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Physicochemical Parameters of water Collected from River Panjkora, Khyber Pakhtunkhwa, Pakistan

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Abstract: The present study was designed to express the "water quality criteria of River Panjkora at Lower Dir" and analyzed for assessment of water temperature, pH, electrical conductivity, total dissolved solids, dissolved oxygen, total hardness, alkalinity, ammonia, sodium and potassium ions, lead, copper, zinc and nickel for a period of six months starting from July to December 2012. The physicochemical parameters remained within the safe limits throughout the study period. However, Pb and Ni exceeded the limits permissible for drinking water quality parameters. The determined results showed various physical and chemical parameters ranged, temperature (8-21°C), pH (6.53-7.14), electrical conductivity (136.6-255 mg/l), total dissolved solids (86.33-175 mg/l), dissolved oxygen (6.23-8.33 mg/l), total hardness (90.44-138mg/l), alkalinity (60.67-104mg/l), ammonia (0-0.81 mg/l), sodium ions (6.90-12.07ppm), potassium ions (2.47-3.13ppm), lead (0-0.43ppm), copper (0-0.14ppm), zinc (0-0.87ppm) and nickel (0-0.18) are within permissible limits of Pakistan National Environmental Quality Standards. It is also concluded that all the physicochemical parameters showed the safe range according to water quality standards of American Public Health Association.

Key words: Physicochemical Parameters · Electrical Conductivity · River Panjkora and Alkalinity

INTRODUCTION

Water quality deals with the physical, chemical and biological characteristics in relation to other hydrological properties. Water quality parameters which affect the survival, reproduction, growth and production of aquatic species are called water quality variables [1]. Physicochemical parameters of water such as temperature, pH, conductivity, alkalinity, hardness, sodium ion, potassium ion, ammonia, phosphate and nitrates are very important for the growth of primary productivity [2].

Water temperature is the most essential and important parameter which governs most of the physical, chemical and biological properties of aquatic habitats. Water temperature influences growth, liability, abundance and distribution of fishes. Freshwater fishes have optimum growing temperature ranged from 25-30 °C to which they grow quickly. About 35°C is commonly considered as the maximum tolerance for most survival of aquatic life [3].

Water pH also plays a vital role in biodiversity of fish fauna in the aquatic environment. The suitable pH value of fish production ranges from 6.5-9.0. pH 4.0 is the acidic death point, at pH 4.0-5.0 no reproduction occurs, at pH 4-6.5 slow growth and pH 11 is the alkaline death point of water. Electrical conductivity is directly proportional to the concentration of ions in the water, such as nitrate, nitrites and phosphate, so different ions vary in their ability to conduct the electricity. Natural water, electric conductivity is 20-1500 µohms/cm [4].

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Total dissolved solids are the sum of salts and minerals dissolved in water. These are the inorganic salts such as sodium chloride, calcium, potassium and magnesium and small amounts of organic matter are dissolved in water.

A TDS value higher than 500mg/L is not suitable for drinking and irrigation. Therefore the appropriate concentration of salt is very important for aquatic plants and animals. Salinity beyond their normal value, reduce fertilization rates of fish, productivity, growth in algae and cause death of aquatic organisms [5].

Dissolved oxygen is important for the decompose which break down the organic detritus essential for respiration and enables completion of biochemical pathways (4). The minimum level of dissolved oxygen is 5mg/L for fish reproduction. About 0.3-1.0 mg/L DO is dangerous for fish survival and 3.5mg/L is incurable to many fish species within 20 hours.

Hardness of water is due to alkaline earth metals such as Mg^{++} and Ca^{++} ions and $CaCO_3$ and $MgCO_3$ [6]. Suitable hardness for fish growth is about 15mg/L, less than 11mg/L requires liming for higher fish production, so water having less than 5mg/L $CaCO_3$ cause pain, slow growth rate and ultimately death of fish.

At alkalinity ranging from 0.0-20 ppm cause low production, from 20-40 ppm cause medium production and from 40-90 ppm are considered for high production. Water with alkalinity less than 10 ppm rarely produces large craps [7].

Ammonia is lethal to aquatic life even if present in a small (0.02mg/L) concentration. Some regulatory agencies have set a standard of 0.02 to 0.5mg/L for unionized ammonia [8]. Heavy metals like Lead, copper, nickel and zinc may exhibit extreme toxicity even at low concentration under certain conditions [9]. Biodiversity is very important for the stability of the aquatic ecosystem, for the safety of overall environmental quality and to understand the importance of all species. Keeping in mind the importance of Physiochemical parameters in fish biodiversity the present study was intended to direct the water quality parameters of River Panjkora at Lower Dir.

MATERIALS AND METHODS

Study Area: The word Panjkora is derived from a Persian word which means "five rivers". It originates from the high mountains ranges of Hindu Kush at latitude, 35° 45, flows in the north and south direction crossing various tributaries like (Roade, Konai, Guladai, Usharai, Barawal, Rabat, Dir, Toormang, Narhan, Karo, Nihag), banks along its course in both district Dir Upper and Lower. In south of district Lower Dir the River Panjkora join with River Swat at Qalangi village. Both rivers flow southward and merged with River Kabul at Nisatta lies in district Charsadda (Figure 1).

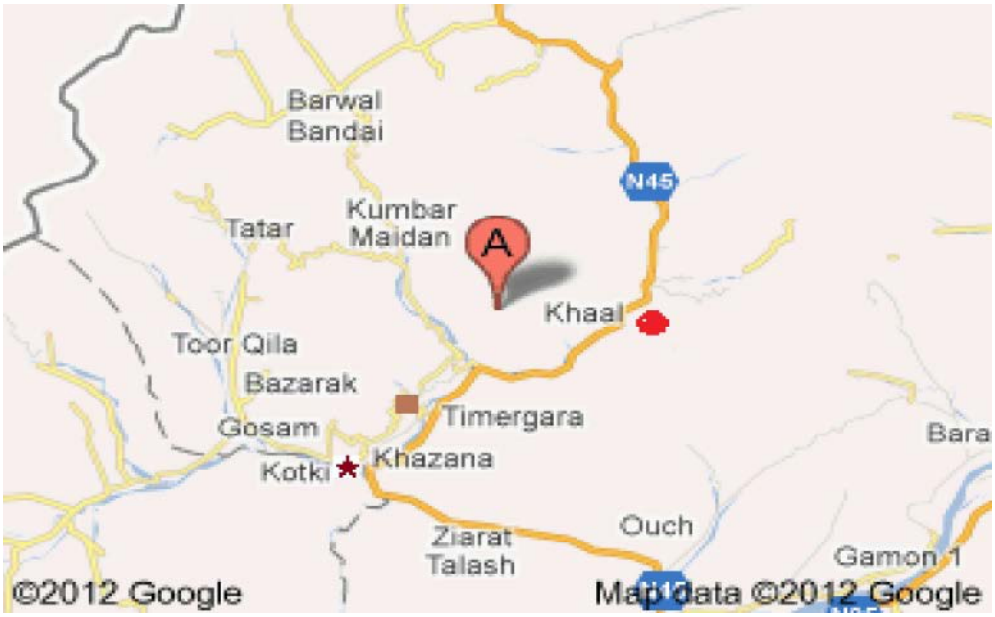

Fig. 1: Map of Lower Dir showing sampling stations.

Water Samples Collection: For physiochemical parameters the water samples were collected from the specific stations A (Khal), B (Timergara) and C (Talash), as shown in fig 1, on monthly basis in plastic bottles having a 1 liter capacity from July to December, 2012. The bottles were first washed with detergent thoroughly, then with tap water and after that washed with sampling water three times. Water samples were directly collected from a main river area having a minimum depth of two to three feet. Water samples were brought to the Pakistan Council of Scientific and Industrial Research Center (PCSIR) lab Peshawar for determining the physicochemical parameters. For determination of physicalchemical parameters.

Physical Parameters

Temperature: The digital centigrade thermometer was used for detection of water temperature at the time of water sampling. Water temperature was recorded by dipping the thermometer in sample water and waited for about three to five minutes.

pH: The pH of sample water determined by pH meter model 320 serial No Mu150. First tested the pH meter with distilled water and calibrated to zero. Then tested it with standards having pH 4 and pH 7 and press calibrate button. Then washed the electrode of pH meter with distilled water. The sample water 25 ml was taken in a beaker and pH meter electrode dips in at and noted the reading directly from the screen.

Electrical Conductivity (EC): Electrical conductivity of sample water determined by conductivity meter (Digital instrument Taiwan made, I.D No. PLC/MBC (EnviR/009).

Total Dissolved Solid (TDS): Total dissolved solid of sample water was detected by TDS meter (Digital instrument Taiwan made. I.D No. (Env. R/004).

Dissolved Oxygen (DO): For determination of dissolved oxygen of sample water DO Meter was used (Modal, D.38968 Taiwan made).

Chemical Parameters

Total Hardness: Titrimetric method was used to determine the total hardness of sample water. A conical flask was rinsed with sample water three times. Then taken 25 ml of sample water and added 1 to 2 ml of buffer pH 10 (67.5g NH_4Cl in 570ml conc. NH_4OH), then added indicator Erichrome Black T (0.5g sodium salt of 1-(1-hydroxy-2-naphthylazo)–5nitro-2naphthanol-4sulfonic acid dye in 100g Triethanolamine) and shake well. Titrate it with Ethylene Diamine tetra Acetic acid (EDTA) of 0.01 N until the color was changed to pink.

$$\text{Total hardness} = \frac{\text{Vol. of use Std. x Con. of Std. Sol. x Mol. wt of } CaCO_3}{\text{Vol. used of sample water}} \text{ x } 1000$$

Alkalinity: Alkalinity of water was determined by titrimetric method. A conical flask was taken and washed with distilled and sample water. Then 25 ml of water sample was taken and added three to four drops of methyl orange. Titrate it against 0.02 N H_2SO_4 until the color of sample water was changed from orange to blue. Note the reading directly from burette and used the same formula as for total hardness.

$$= \frac{\text{Std.Sol.Vol.use} \times \text{Std.Sol.Con.} \times \text{Molecular weight of } _{CaCo4}}{\text{Used samplewater volume}} \times 100$$

Ammonia NH_3: For determination of ammonia UV Model NO (U-2900 Hitachi) was used. Ammonia concentration of sample water was determined by the direct nesslerization method. First took 5 volumetric flasks of 100 ml volume and write down on them 0, 2, 4, 6 and 8. Then added distilled water and standard solution of ammonia in each. In volumetric flask 0 does not add any standard of ammonia, in volumetric flask 2 added 2ml of standard solution of ammonia, in 4 added 4 ml, in 6 added 6 ml and in 8 added 8ml of standard of ammonia. Then added 5 ml of nesslers reagents into each of them and dilute to 100 ml with distilled water. Sample water of 50 ml was taken in a volumetric flask and added 5 ml of Nessler reagents and diluted with distilled water to 100 ml and waited 30 minutes. Adjust the UV spectrophotometer at 420 nm wavelength. One of the two UV flasks was filled with distilled water and the other was filled from volumetric flask 2, 4, 6 and 8 in a series. A standard curve was formed by plotting absorbance against a standard solution of ammonia. Then the second flask was filled from sample water and notes the absorbing reading and used the following formula for calculating the ammonia concentration in sample water.

$$\text{NH3-H}\left(\frac{\text{mg}}{\text{L}}\right) = \frac{mg\ NH3-N \times 1000}{Samplevolume}$$

Sodium Ions (Na^+) and Potassium Ions (K^+): Flame Photometer modal PFP7 serial No. 12241 Jenway made was used for determination of sodium and potassium ion concentrations. First checked flame photometer with distilled water and adjust to zero by adjuster button. Then check it with standard solutions. For sodium ions (Na^+) 40 ppm and for potassium ions (K^+) 20 ppm standard were used and adjusted it by fine adjuster. Sample water of 50 ml was taken in a beaker. Dip the flame photometer electrode in sample water and was noted the reading directly from the screen. After completing all the samples turn off power button, gas pipeline and ignition button.

Heavy Metals (Pb, Cu, Zz and Ni)

Digestion Process: 100ml of sample water was taken in a beaker and added 5ml of nitric acid (HNO_3). Then the baker kept on a hot plate and waited until 50 ml were remained. Then added 20 ml distilled water and 5ml of HNO_3 and kept again on a hot plate. Waited until 30 or 40 ml was reminded. Then transferred the digested sample to 100 ml volumetric flask and added distilled water up to 100 ml mark. Then transferred the sample for atomic absorption model No Z-2000 Hitachi made.

RESULTS

Physical Parameters

Temperature (°C): During the current study temperature was recorded almost same at different stations. The maximum (21°C) average temperature was recorded in the month of August while minimum (8 °C) was determined in the month of December. The temperature ranged from 8 to 21°C. At all the stations, Khal, station A, Taimergara, station B and Talash, station C, the recorded temperature in the months of July, September, October and November were 20, 19, 16 and 9°C respectively. But the temperature of station C was recorded 17 °C in the month of October particularly (Table 1).

pH: Throughout the study period, no such clear variation in pH values was recorded. The highest mean (7.14) value of pH was observed in the month of October at the same time as lowest mean (6.53) value of pH was measured in August. At station A the pH value ranged from 6.13 to 7.07. The highest (7. 07) pH value was recorded in July and lowest (6.13) in December. The pH value 6.6, 6.8, 6.54 and 6.7 were detected in the months of August, September, October and November respectively. The pH value at station B was ranged from 6.5 to 8.2. The highest (8.2) pH value was recorded in December and lowest (6.5) in August. The pH values recorded it the rest of the month were 6.81, 6.9, 7.8 and 6.6 in July, September, October and November respectively. At station C the pH value ranged from 6.49 to 7.07. The highest (7.07) pH value was recorded in the months of July and October and lowest (6.49) in August. The pH values 6.8, 6.87 and 6.85 were recorded in the months of September, November and December respectively (Table 1).

Electrical Conductivity (µs/cm): The highest average (246.6 µs/cm) electrical conductivity was recorded in the month of August while the lowest average (136.6 µs/cm) electrical conductivity determined in July. At station A the maximum (250µs/cm) electrical conductivity was recorded in December and the minimum (140µs/cm) in July. Electrical conductivity values 210, 190, 180 and 230µs/cm were recorded in August, September, October and November respectively. On station B the maximum (300µs/cm) electrical conductivity was recorded in August and the minimum (140µs/cm) was recorded in July. The EC value 200µs/cm was recorded in the months of September and October and 250 and 230µs/cm were recorded in November and December respectively (Table 1).

Total Dissolved Solids (mg/L): The maximum mean (175mg/L) value of total dissolved solids was measured in December whereas minimum mean (86.33mg/L) value was noted in the month of July. Total dissolved solids (TDS) ranged from 86 to 171mg/L at station A, at station B it ranged from 90 to 210mg/L and at station C it ranged from 83 to 188mg/L. At station A the highest (171mg/L) TDS value was recorded in December and lowest (86mg/L) in July. The TDS values 130, 134, 139 and 163mg/L were recorded in the months of August, September, October and November respectively. On station B the highest TDS value (210mg/L) was recorded in August and the lowest (90mg/L) in July. Total dissolved solid values 138, 145, 166 and 170mg/L were recorded in September, October, November and December respectively. At station C the highest TDS value (188mg/L) was recorded in November and lowest (83mg/L) in July. The total dissolved solid values 133, 161, 170 and 184mg/L were determined in August, September, October and December respectively (Table 1).

Dissolved Oxygen (mg/L): The minimum average (6.23mg/L) concentration of dissolved oxygen was noted in the month of July while the maximum average

Table 1: Physical water quality parameters and their mean ± SD at all stations

Parameters	Station (Area)	Months							WHO	
		Jul	Aug	Sep	Oct	Nov	Dec	STD	Standards	P-values
Temp (°C)	A (Khaal)	20	21	19	16	9	8	5.68	--	0.0000
	B (Timergara)	20	21	19	16	9	8	5.68		
	C (Talash)	20	21	19	17	9	8	5.75		
	Mean	20	21	19	16.33	9	8	5.70		
pH	A (Khaal)	7.07	6.6	6.8	6.54	6.70	6.13	0.31	6.5-8.5	0.7023
	B (Timergara)	6.81	6.5	6.9	7.8	6.60	8.2	0.70		
	C (Talash)	7.07	6.49	6.8	7.07	6.87	6.85	0.21		
	Mean	6.98	6.53	6.83	7.14	6.72	7.06	0.41		
EC.µS/cm	A (Khaal)	140	210	190	180	230	250	38.9	800-1000	0.0020
	B (Timergara)	140	300	200	200	250	230	54.04		
	C (Talash)	130	230	230	240	270	285	54.26		
	Mean	136.6	246.6	206.6	206.6	250	255	49.09		
TDS mg/L	A (Khaal)	86	130	134	139	163	171	29.98	1000	0.0033
	B (Timergara)	90	210	138	145	166	170	39.91		
	C (Talash)	83	133	161	170	188	184	39.6		
	Mean	86.33	157.6	144.3	151.3	172.3	175	36.5		
DO mg/L	A (Khaal)	6.5	7	7.6	7.8	8	8.5	0.72	4.0-6.0	0.0011
	B (Timergara)	6.2	7	6.8	7	7.1	7.9	0.55		
	C (Talash)	6	7.1	7.7	6.9	8.2	8.6	0.95		
	Mean	6.23	7.03	7.73	7.23	7.77	8.33	0.74		

Table 2: Chemical water quality parameters and their mean ± SD at all stations

Parameters	Station (Area)	Months							WHO	
		Jul	Aug	Sep	Oct	Nov	Dec	STD	Standards	P Values
T. Hardness (mg/L)	A (Khaal)	73	106.6	100	120	120	136	21.7	300-600	0.0032
	B (Timergara)	96	133.3	108	118	132	132	14.25		
	C (Talash)	102	96	98	120	148	148	22.43		
	Mean	90.4	112	102	119	138	138	19.46		
Alkinilaty (mg/L)	A (Khaal)	60	80	86	80	100	108	16.90	200-600	0.0003
	B (Timergara)	54	72	78	88	96	100	15.56		
	C (Talash)	68	88	98	100	112	104	14		
	Mean	60.6	80	87.3	89.3	102.6	104	15.50		
Ammonia (mg/L)	A (Khaal)	0	1.2	0	0	1.43	1.42	0.95	0.2-0.5	0.0037
	B (Timergara)	0	0	0	0	0.9	0.92	1.03		
	C (Talash)	0	1.1	0	0	0	0	0.45		
	Mean	0	0.77	0	0	0.78	0.78	0.81		
Sodium Na^+ (ppm)	A (Khaal)	7.4	9.7	7.8	8.3	9.8	12	1.7	200	0.0375
	B (Timergara)	7	15.3	8.5	8.8	10.5	8.7	2.91		
	C (Talash)	6.3	11.2	10.4	10.5	13.2	12	2.35		
	Mean	6.90	12.07	8.9	9.2	11.17	10.1	2.32		
Potassium K^+ (ppm)	A (Khaal)	2.5	2.8	2.9	2.6	1.7	3	0.47	10	0.0185
	B (Timergara)	2.4	3.6	2.9	2.7	2.2	2	0.58		
	C (Talash)	2.5	3	2.7	2.5	2.3	2.4	0		
	Mean	2.47	3.13	2.83	2.6	2.07	2.47	0.43		

(8.33mg/L) concentration of DO measured in December. At station A the highest (8.5mg/L) dissolved oxygen value was recorded in December and lowest (6.5mg/L) in July. Dissolved oxygen value 7mg/L were recorded in August and September, 7.8 and 8mg/L were determined in the months of October and November respectively. At station B the minimum (6.2mg/L) dissolved oxygen value was recorded in July and maximum (7.9mg/L) in December. In the months of August, September, October and November dissolved oxygen values were recorded 7, 6.8, 7 and 7.1mg/L respectively. At station C the highest (8.6mg/L) dissolved oxygen value was detected during the month of December and lowest (6mg/L) in July. Dissolved oxygen values 7.1, 7.7, 7.1 and 8.2mg/L were determined in July, August, September, October and November respectively (Table 1).

Chemical Parameters

Total Hardness (mg/L): The highest mean (138.67mg/L) value of total hardness was noted in the month of December while the lowest mean (90.44mg/L) value was determined in July. At station A maximum (136mg/L) total hardness value was recorded in December and minimum (73mg/L) in July. Total hardness values were recorded 106.6 and 100mg/L in August and September and 120mg/L in October and November. At station B the highest (133.3mg/L) total hardness value was recorded in August and the lowest (96mg/L) in July. Total hardness values were 108 and 118mg/L were recorded in the months of September and October and 132mg/L value was recorded in November and December respectively. At station C the highest (148mg/L) total hardness value was determined in November and December and lowest (96mg/L) in August. Total hardness values102, 98 and 120mg/L were determined in the months of July, September and October respectively (Table 2).

Alkalinity (mg/L): The highest average (104mg/L) alkalinity was recorded in the month of December while lowest (68.67 mg/L) was measured in the month of July. At station A alkalinity ranged from 60 to 108mg/L, at station B it ranged from 54 to 100mg/L and at station C it ranged from 68 to 104mg/L. At station A the highest (108mg/L) and lowest (60mg/L) alkalinity values were recorded in December and July. Alkalinity value 80mg/L was recorded in the months of August and October. In September and November alkalinity values were recorded 86 and 100mg/L. At station B highest (100mg/L) alkalinity value was recorded in December and lowest (54mg/L) in July. Alkalinity values 72, 78, 88 and 96mg/L were determined in August, September, October and December respectively. At station C highest (122mg/L) alkalinity value was recorded in November and lowest (68mg/L) in July. The alkalinity values were recorded 88, 98, 100 and 104mg/L in the months of August, September, October and December respectively (Table 2).

Ammonia (mg/L): The maximum average (0.93mg/L) ammonia concentration was determined in the month of December at the same time as the minimum average concentration (0) was observed in July. At station A higher value (1.43mg/L) was recorded in November and lowest value (0) was recorded in July, September and October respectively. The ammonia concentrations were 1.2 and 1.42 mg/L recorded in August and December respectively. In station B the minimum (0) value was recorded in the months of July, August and September while the maximum value was (1.03 mg/L) in December. In October and November the concenteration of ammonia values were 0.9 mg/L and 0.92 mg/L were observed. At station C the highest (1.1mg/L) value was recorded in August and the lowest (0) value was recorded in the months of July, September, October, November and December respectively (Table 2).

Sodium Ion (ppm): The overall maximum mean (12.07ppm) concentration of sodium ions was noted in the month of August while overall minimum mean (6.9ppm) concentration of sodium ions was detected in July. At station A the highest (12ppm) sodium ion concentration was recorded in December and lowest (7.4ppm) in July. Sodium ions concentration values 9.7, 7.8, 8.3 and 9.8ppm were noted in the months of August, September, October and November respectively. At station B the highest (15.3ppm) sodium ions concentration was recorded in August and the lowest (7ppm) to July. While in September, October, November and December the values of sodium ion's concentration values recorded were 8.5, 8.8, 10.5 and 8.7 ppm respectively. At station C the maximum (13.2ppm) of sodium ion concentration was detected in November and minimum (6.3p.m.) in July. Sodium ion's concentration values 11.2, 10.4, 10.5 and 12ppm were determined in the months of August, September, October and December respectively (Table 2).

Potassium ion (ppm): The highest average (3.13ppm) of potassium ions concentration was observed in the month of August while lowest overall average (2.07ppm)

Table 3: Different concenterations of heavy metals in water and their mean ± SD in all stations

		Months								
									PSQCA	
Metals	Station	Jul	Aug	Sep	Oct	Nov	Dec	STD	Standards	PValues
Lead (pb) (ppm)	A (Khaal)	0	0	0	0	0	0	0	0.05ppm	0.4582
	B (Timergara)	1.29	0	0	0	0	0	0.53		
	C (Talash)	0	0	0	0	0	0	0		
	Mean	0.43	0	0	0	0	0	0.18		
Copper (Cu) (ppm)	A (Khaal)	0.10	0.09	0	0	0	0	0.05	2.00ppm	0.0002
	B (Timergara)	0.22	0.08	0	0	0	0	0.09		
	C (Talash)	0.09	0.09	0	0	0	0	0.05		
	Mean	0.14	0.09	0	0	0	0	0.06		
Zinc (Zn) (ppm)	A (Khaal)	0.21	0.05	0	0	0.28	0	0.12	3.0ppm	0.0136
	B (Timergara)	0.91	0.10	0	0	0.04	0.19	0.35		
	C (Talash)	1.48	0.10	0	0	0.14	0	0.59		
	Mean	0.87	0.08	0	0	0.15	0.06	0.35		
Nickel (Ni) (ppm)	A (Khaal)	0	0	0	0	0.16	0.16	0.08	0.02ppm	0.0000
	B (Timergara)	0	0	0	0	0.2	0.16	0.09		
	C (Talash)	0	0	0	0	0.18	0.13	0.08		
	Mean	0	0	0	0	0.18	0.15	0.09		

potassium ions concentration was noted in November. At station at the minimum (1.7ppm) of potassium ion concentration was recorded in November and maximum (3ppm) in December. Potassium ions concentration values 2.5, 2.8, 2.9 and 2.6ppm were recorded in the months of July, August, September and October respectively. At station B the highest (3.6ppm) potassium ions concentration was recorded in August and the lowest (2ppm) in December. Potassium ion's concentration values 2.4, 2.9, 2.7 and 2.2ppm were recorded in July, September, October and November respectively. At station C the maximum (3ppm) potassium ion concentration was recorded in August while minimum (2.3ppm) in November. It rests of the months potassium ion's concentration values 2.5, 2.7, 2.5 and 2.4ppm were determined in July, September, October and December respectively (Table 2).

Heavy Metals

Lead (Pb): Negligible amount of heavy metals was recorded from River Panjkora during the study period. The highest average (0.43ppm) concentration of lead was noted in the month of July while the lowest average (0) overall concentration was recorded during the current study. At station A the lead concentration was zero during the study time. While at station B only (1.29) value was recorded in July. In rest of the month it was not detected. At station C lead was below the detection level during study time (Table 3).

Copper (Cu): The maximum (0.14ppm) mean concentration of copper was noted in the month of July while minimum (0) mean concentration of copper was observed in the months of September, October, November and December respectively. At station A only small concentration of copper (0.1) was recorded in the month of July while in the rest of the month copper was below the detection level. At station B copper concentration (0.22) and (0.08) were detected in July and August and while the rest of the month copper was below the level of detection. At station C copper (0.09) concentration was recorded in the months of July and August while in rest of the months a copper concentration was below the level of detection (Table 3)

Zinc (Zn): Overall highest average (0.87ppm) concentration of zinc was recorded in the month of July while overall lowest average (0) concentration of zinc was measured in the months of September and October. At station A zinc concentration was very low. Highest (0.28) zinc value was recorded in November and lowest value zero in the months of September, October and December. Zinc values of 0.21 and 0.05 were detected in the months of July and August. At station B maximum (0.91) zinc value was recorded in July while minimum (0) value was recorded in the months of September and October and 0.10, 0.04 and 0.19 zinc concentrations were recorded in the months of August, November and December respectively. While at station C highest (1.48)

value of zinc was recorded in July and lowest zero was recorded in September, October and December. In the remaining months 0.10 and 0.06 values were recorded in August and November (Table 3).

Nickel (Ni): The highest mean (0.18ppm) concentration of nickel was observed in the month of November at the same time as lowest mean (0) concentration of nickel was noted in the months of July, August, September and October respectively. At station A highest (0.16ppm) concentrations of nickel was recorded in the months of November and December. In the months of July, August, September and October it was below the level of detection. While station B maximum (0.20ppm) value of nickel concentration was recorded in the month of November and minimum zero was recorded in the months of July, August, September and October and 0.16ppm was recorded in December. At station C highest (0.18ppm) value was recorded in November and the lowest (0) was recorded in the months of July, August, September and October while in December 0.15 values was recorded (Table 3).

DISCUSSION

The physicochemical characteristics of water are enormously influenced by the richness of biota, its uses and distribution [10]. The physicochemical parameters which affect the aquatic ecosystems are dissolved oxygen, temperature, pH, rainfall and salinity, etc. Such parameters are the restraining factors for the continued existence of aquatic fauna and flora [11]. Freshwater ecosystem is subject to difference in the environmental factors such as temperature, pH, dissolved oxygen, turbidity, density, light penetration, etc. Such parameters play vital role for the distribution and abundance of aquatic organisms in different freshwater ecosystems, according to their adaptation manner, which allow them to live in definite ecosystems [12]. While the distribution and abundance of fishes entirely depend on physical, environmental condition and the level of tolerance, which fish potential to survive under sudden environmental variations more or less [13].

The present study showed various physical and chemical water quality parameters found within permissible limits of Pakistan National Environmental Quality Standards [14].

In the present study maximum temperature of 21 °C in August and minimum was 8 °C in December. The same result was recorded by Ashraf [15].

In the present study pH values were reported in the range of 6.53 to 7.14 which are suitable for fish production and survival. While in another study the pH value of 8.0 to 9.0 was reported for River Soan Chakwal, Pakistan [16].

During the present study the minimum value of (136.6 µS/cm) of electrical conductivity was recorded in July and maximum (255 µS/cm) in December. Electrical conductivity showed variations during the study period, such variations might be due to different factors such as salinity, dissolved solids, the concentration of free ions; high level of industrial waste, temperature, etc. Similar results are reported by Boyd [4].

Total dissolved solids (TDS) designated the total quantity of carbonates, sulfates, bicarbonates and some other inorganic components in water. For diverse fish population the maximum total dissolved solid values as 400mg/L [17]. During present investigation TDS values ranged from 86.33 to 175mg/L. Total dissolved solid values were minimized (86.33mg/L) in July due to monsoon seasons and high flow of water and maximum (175mg/L) in December it is within the permissible limits of WHO [18].

Minimum (6.23 mg/L) value of dissolved oxygen was reported in July and maximum (8.33 mg/L) in December during the present study. Dissolved oxygen is inversely proportional to water temperature and photoperiods, with a high value of temperature and long photoperiod, dissolved oxygen showed minimum values. When low temperature and short photoperiod the dissolved oxygen showed maximum values. In July the temperature was high and dissolved oxygen was low, in December the temperature was low and dissolved oxygen was high. Similar results were observed by Ali *et al.* [19].

Water hardness is mainly caused by the presences of iron, magnesium and calcium ions and also because of Al, Zn, Mg, Ni and some other heavy metals in water. Hardness value lower than 5 mg/L cause death of fish, at values less than 15 mg/L growth rate of fish becomes slower and more than 15 mg/L is suitable for fish production [4]. In the present investigation the minimum (90.44mg/L) value of hardness was observed in July and maximum (138mg/L) in December. Hardness fluctuated from July to December was due to seasonal changes. Yousafzai *et al.* 175.2 to 182.8 mg/L was reported for River Kabul and Muhammad *et al*. [20] 21.6mg/L investigated for River Swat. The present value is more than that River Kabul and less than that of River Swat [21].

During the present observations alkalinity was reported in the range of 60.67-104 mg/L. Minimum 60.67 mg/L value of alkalinity was reported in July and maximum

104 mg/L in December it was within the range of WHO [18]. Our result was compared to other rivers of the region. Subramanian reported 128 mg/L for Ganges, 105mg/L for Godavari, 135 mg/L for Cauvery, 64 mg/L for Indus River and 122 mg/L for River Mahandi [22]. Muhammad *et al.* [20] reported 1.32 mg/L for River Swat at Mingora.

The highest concentration of ammonia is toxic to aquatic organisms. During the present investigation ammonia ranged from 0-0.81 mg/L at all stations. The minimum value was zero in July and maximum (0.81 mg/L) was in December. The high concenteration of ammonia in water may be due to low flow and less volume of water.

Sodium and potassium ions mean concentrations between the range of 6.90 – 12.07ppm and 2.47-3.13ppm was reported during the present study. Similar results were investigated by Ali *et al*. [23] from Ghazi Ghat, Indus River.

Fish growth is a dependable and the susceptible endpoint in constant toxicological examination [24]. During the present analysis heavy metals pb, Cu, Zn and Ni were found in the range of 0-0.14, 0-0.43, 0-0.87 and 0-0.18ppm, respectively. These heavy metals are detected within safe limits except nickel and lead. Nickel and lead exceeds PSQCA, [25] standards for drinking water quality of downstream spot of Timergara city making the water unfit for drinking. It means that city sewage contains Ni and Pb which are exceeding the quantity of these metals in river water making it unfit for drinking. Prolong exposure of fish in the particular area will be having life threats also especially the Juvenile and eggs. Furthermore, in the result of bioaccumulation of these metals within the fish body can pose human health problems in the case of consumption of of such fish the presence of Pb and Ni in water could potentially pose health threats to humans either via through direct consumption of surface water or bioaccumulation process [25].

The source of heavy metals (Cu and Zn) in fresh water bodies is mainly through industrial effluents. In freshwater bodies, the acceptable level of copper is 2.0ppm and zinc is 3.0ppm [26]. Higher concentration will be life threatening. The present study reports that the concentrations of Cu and Zn were within the safe limits (Table 3).

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CONCLUSION

- From the current study it was concluded that all the physicochemical parameters showed the safe range according to water quality standards of APHA [24, 25].
- Pb and Ni exceeded from the permissible limits for drinking water quality according to PSQCA [25] and WHO [18].
- Dissolved oxygen and temperature have a great authority on fish richness and abundance. The effects of other parameters were insignificant.

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