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Monitoring of water quality parameters to know the suitability of water for fish fauna at River Sardaryab, Khyber Pakhtunkhwa, Pakistan

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Abstract

Physiochemical parameters of River Sardaryab (a tributary of River Kabul) were analyzed in Khyber Pakhtunkhwa (KPK) province of Pakistan. The water quality was studied during the months of March to July 2011. Aim of the study was to observe the suitability of River water for fish fauna. Possible sources of contamination were analyzed. The major contaminant found in the River Sardaryab signifying the release of domestic waste water into the River without any treatment. Parameters measured included Water Temperature, pH, Alkalinity, Total hardness, Total Chloride level, Nitrite and Nitrates. All the parameters were within the permissible limit with mean values and standard error include Air Temperature = $33^0 \pm 5.79^0$C; Water Temperature = $30.12^0 \pm 5.87^0$C; pH = 8.22 ± 1.26; Chloride = 0 ± 0mg/l; Nitrite = 0.32 ± 0mg/l; Nitrate = 7.1 ± 2.56mg/l; Hardness = 150 ± 37.14mg/l; Alkalinity = 232 ± 26.41 mg/l. The water chemistry of the River reflects the absence of sub lethal pollution rendering the River water fit for fish and other aquatic organisms, livestock and irrigation.

1. Introduction

Water quality parameters are the physical, chemical and biological characteristics of water [4]. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose [9]. Water also exists in a liquid crystal state near hydrophilic surfaces [8]. Under nomenclature used to name chemical compounds, Dihydrogen monoxide is the scientific name for water, though it is almost never used [2]. On Earth, 96.5% of the planet's water is found in oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapor, clouds (formed of solid and liquid water particles suspended in air), and precipitation [6]. Only 2.5% of the Earth's water is freshwater, and 98.8% of that water is in ice and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products [6].

Water is essential for the survival of any form of life. An average human consumes about 2 liter of water every day. About 80% of the earth surface is covered by water. Out of the estimated 1011 million km of the total water present on the earth, only $33400 m^3$ of water is available for drinking, agriculture, domestic and industrial consumption. The rest of the water is locked up in oceans as salt water, polar ice caps, glaciers, and underground. Owing to increasing industrialization on one hand and exploding population on the other, the demands of water supply have been increasing tremendously. Moreover, sewage, industrial wastes and a wide array of synthetic chemical pollute considerable part of this limited quantity of water born disease and epidemics still threatens the well being of not only the human but also the fish population. Thus the quality as well as quantity of clean water supply is of vital significance for the welfare of mankind [5].

Many of the major problems that humanity is facing in the twenty-first century are related to water quantity and water quality issues [1].These problems are going to be more aggravated in the future by climate change, resulting in higher water temperatures, melting of glaciers, and an intensification of the water cycle, with potentially more floods and droughts [3]. With respect to human health, the most direct and most severe impact is the lack of improved sanitation, and related to it is the lack of safe drinking water, which currently affects more than a third of the people in the world. Additional threats include, for example, exposure to pathogens or to chemical toxicants via the food chain (e.g., the result of irrigating plants with contaminated water and of bioaccumulation of toxic chemicals by aquatic organisms, including seafood and fish) or during recreation (e.g., swimming in polluted surface water). This review deals with the pollution of freshwater resources, including lakes, rivers, and groundwater. Because numerous reviews have appeared recently that cover the various aspects of waterborne diseases in a comprehensive way [5]. More than one- third of Earths accessible renewable freshwater is consumptively used for agricultural, industrial, and domestic purposes. As most of these activities lead to water contamination with diverse synthetic and geogenic natural chemicals, it comes as no surprise that chemical pollution of natural water has become a major public concern in almost all parts of the world.

2. Materials and Methods:
2.1 Water Sample Collection:
Water samples were collected for five months from the month of March to July 2011 under high flow condition in clean one liter polythene bottles. Before sample collection the bottles were rinsed three times with sample water. Water temperature and pH were examined on the spot while for the estimation of rest of the parameters water was brought to the laboratory.

2.2 Water Quality Parameters estimation methods:
2.2.1. Total hardness estimation:
Total hardness was estimated with EDTA titrimetric method. Well-mixed water sample (25 ml) was diluted to 50 ml with distilled water in a flask. To this flask add 2-4 ml buffer pH 10 (67.5g NH_4Cl in 570 ml conc. NH_4OH and diluted to 1 liter), and 2 to 3 drops of Eriochrome Black-T [0.5g sodium salt of 1-(1-Hydoxy-2-naphthylazo)-5-nitro-2-naphthanol-4-sulfonic acid dye in 100g triethanolamine indicator were added and slowly titrated against 0.01 M EDTA with continuous stirring until the last reddish tinge color changed to bluish purple.

$$\text{Total hardness (mg/L)} = Ca + Mg \text{ (as } CaCO_3) = \frac{V \times M \times 100 \times 1000}{Sample\,(mL)}$$

Where V is volume of EDTA used is molarity of EDTA (0.01 M) and 100 is the molecular weight of$CaCO_3$.

2.2.2. Calcium hardness estimation:
Calcium hardness was estimated with EDTA titrimetric method. Well-mixed water sample (25 ml) was diluted to 50 ml with distilled water to which was added 2-4 ml of KOH buffer pH 12.5 [20% (w/v) KOH solution] and 0.2g of murexide indicator (0.2g of murexide per 100g of NaCl). The resulting reddish color solution in the flask was titrated against 0.01M EDTA with continuous stirring until the reddish color changed to bluish purple (violet). Calcium hardness was calculated as under:

$$\text{Ca hardness as } CaCO_3 \text{ (mg/L)} = \frac{V \times M \times 100 \times 1000}{Sample\,(mL)}$$

Where V is volume of EDTA (ml) used, M is molarity of EDTA (0.01 M), and 100 is molecular weight of $CaCO_3$. Difference magnesium hardness, between total and calcium hardness directly determines the extent of Mg hardness (mg/L) Total hardness as $CaCO_3$ (mg/L) - Ca hardness as $CaCO_3$ (mg/L).

2.2.3. Total alkalinity estimation:
Total alkalinity was estimated with titrimetric method. One drop of methyl orange indicator was added to 25 ml of sample and titrated against 0.02 NH_2SO_4 solutions until color changed from red to pink/orange.

$$\text{Total alkalinity as } CaCO_3 \text{ (mg/L)} = \frac{N \times E \times 1000 \times V}{Sample\,(mL)}$$

Where N is normality of H_2SO_4 (0.02 N), E is the equivalent weight of $CaCO_3$ (50), and V is the volume Of H_2SO_4 (ml) used during titration.

2.2.4. Chloride estimation:

Chloride was estimated with Argentometric method in which the water sample is titrated against standard $AgNO_3$ titrant. A 25 ml well-mixed water sample was diluted to 50 ml with distilled water to which was added same volume of 0.02 NH_2SO_4 as used for the total alkalinity followed by 2 to 4 drops of potassium chromate (K_2CrO_4) indicator and titrated against 0.0141 N $AgNO_3$ solution until the color changed to a pinkish yellow. Amount of chloride present was calculated from the amount of silver nitrate used as a titrant.

$$1 \text{ ml } AgNO_3 = 0.45 \text{ mg chloride} = \frac{C1(mg/L) = A \times 1000}{Sample (m/L)}$$

Where A is the volume of $AgNO_3$ used in titration.

2.2.5. Nitrate estimation:

Nitrate estimation was carried out with the help of phenoldisulfonic acid method. Volume of silver sulfate (Ag_2SO_4) equal to the volume of 0.02 NH_2SO_4 used for the estimation of total alkalinity was added to 100ml of water sample, heated for a few minutes, neutralized to pH 7 and evaporated to dryness on water bath. The residue was mixed with 2ml phenoldisulfonic acid, followed by 20ml distilled water and 7ml concentrated NH_4OH and waited until maximum yellow color was developed. Absorbance was read at 420nm wavelength against the blank prepared for the same volume of distilled water, phenoldisulfonic acid and NH_4OH used for the sample. Nitrite concentration was estimated from the standard curve. For preparation of standard curve, 50ml stock nitrate solution (100 mg/l) was placed in the boiling water bath until dryness. The residue was dissolved with 2ml phenoldisulfonic acid reagent and diluted to 500ml with distilled water to make a solution of 10µgN/ml. Different quantities viz., 0.1, 0.5, 0.7, 1.0, 1.5, 2.0, 3.5, 6.0, 10, 15 and 30ml of the standard nitrate solution were taken in separate 100ml flasks, to which 2ml phenoldisulfonic acid and 7ml concentrated NH_4OH was added. A blank was prepared from the same volumes of phenoldisulfonic acid and NH_4OH. Absorbances of standards were read against the blank at 420nm wavelength. The calibration curve was prepared by plotting absorbance against the amount ofNO3.N. The corresponding value of the sample was read from the standard curve. The amount of nitrate-N was calculated as follows:

$$\text{Nitrate-N (mg/L)} = \frac{NO3\text{-}N (mg) \times 1000}{Sample \ volume(mL)}$$

Nitrate-N (mg/L) x 4.428 = NO_3 (mg/L).

Where 4.43 is the factor for the conversion of nitrogen (NO_3-N) into nitrate and is obtained by dividing the molecular weight of nitrate (62) by the atomic weight of nitrogen (14).

2.2.6. Nitrite estimation:

Nitrite estimation was carried out with the help of diazotization method. Water sample (50ml) was neutralized to pH 7 and then 1ml sulfanilic acid was added and pH adjusted to 1.4. To this mixture the reddish purple color was measured at 520nm wavelengths against the blank prepared by using distilled water instead of sample and adding the same reagents in the same volumes as used for the sample. The nitrite concentration was derived from the standard curve prepared by plotting absorbance against different concentrations of sodium nitrite stock solution. Stock solution was prepared by dissolving 0.246g anhydrous $NaNO_2$/liter distilled water to form nitrite stock solution of 0.05mg N/ml. This stock solution was further diluted by dissolving its 10ml portion in distilled water to make 1 liter solution (0.5 g N/ml). Different quantities, viz., 0.0, 0.1, 0.2, 0.4, 0.7, 1.4, 1.7, 2.0 and 2.5ml solution were taken in separate volumetric flasks, diluted to 50ml with distilled water, and same volumes of reagents were added. Absorbances were determined against the blank at 520nm wavelength and plotted on the graph paper against concentration. The NO_2-N concentration was calculated as follows.

$$\text{Nitrite-N (mg/1)} = \frac{NO2\text{-}N (mg) \times 1000}{Sample \ volume(ml)}$$

Nitrite-N (mg/1) x3.285=NO_2 (mg/1)

Where 3.285 is the factor for the conversion of nitrogen (NO_2-N) into nitrite and is obtained by dividing the molecular weight of nitrite (46) by the atomic weight nitrogen (14).

3. Results
3.1. Air Temperature:

The values of air temperature for the study period of March to July was 10 ^{0}C, 40 ^{0}C, 39 ^{0}C, 40 ^{0}C, 36 ^{0}C respectively with mean value and standard error 33±5.79 ^{0}C, showing highest values in the months of April and June while lowest in the month of March.

3.2. Water temperature: The values of water temperature for the study period of March to July was 7 ^{0}C, 32.5 ^{0}C, 37.2 ^{0}C, 38.8 ^{0}C, 35.1 ^{0}C respectively with mean value and standard error 30.12±5.87 ^{0}C, showing highest values in the months of April and June while lowest in the month of March.

3.3. pH:
The values of pH for the study period of March to July were 8.4, 8.4, 8.2, 7.9, 8.2 respectively with mean value and standard error 8.22±1.26, showing highest values in the months of March and April while lowest in the month of June.

3.4. Total alkalinity:
The values of alkalinity for the study period of March to July were 250, 250, 120, 260, 280 respectively with mean and standard error 232±26.41 mg/l, showing the highest value in the month of July while lowest in the month of May.

3.5. Total hardness:
The values of total hardness for the study period of March to July was 300, 150, 75, 75, 150 respectively with mean value and standard error 150±37.14 mg/l,

showing highest value in the month of March while lowest in the months of May and June.

3.6. Chloride:
The values of total chloride level for the study period of March to July were 0, 0, 0, 0, 0 mg/l respectively.

3.7. Nitrite:
The values of nitrate for the study period of March to July were 0.2, 0.3, 0.4, 0.3, 0.4, respectively with mean value and standard error 0.32±0 mg/1, showing a highest value in the month of March while lowest in the months of May and June.

3.8. Nitrate:
The values of nitrite for the study period of March to July were 0.5, 5, 5, 15, 10 respectively with mean value and standard error 7.1±2.56 mg/1, showing highest value in the month of June while lowest in the month of March.

Values of all the parameters for study months are shown in Table.1 and Fig.1-8.

Table 1: Showing values of studied parameters during studied period

Parameters/Months	March	April	May	June	July	Mean ± S.E
pH	8.4	8.4	8.2	7.9	8.2	8.22±1.26
Air temp (^{0}C)	10	40	39	40	36	33±5.79
Water temp (^{0}C)	7	32.5	37.2	38.8	35.1	30.12±5.87
Hardness (mg/l)	300	150	75	75	750	150±37.14
Chloride (mg/l)	0	0	0	0	0	0±0
Alkalinity (mg/l)	250	250	120	260	280	232±26.41
Nitrite (mg/l)	0.2	0.3	0.4	0.3	0.4	0.32±0
Nitrate (mg/l)	0.5	5	5	15	10	7.1±2.56

Fig 1-8: Showing values of studied parameters during studied period.
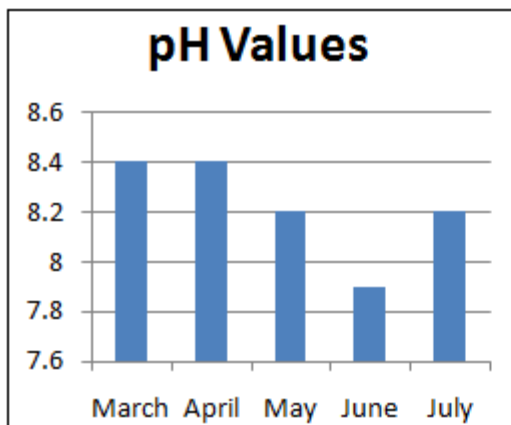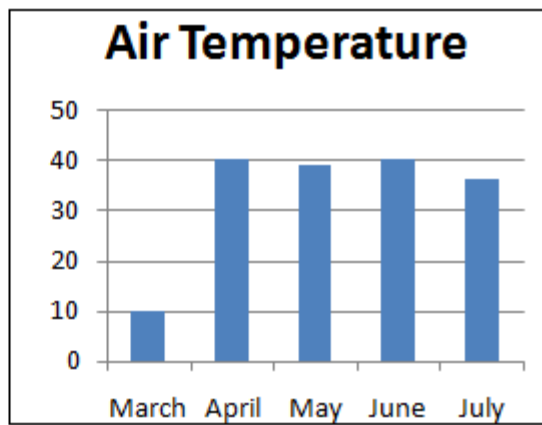

Fig 1: pH values

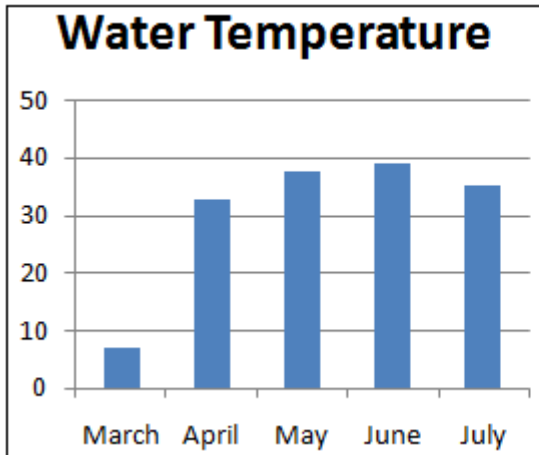**Fig 2:** Air temperature values
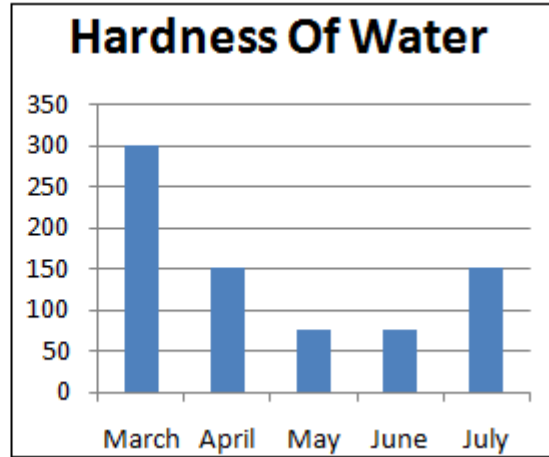
Fig 3: Water temperature values
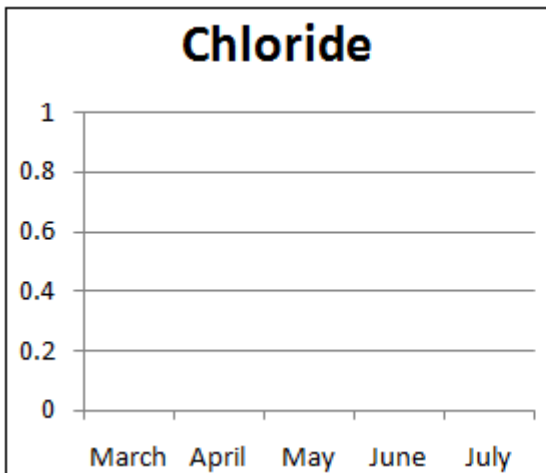

Fig 4: Water hardness values

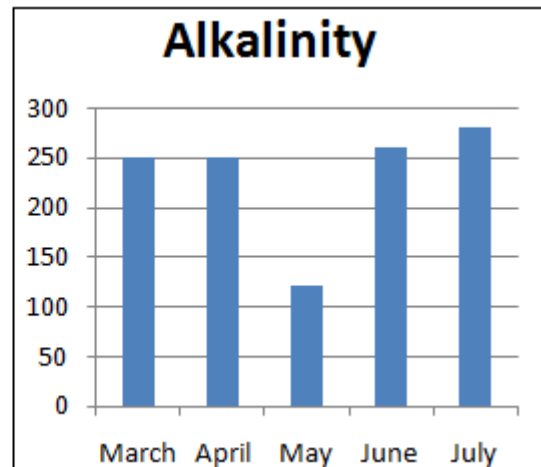**Fig 5:** Chloride values

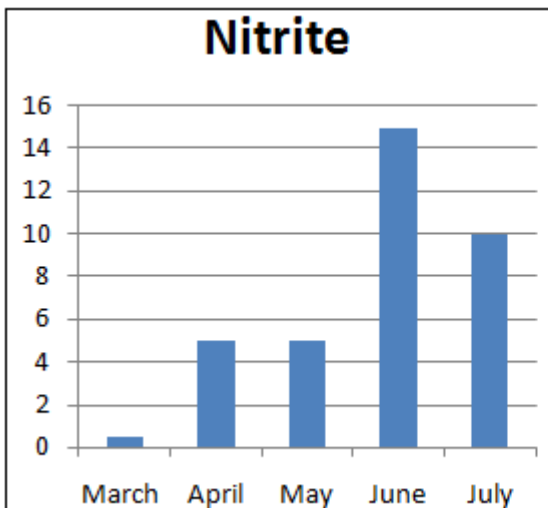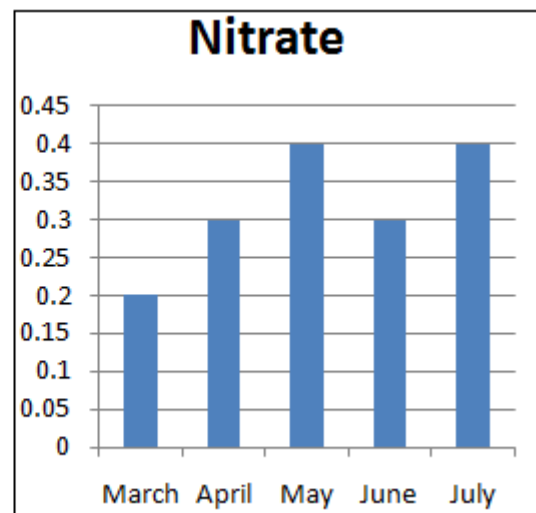**Fig 6:** Alkalinity values

Fig 7: Nitrite values

Fig 8: Nitrate values

4. Discussion

In the present study pH in all the samples for the study period fell between 6-9. The pH of all the samples for the study period exhibited no drastic change. This correlates with the pH of the other large rivers of Pakistan. Hamza (2006), has reported pH 7.6 for Mattani Azakhel, Pakistan. Khan and Khan (1997) have reported a pH 7.6 for River Kabul. Muhammad et al., (1998), have reported a pH 6.7 for River Swat at Mingora, Pakistan.

Generally our findings show that River Sardaryab water is more alkaline in comparison with River Swat, River Kabul and Mattani Azakhel .The mean value and standard error of alkalinity for the study period were 232±26.4 1 mg/1, which exceeds from the normal range. Higher levels of total alkalinity may be due to the leaching of soils during natural filtration [11]. Hamza (2006), has reported alkalinity 143.5 mg/l for Mattani Azakhel, Pakistan. Khan and Khan (1997) have reported alkalinity 93mg/l for River Kabul. Muhammad et al., (1998), have reported total alkalinity of 1.32 mg/l for River Swat at Mingora, Pakistan. The values reported are within the suitable range for fish survival, reproduction and growth in Pakistan.

The mean value and standard error of total hardness for the study period were 1 50±37.14 which shows a moderately hard nature of River Sardaryab water and is suitable for aquatic fauna. Generally our findings shows that fluctuations of total hardness level during the study period may be due to the addition of nearby population effluents, which cause sudden changes in the level of hardness. Hamza (2006), has reported total hardness 193.75mg/1 for Mattani Azakhel , Pakistan. Khan and Khan (1997) have reported total hardness 103mg/l for River Kabul. Muhammad et al., (1998), have reported total hardness of 21.6 mg/l for River Swat at Mingora, Pakistan.

The mean value and standard error of total chloride level for the study period were 0±0. In our study chloride level for the study period fell in the safe range. Total chloride level of the river in the present study period exhibited no drastic changes. Hamza (2006), has reported a total chloride level 11.9 mg/l for Mattani Azakhel, Pakistan. Khan and Khan (1997) have reported a total chloride level 12mg/l for River Kabul. Muhammad *et al*., (1998) have reported total chloride level of 1 .32 mg/l for River Swat at Mingora, Pakistan.

The mean value and standard error of nitrite for the study period were 0.32±0 mg/l. In the present study the difference may be due to fluctuations in photosynthetic activity by algae. Khan and Khan (1997), have reported

the nitrite level 0.07rng/l for River Kabul. The mean value and standard error of nitrate for the study period were 7. 1±2.56mg/l. The gradual increase in the nitrate level in the samples for the study period may be due to pollution by human and animal wastes or fertilizer run-off. Hamza (2006), has reported the nitrate level of 7.8 mg/l for Mattani Azakhel, Pakistan which correlates with the present study. Khan and Khan (1997) have reported the nitrate level 0.07mg/l for River Kabul and have low level of nitrate in comparison with River Sardaryab. However, in the present study, level of nitrite and nitrate during the either study period remained in the safe level and nitrite and nitrate in no way could be a limiting factor for fish population.

5. Conclusion

The present study of River Sardaryab (River Kabul) water reveals that all of the physiochemical parameters are within the permissible limit. The results show that the River Sardaryab water is fit for livestock drinking, irrigation and also for fish productivity.

6. References

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