identification, fish species were systematically classified according to Nelson (2006).

Sampling Procedure of water and soil

Three samples of soil and water were collected from the dam. The collection of water samples was carried out in properly washed and sealed plastics bottles, while soil collection were carried out from nearer the bottom of dam and then packed in an air tight polyethylene bags until analysis. The analysis was carried out by using the methodology adapted previously with slight modification [13].

Sample Analysis

At the sampling site, physical parameters including color, odor, taste, elasticity and temperature of soil and water samples were examined while chemical parameters including pH, conductivity and water and soil total dissolved oxygen (TDS) were tested in the laboratory using different laboratory instruments and apparatuses. Water temperature and pH is calculated using pH meter (Milwaukee mw 102 pH / temp), while soil temperature is measured using a thermometer. Soil PH was calculated by pH meter (Model 3505, made). A common conductivity meter used for the calculation of soil and water conductivity (Model 103 Jencose).Conductivity meter was calibrated by using 0.1 M solution of KCl. After calibration each soil and water sample was analyzed for conductivity.

Physiochemical Characteristics

Physiochemical parameters such as Total Dissolved Solids (TDS), Electrical Conductivity (EC), temperature, colour, odor, concentration of hydrogen ions, and elasticity of water and soil samples collected from the dam were analyzed. Physiochemical parameters of water including temperature, taste, color, odor, conductivity and pH calculated using analytical procedures adopted previously [14], while the properties of the soil including temperature, elasticity, color and total dissolved solids were measured using the method used Gul *et al*. [15]

Electrical conductivity & Total dissolved solids

The EC and TDS of both (water and soil) samples were measured using Jenway conductivity meter, and 0.1 M Potassium chloride solution was used for calibration.

Results

Fish fauna

During the present study, a total of 107 fish were collected. Classification of fishes indicated presence of nine species collected from Zameer gul dam. The reported nine species belonged to single order, single family and nine genra. These nine species *Barilius vagra*, *Carassius auratus*, *Catla catla*, *Cirrhinus marigala*, *Labeo rohita*, *Pethia ticto*, *Hypophthalmichthys molitrix*, *Cyprinus carpio*, *Ctenopharyngodon idella* were belongs to with class Actinopterygii order Cypriniformes and with family Cyprinidae as represented in table 1.

Table 1: Taxonomic representation of fishes of Zameer Gul dam Kohat.

S/N	Local name	Order	Family	genus	species
1	Rohu	Cypriniformes	cyprinidea	Labeo	*L. rohita*
2	Thaila	Cypriniformes	cyprinidea	Catla	*C. catla*
3	Ticto/ Ticto popra	Cypriniformes	cyprinidea	Pethia	*P. ticto*
4	Goldfish	Cypriniformes	cyprinidea	Carassius	*C.auratus*
5	Mori	Cypriniformes	cyprinidea	Cirrhinus	*C. marigala*
6	Chalwa	Cypriniformes	cyprinidea	Barilius	*B. vagra*
7	Silver carp	Cypriniformes	cyprinidea	Hypophthalmichthys	*H. molitrix*
8	Gulfam/common carp	Cypriniformes	cyprinidea	Cyprinus	*C. carpio*
9	Grass carp	Cypriniformes	cyprinidea	Ctenopharyngodon	*C. idella*

Physiochemical parameters of soil and water

Table 2 represents physiochemical parameters of water samples of the Zameer gul dam Kohat. All the physiochemical parameters was determined in three set point i.e, start mid and end point. Temperature was 32°C, 34°C and 35°C at start mid and end point, respectively. pH was 7.5, 7.7 and 7.4 at start mid and end points. At start point TDS was 0.01 mg/100ml, 0.02 mg/100ml at mid-point while at end point TDS was 0.01 mg/100ml. TS was 0.03 mg/100ml at start point, 0.02 mg/100ml at mid and 0.03 mg/100ml end point. Conductivity was also measured in three set points and was recorded 0.27µs/m at start point, at mid piont 0.29µs/m and at end 0.27µs/m. Water of dam was odorless, slightly saline in taste, non-elastic in nature and light green in color at all three point.

Table 2: Physiochemical parameter of water samples collected from Zameer Gul dam Kohat, Pakistan.

S. No	Parameters	Start point	Mid point	End point
1	Temperature	32°C	34°C	35°C
2	PH	7.5	7.7	7.4
3	TDS	0.01 mg/100ml	0.02 mg/100ml	0.01 mg/100ml
4	TS	0.03 mg/100ml	0.02 mg/100m	0.03 mg/100m
5	Conductivity	0.27µs/m	0.29µs/m	0.27µs/m
6	Taste	Slightly saline	Slightly saline	Slightly saline
7	Odor	Odorless	Odorless	Odorless
8	Elasticity	Non-elastic	Non-elastic	Non-elastic
9	Colour	Light green	Light green	Light green

Table 3 represents physiochemical parameters of soil samples of the Zameer Gul dam Kohat. All the physiochemical parameters was determined in three set point i.e., start mid and end point. Temperature was 24°C, 20°C and 23°C at start mid and end point respectively, similarly pH was 8.8, 8.3 and 8.8 at start mid and end point. TDS was 17 mg/100ml at start point, 15 mg/100ml at mid-point and 16 mg/100ml at end point. At start point TS was 10.4 mg/100ml, at midpoint 11.2 mg/100ml and at end point 9.7 mg/100ml. conductivity was 0.23µs/m at start point, 0.24µs/m at mid-point, 0.21µs/m at end point. Soil taste was slightly saline, odorless, non-elastic and brown yellowish in color at all three point.

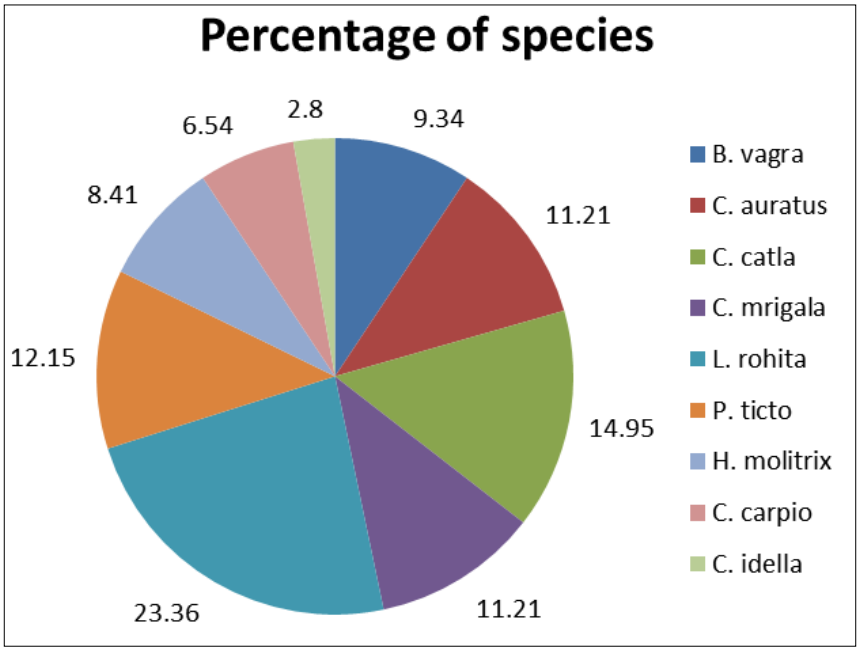
Table 3: Physiochemical parameter of soil samples collected from Zameer Gul dam Kohat, Pakistan.

S. No	Parameter	Start point	Mid point	End point
1	Temperature	24 °C	20°C	23°C
2	PH	8.8	8.3	8.8
3	TDS	17mg/100ml	15mg/100ml	16mg/100ml
4	TS	10.4 mg/100ml	11.2 mg/100ml	9.7 mg/100ml
5	Conductivity	0.23µs/ml	0.24µs/ml	0.21µs/ml
6	Taste	Slightly saline	Slightly saline	Slightly saline
7	Odor	Odorless	Odorless	Odorless
8	Elasticity	Non-elastic	Non-elastic	Non-elastic
9	Color	Brown yellowish	Brown yellowish	Brown yellowish

Discussion

During the current study on Zameer Gul dam Kohat nine fish species were found and classify up to the species level and their proper systematic classification is given in the table 1. The selected nine species were belonged to one class Actinopterygii, one order Cypriniformes, one family Cyprinidae, nine genera and nine species.

The graph shows *Labeo rohita* as the dominant spices in the assemblage composition contributing 23.36% to total fish diversity, *Catla catla* contributing 14.95%, Pethia ticto contributing 12.15%, *Carassius auratus* contributing 11.21%, *Cirrhinus marigala* contributing 11.21%, *Barilius vagra* contributing 9.34%, *Hypophthalmichthys molitrix* contributing 8.41%, *Cyprinus carpio* contributing 6.54% and *Ctenopharyngodon idella* contributing 2.8% to the total diversity of fish as shown on graph No 1.



Graph 1: Percentage composition of fish species of Zameer Gul dam Kohat Pakistan

According to [16] in 2015, 11 fish species are found in Tanda Dam, Kohat District, Khyber Pakhtunkhwa, belonging to four orders, five families and eleven genera. Seven of them belonged to the Cyprinidae family, while the remaining four species were belonging to families Anguillidae, Belonidae, Cobitidae and Siluridae. Similar study was also done. By [17] on Darwazai Dam Tehsil Lachi District Kohat, in which they reported seven species, in these seven species five were belonging with family Cyprinidae, order Cypriniformes while single specie belong from order Anguilliformes family Anguillidae and one specie belong with order Siluriformes and family Siluridae.

Color, Odor and Elasticity

An object's color is define by the visible light's wavelength that particular object reflects. Pale color, medium greenish and greenish color is best for fish production, according to the previous work [18]. The dark brown color is lethal for fish cultivation and induces death, where the light green color is relatively good for fish cultivation and the dark green color is not suitable for fish cultivation [19]. The gray, bluish green and brown, green water colors are the symbol or clear indication that the water contains an enormous number or abundance of phytoplankton population. These planktons act as direct food for herbivorous fish and are also responsible for the oxygen due to which the depletion of oxygenation is removed completely, and this is best for the growth and survival of fish [20].

According to both chemical and biological processes, the soil color pattern may be the one. The yellow or red soil indicates iron oxides, while the dark brown or black color indicates that the soil contains high organic matter. The occurrence of certain specific minerals also can affect the color of the soil. In addition, manganese oxide (Mno) causes a black colour, glauconitic makes the soil green, while calcite makes the soil appear white [21]. Odor affects recreational water aesthetics and also fish taste [22]. Zameer gul dam kohat's water and soil is odorless and non-elastic while water color is Light green and soil is brown yellowish.

Temperature

Water temperature controls the rate of all chemical processes, reproduction and immunity, and effectively impacts the growth of fish. Drastic, sudden changes in temperature can be fatal for fishing [23]. The ideal temperature which required for proper growth of fishes lies between 26-32 °C [2]. Fish are exothermic (cold blooded) and obtain heat from their external environment, so when the external environment temperature fluctuates, changes in the temperature of the fish can occur accordingly [24]. The Temperature of the zameer gul dam water taken from the three different points which are following start point, midpoint, and end point are (32 °C, 34 °C, 35 °C) respectively and the soil taken from start point, midpoint, and end point are (24 °C, 20 °C, 23 °C) respectively as shown table no 2 and 3.

PH

PH is one of the most important factors related to water quality. The lower pH levels can cause tuberculosis and degradation while the higher values can cause incrustation, sedimentation, deposition and chlorination difficulties for water disinfection [25]. Extreme pH negatively distresses fish reproduction and growth [26]. In most natural freshwater lakes, streams and rivers the PH is approximately 6.5 -7.5, and according to the WHO the PH range is approximately 6.5-8.5 favorable for the growth and survival of fish [27]. Soil pH is one of the physicochemical parameters of greatest importance. It affects the mineral nutrient quality of the soil and the activity of many microorganisms [28]. The PH of the zameer gul dam water taken from the three different points which are following start point, midpoint, and end point were (7.5, 7.7, and 7.4) and the PH of soil from start point, midpoint, and end point were (8.8, 8.3, and 8.8) respectively as shown table no 2 and 3.

Total Dissolve Solids

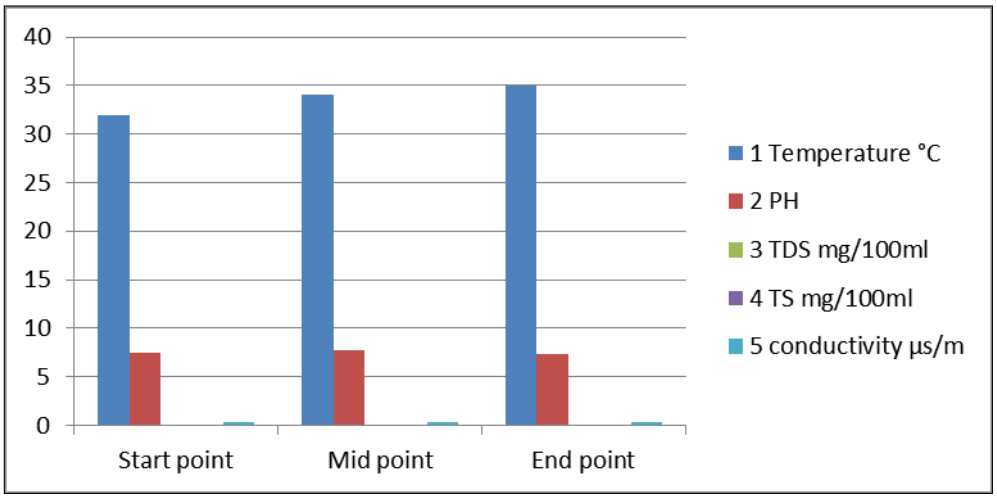
Total dissolved solids (TDS) primarily apply to the different types of minerals found in the water. "Dissolved solids" refers to any dissolved mineral salts, metals, cations or anions in water. A major or serious change in TDS may result in the killing of aquatic life [29]. TDS ranging from 5 to 1000 mg / L is normally considered as a more appropriate range for fish growth [30]. TDS analysis has large implications in the control of physical and biological waste water treatment processes [31]. The quantity of TDS is proportional to the degree of pollution [32]. All of the values ranges within permissible limits suggested by WHO (i.e. 500-1000mg/l) [33]. The TDS value of the Zameer Gul dam water and soil of the start point, midpoint, and end point are (0.01mg/100ml, 0.02mg/100ml, and 0.01mg/100ml) and (17mg/100ml, 15mg/100ml, 16mg/100ml) respectively as shown table no 2 and 3.

Total solid (TS)

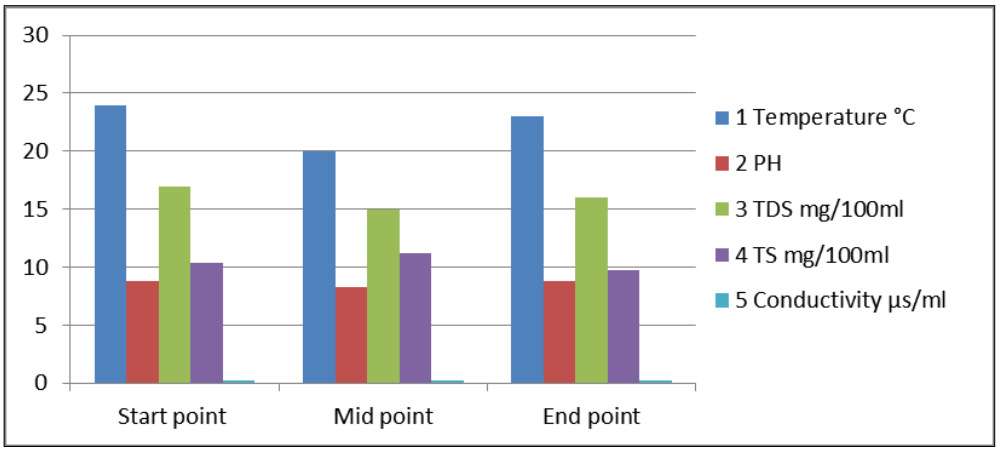
The TS value of the Zameer Gul dam water and soil of the different sites start point, midpoint, and end point are (0.03, 0.02, and 0.03) and (10.4, 11.2, 9.7) respectively as shown table no 2 and 3.

Electrical Conductivity (EC)

Electrical conductivity is an aqueous solution capable of carrying or passing electric current. As fish are very sensitive to electrical conductivity, conductivity is therefore directly related to the amount of osmotic pressure exerted or fell on their cell membranes. Conductivity of freshwater mostly ranges between 50 to 1500 µs/ml [34]. It is a useful important tool to check and analyze the purity of water. According to WHO normal range of EC for water lies between 400-600µS/cm [35]. The EC value of the Zameer Gul dam water and soil of the different sample taken start point, midpoint, and endpoint are (0.27us/ml, 0.29us/ml, 0.27us/ml) and (0.23us/ml, 0.24us/ml, 0.21us/ml) respectively as shown table no 2 and 3.



Graph 2: Graphical representation of Physiochemical parameters water of Zameer Gul dam



Graph 3: Graphical representation of physiochemical parameters soil of Zameer Gul dam Kohat, Pakistan

Conclusion

From the present study, it may be concluded that Zameer Gul dam kohat has huge fauna of Cyprinidae family and the environmental conditions of Zameer Gul dam kohat may be more favorable for Cyprinidae family. Among the freshwater fishes, *Labeo rohita* and *Catla catla* are commonly found in most sites. All the physic-chemical parameters were in normal range and have no adverse effect on survival, reproduction, and growth of aquatic flora and fauna. Physical and chemical analysis of water shows a good range of properties for all these dams, suitable for fish growth, soil was also found to be of good quality. Hence, from the present study we concluded that the Zameer Gul dam water and soil is suitable for the fish growth, survival and breeding and it would also provide useful information to fish culturists and fisheries managers for promoting the fish culturing in the local area to raise the economic and social benefits for the local population of Kohat district.

References

1. Battul PN, Rao KR, Navale RA, Bagale MB, Shah NV. 'Fish Diversity from Ekrukh Lake near Solapur Maharashtra. J Aqua. Biol. 2007; 22:68-72.
2. Bin Kang, Daming He, Lisa Perrett, Hongyuan Wang, Wenxian Hu, Weide Deng *et al*. Fish and Fisheries in the Upper Mekong: Current Assessment of the Fish Community, Threats and Conservation, Reviews in Fish Biology and Fisheries. 2009; 19:465.
3. Reiner FROESE. Fishbase. World Wide Web Electronic Publication, 2009. http://www. fishbase. org
4. Quentin Bone, Richard Moore. Biology of Fishes Taylor & Francis, 2008.
5. Stephen Walsh J, Howard Jelks L, Noel Burkhead M. The Decline of North American Freshwater Fishes. Actionbioscience, 2009.
6. Nelson JS. Fishes of the World, 4th Edn. Jhon Wiley & Sons, Inc., Hoboken, New Jersey, 2006.
7. Muhammad Rafique, Najam Ul Huda Khan. Distribution and Status of Significant Freshwater Fishes of Pakistan, Rec. Zool. Surv. Pakistan. 2012; 21:90-95.
8. Ehiagbonare JE, Ogunrinde YO. Physico-Chemical Analysis of Fish Pond Water in Okada and Its Environs, Nigeria. African Journal of Biotechnology, 2010, 9.
9. Venkatesharaju K, Ravikumar P, Somashekar RK, Prakash KL. Physico-Chemical and Bacteriological Investigation on the River Cauvery of Kollegal Stretch in Karnataka. Kathmandu University Journal of Science, Engineering and Technology. 2010; 6:50-59.
10. Robert Wetzel G. Freshwater Ecology: Changes, Requirements, and Future Demands, Limnology. 2000; 1:3-9.
11. Radha Krishnan R, Dharmaraj K, Ranjitha Kumari BD. A Comparative Study on the Physicochemical and Bacterial Analysis of Drinking, Borewell and Sewage Water in the Three Different Places of Sivakasi. Journal of Environmental biology. 2007; 28:105-08.
12. Wayne Hubert A, William J, LaVoie IV, Lawrence D DeBray. Densities and Substrate Associations of

Macroinvertebrates in Riffles of a Small, High Plains Stream. Journal of Freshwater Ecology. 1996; 11:21-26.
13. Zubia Masood, Nousheen Rafique Hameed-Ur-Rehman, Nelofer Jamil, Fariha Mengal, Saima Durrani, Huma Tareen *et al*. Physicochemical Analysis of Water and Soil of Fresh Water Damai Stream of Tehsil Domel of Bannu District with Special Reference to Their Impact on Survival of Fishes, 2015.
14. Afshan Majeed, Benazeer Mussa Mandokhail, Zubia Masood, HUR Rehman, A Ullah, Gul N. Assessment Study About the Water Quality Criteria and Heavy Metals Concentrations in Different Fish Ponds of Four Districts of Balochistan Province, Pakistan, Global Vet. 2015; 14:351-57.
15. Naila Gul, Benazeer Mussaa, Zubia Masood, Asim-Ullah Hameed-UR-Rehman, Afshan Majeed. Study of Some Physiochemical Properties of Soil in Fish Pond at Circuit House, District Sibi of Province Balochistan, Pakistan, Global Vererinaria. 2015; 14:362-65.
16. Hameed Ur Rehman, Asim Ullah, Faiz Ur Rehman, Baharullah Khattak, Sami Ullah, Amir Atlas *et al*. Biodiversity of Fish Fauna of Ghandiali Dam, District Kohat, Khyber Pakhtunkhwa, Pakistan, World Applied Sciences Journal. 2015; 33:1511-13.
17. Hameed Ur Rehman, Abdul Haseeb, Tahir Azeem. Ghurzandi Dam Fish Biodiversity Tehsil Lachi District Kohat Kpk, Pakistan. International Journal of Basic Medical Sciences and Pharmacy (IJBMSP). 2015, 5.
18. Borkar AD. Studies on Some Physicochemical Parameters of Soil Samples in Katol Taluka District Nagpur (Ms), India. Research Journal of Agriculture and Forestry Sciences. 2015; 3:16-18.
19. Anita Bhatnagar, Jana SN, Garg SK, Patra BC, Gajender Singh, Barman UK. Water Quality Management in Aquaculture, Course Manual of summer school on development of sustainable aquaculture technology in fresh and saline waters, CCS Haryana Agricultural, Hisar (India). 2004; 203:210.
20. Guy Delincé. The Ecology of the Fish Pond Ecosystem with Special References to Africa, in Developments in HydrobiologyKluwer Academic. 1992, 1-230.
21. Bhatnagar SNA, Jana SK, Garg BC, Patra G, Singh UK. Barman. Water Quality Management in Aquaculture, Course Manual of summer school on development of sustainable aquaculture technology in fresh and saline waters, CCS Haryana Agricultural, Hisar (India), 2004, 203.
22. Claude Boyd E. Water Quality in Warmwater Fish Ponds, Auburn University, 1979.
23. Borkar AD. Studies on Some Physicochemical Parameters of Soil Samples in Katol Taluka District Nagpur (Ms), India. Research Journal of Agriculture and Forestry Sciences. 2015; 3:16-18.
24. Patil PN, Sawant DV, Deshmukh RN. Physico-Chemical Parameters for Testing of Water-a Review, International Journal of Environmental Sciences. 2012; 3:1194.
25. Priyanka Trivedi, Amita Bajpai, Sukarma Thareja. Evaluation of Water Quality: Physico–Chemical Characteristics of Ganga River at Kanpur by Using Correlation Study, Nature and Science. 2009; 1:91-94.
26. Gupta SK, Gupta PC. General and Applied Technology (Fish and Fisheries) S, Chand and Company, New Delhi, 2006, 1130.
27. Ruqia Nazir, Muslim Khan, Muhammad Masab, Hameed Ur Rehman, Naveed Ur Rauf, Surrya Shahab *et al*. Accumulation of Heavy Metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the Soil, Water and Plants and Analysis of Physico-Chemical Parameters of Soil and Water Collected from Tanda Dam Kohat. Journal of Pharmaceutical Sciences and Research. 2015; 7:89.
28. Shivesh Pratap Singh, Deepa Pathak, Rashmi Singh. Hydrobiological Studies of Two Ponds of Satna (Mp), India. Ecology Environment and Conservation, 2002; 8:289-92.
29. Nelly Isyagi A, Karen Veverica L, Rashid Asiimwe, William Daniels H. Manual for the Commercial Pond Production of the African Catfish in Uganda, Kampala, 2009, 222.
30. Sivakumar R, Mohanraj R, Azeez PA. Physico-Chemical Analysis of Water Sources of Ooty, South India, Pollution Research. 2000; 19:143-46.
31. Rafia Naz Nasrullah, Hamida Bibi, Mudassar Iqbal, Ilyas Durrani M. Pollution Load in Industrial Effluent and Ground Water of Gadoon Amazai Industrial Estate (Gaie) Swabi, Nwfp. Journal of agricultural and biological science. 2006; 1:18-24.
32. Gaikwad LB. Hydrobiological Study of Nandrabad Dam, Ph. D. thesis. Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, 2003.
33. Rani FH, Thatcher LL. Methods for Collection and Analysis of Water Samples, Us Govt', Office Washington, USA, 1990.
34. Udhayakumar R, Manivannan P, Raghu K, Vaideki S. Assessment of Physico-Chemical Characteristics of Water in Tamilnadu, Ecotoxicology and environmental safety. 2016; 134:474-77.
35. Medudhula Thirupathaiah. Ch. Samatha, Chintha Sammaiah. Analysis of Water Quality Using Physicochemical Parameters in Lower Manair Reservoir of Karimnagar District, Andhra Pradesh, International Journal of Environmental Sciences. 2012; 3:369-78.