



*STUDY OF PHYSICO-CHEMICAL PARAMETERS FROM JEEVREKHA DAM,
 MAHARASHTRA, INDIA*

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ABSTRACT:

The present study was carried out from July 2006 to June 2008. During the study period water quality studied. Various quality parameters are measured including pH, air temperature, water temperature total solids, free CO₂, BOD, COD, total hardness, calcium, DO, total alkalinity, magnesium, chloride, and sulphate. All water parameters are within the permissible limit and suitable for biodiversity. The result indicated and discussed.

Key Words: Parameter, Jeevrekha, Water Quality and biodiversity

Introduction: Water is life for human. According to WHO 70 % people are without access of safe drinking water. All the peoples are depends on water for agriculture, food production, industries and very importance for waste disposal. The other biota is also depends on freshwater. our main resources of freshwater is dams and from last two decade it will observed that our resources get polluted and hence the time comes to get reform and analysis the water quality of our near by dams. water quality is of vital concern for the mankind because it related to human welfare

Material and Methods

To study the water quality, which define as physical, chemical and biological characteristics of Water samples were collected monthly at 2 feet depth from the surface area of the water body from the two sampling points in between 7 to 11 am during the study period. The first sampling point (S₁) near the wall of the dam and second sampling site (S₂) at the river entry point and the distance between two sampling points were approximately 2 to 5 km.

The parameters studied were pH, air temperature, water temperature total solids, free CO₂, BOD, COD, total hardness, calcium, DO, total alkalinity, magnesium, chloride, and sulphate. Parameters like pH, air temperature and dissolved oxygen was measured at the site, and samples in 5 liter plastic cans were brought to the Fishery research laboratory, Department of Zoology, Dr Babasaheb Ambedkar Marathwada University Aurangabad for further estimation by using standard water analysis method described by APHA (1992), Kodarkar (1992), Trivedy and Goel (1986).

1.1 Morphometric Study

1.2 Study of physical parameters: Physical parameters such as air temperature, water temperature, total solids, total dissolved solids and total suspended solids were analysed by the standard methods by Trivedy and Goel(1986), Kodarkar (1992).

- i) **pH (Hydrogen ion concentration):** pH of water was recorded by field pH Meter Hanna –Model champ during study period on sampling site.
- ii) **Temperature:** Water and air temperature of sampling site was recorded from June 2006 to May 2008. The temperature was recorded with a centigrade mercury thermometer (graduated from 0.0 °C to 110 °C) in the field.
- iii) **Total Solids, (TS), Total Dissolved Solids, (TDS) Total Suspended Solids (TSS).** Total solids, total dissolved solids and total suspended solids were determined on monthly basis during the study period. Total dissolved solids (TDS) were determined in the laboratory as the residue left after evaporation of the filtered water sample while total suspended solids were determined by calculating the difference between total solids and total dissolved solids.

1.3 Study of Chemical parameters: Water samples from sampling site during the study period June 2006 to May 2008 were collected monthly and brought to the Fishery research laboratory, Department of

Zoology, Dr Babasaheb Ambedkar Marathwada University, Aurangabad, for analysis of various chemical parameters. Chemical parameters like dissolved oxygen, free CO₂, BOD, COD total hardness, magnesium, calcium, total alkalinity, chlorides, and sulphate, were determined by standard methods as described by Trivedy and Goel (1986), Kodarkar (1992).

- i) Total Alkalinity :** Total alkalinity of water samples was estimated in laboratory by using standard method as described by Trivedy and Goel. (1986).
- ii) Total Hardness:** Total hardness of collected water samples was estimated by EDTA method in the laboratory as described by Trivedy and Goel. (1986).
- iii) Magnesium (Mg⁺⁺) and Calcium (Ca⁺⁺):** Calcium and Magnesium was determined in the laboratory by using titration method as described by Trivedy and Goel (1986). While magnesium was determined as the difference between

- iv) Sulphate:-** Sulphate was estimated in the laboratory by using Gravimetric method as described by Trivedy and Goel (1986).
- v) Dissolved oxygen :-** Dissolved oxygen was estimated in the laboratory by using Winklers iodometric method as described by Trivedy and Goel (1986).
- vi) Free Co₂ :-** Free Co₂ was estimated in the laboratory by using titration method as described by Trivedy and Goel (1986).
 1. **Biological Oxygen Demand :-**BOD of water samples was estimated in the laboratory by the method described by APHA (1992).
 2. **Chemical Oxygen Demand :-** COD of water samples was estimated in the laboratory by the method described by APHA (1992).
- ix) Chloride :-** Chloride was estimated in the laboratory by using titration method as described by Trivedy and Goel (1986).

TABLE 01: PHYSICO-CHEMICAL PARAMETERS OF JEEVREKHA DAM, 2006-2007

| Parameters | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Air Temp. | 27.5 | 25.75 | 24.5 | 26.75 | 23.5 | 20.5 | 19.75 | 21 | 22.25 | 25.25 | 28.75 | 32.75 |
| Water Temp. | 24.25 | 23.75 | 21.25 | 24.5 | 22.75 | 19.5 | 18.75 | 19.75 | 21 | 21.75 | 24.25 | 28 |
| pH | 7.05 | 7.0 | 7.65 | 7.25 | 7.25 | 7.45 | 7.85 | 8.1 | 8.25 | 8.3 | 8.1 | 7.9 |
| TS | 337 | 346.5 | 339 | 268.5 | 242.5 | 193 | 202.5 | 230.0 | 254 | 277.5 | 318.5 | 302 |
| TDS | 287.5 | 287.5 | 277.5 | 207.5 | 190 | 167.5 | 175 | 195 | 218.5 | 232.5 | 265 | 242.5 |
| TSS | 49.5 | 59 | 61.5 | 61 | 52.5 | 25.5 | 27.5 | 35 | 35.5 | 45 | 53.5 | 59.5 |
| DO | 4.05 | 4.55 | 4.65 | 4.65 | 5.8 | 7.0 | 8.0 | 8.15 | 6.8 | 4.75 | 3.95 | 3.65 |
| CO ₂ | 6.0 | 5.75 | 5.95 | 5.75 | 4.0 | 3.0 | 3.4 | 3.15 | 3.7 | 5.0 | 6.0 | 6.95 |
| Total Alkalinity | 155.5 | 110.5 | 131.5 | 143.5 | 156 | 165 | 161.1 | 155 | 180 | 190 | 183.5 | 197.5 |
| Chloride | 110 | 96.5 | 82.25 | 82.25 | 75 | 66 | 60 | 56 | 64.5 | 73.5 | 101 | 157 |
| Sulphate | 15.65 | 17.5 | 12.75 | 13.75 | 15.25 | 16.55 | 13.05 | 16.9 | 17.25 | 14.25 | 17.75 | 18.75 |
| BOD | 5.5 | 5.65 | 5.1 | 3.9 | 3.25 | 3.0 | 3.05 | 2.9 | 2.6 | 4.9 | 5.45 | 5.9 |
| COD | 11.4 | 11.4 | 10.15 | 7.05 | 7.8 | 5.7 | 6.85 | 6.6 | 4.15 | 9.2 | 13.15 | 14.35 |
| Hardness | 167.5 | 172.5 | 164 | 145 | 125 | 117.5 | 126 | 196 | 147.5 | 126.5 | 140.5 | 174.5 |
| Calcium | 45 | 46.5 | 42 | 40 | 39.5 | 38 | 41 | 56 | 39.5 | 38.5 | 40 | 49 |
| Magnesium | 13.6 | 14.05 | 14.45 | 11.05 | 7.5 | 5.8 | 5.8 | 13.85 | 12 | 8.25 | 10.05 | 12.75 |

All values are expressed in mg/L except Temperature (°C) and pH.

TABLE 02 : PHYSICO-CHEMICAL PARAMETERS OF JEEVREKHA DAM, 2007-2008

| Parameters | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|-------|
| Air Temp. | 29.25 | 25.75 | 26 | 26.75 | 24.5 | 22.25 | 23.75 | 22.0 | 22.0 | 25.25 | 30.5 | 35.25 |
| Water Temp. | 25 | 22.25 | 23.70 | 23.75 | 21.5 | 20.2 | 20.0 | 19.50 | 21.0 | 22.0 | 27.0 | 28.25 |
| pH | 7.4 | 7.35 | 7.9 | 7.4 | 7.2 | 7.75 | 8.05 | 8.0 | 7.85 | 7.8 | 8.15 | 8.25 |
| TS | 298 | 321.5 | 351.5 | 303.5 | 254.5 | 215.5 | 230.0 | 233.5 | 243.5 | 293.5 | 325 | 335 |
| TDS | 257.5 | 275 | 302.5 | 257.5 | 217.5 | 183.5 | 202.5 | 203.5 | 215.5 | 255 | 280 | 287.5 |

| | | | | | | | | | | | | |
|------------------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| TSS | 40.5 | 46.5 | 49 | 46 | 37 | 32 | 28 | 30 | 29.5 | 38.5 | 45 | 47.5 |
| DO | 4.05 | 4.2 | 4.95 | 5.2 | 6.45 | 6.95 | 7.55 | 7.95 | 6.4 | 4.7 | 3.95 | 3.95 |
| CO ₂ | 6.0 | 4.7 | 5.6 | 6.05 | 4.0 | 3.15 | 3.1 | 3.2 | 3.85 | 5.05 | 6.65 | 7.4 |
| Total Alkalinity | 150 | 126 | 145 | 125 | 198 | 170 | 165 | 197.5 | 197.5 | 180 | 199.5 | 200 |
| Chloride | 96.5 | 82.5 | 77.5 | 70 | 63.75 | 61 | 61 | 60 | 76.5 | 95 | 153 | 162.5 |
| Sulphate | 12.75 | 13 | 13 | 15.25 | 15.75 | 13.25 | 13.75 | 17.25 | 17.5 | 16.5 | 17.75 | 16.6 |
| BOD | 5.05 | 5.85 | 5.2 | 4.1 | 3.6 | 5.95 | 2.05 | 2.95 | 2.7 | 5.55 | 5.8 | 6.0 |
| COD | 9.9 | 10.55 | 9.85 | 9.0 | 8.75 | 7.4 | 4.95 | 6.55 | 5.10 | 11.6 | 11.25 | 12.05 |
| Hardness | 185 | 193 | 176 | 168.5 | 171 | 189.5 | 144 | 159.5 | 110 | 120.5 | 133.5 | 195 |
| Calcium | 41 | 44 | 38.5 | 32 | 33.5 | 36.5 | 32 | 29 | 26.5 | 28 | 29.5 | 48 |
| Magnesium | 8.35 | 8.4 | 8.05 | 9.05 | 8.8 | 9.9 | 6.45 | 8.75 | 4.45 | 5.15 | 6.05 | 7.55 |

All values are expressed in mg/L except Temperature (°C) and pH.

RESULTS & DISCUSSION

1. **AIR TEMPERATURE** : During study period from June 2006 to May 2008 it was observed that site IV had air temperature ranging between 19.75 °C and 35.25 °C. The average minimum temperature was 19.75 °C in December 2006 and 22.0 °C in January and February 2008 respectively and maximum was 32.75 °C in May 2007 35.25°C in May 2008 (Table 01 & 02).

In the present investigation it was observed that air temperature is minimum in winter season and maximum in summer season. Salve and Hiware, (2006) reported air temperature range between 27.0°C to 35.0°C where minimum temperature was recorded in winter season and maximum temperature in summer season from Nagapur near Parli Vajjanath, Beed district. Mane and Pawar, (2007) reported similar results from Manar river, Nanded district, Sunkad and Patil, (2003) also reported minimum air temperature in winter season and maximum in summer season from Rakasakoppa reservoir of Belgaum, Karnataka. Air temperature was minimum in winter season and maximum in summer season during the study period June 2006 to May 2008. This change in temperature may be related to the photoperiod.

2. **WATER TEMPERATURE** : Recorded water temperature at site IV from June 2006 to May 2008 ranged between 18.75 °C and 28.25°C. The average minimum water temperature was 18.75 °C in December 2006 and 19.5 °C in January 2008, and maximum was 28.0 °C in May 2007 and 28.25 °C in May 2008 (Table 01 and 02).

Results show that water temperature was minimum in winter season and maximum in summer season, Salve and Hiware (2006) reported water temperature range between 21 °C and 31.1°C where the water temperature is lower than the atmospheric temperature by 1°C to 3.9 °C. Mane and Pawar, (2007) from river Manar, Nanded district, Sunkad and Patil, (2003) from Rakasakoppa reservoir of Belgaum, Karnataka, have also reported similar findings. The water temperature was minimum in winter season and maximum in summer season this must be related to the air temperature.

3. **pH** : Recorded pH at site IV from June 2006 to May 2008 ranging between 7.0 and 8.3. The average minimum pH was 7.0 in July 2006 and 7.2 in October 2007, and maximum was 8.3 in March 2007 and 8.25 in May 2008 (Table 01 and 02).

In the present investigation pH is alkaline in nature and ranges between 7.0 and 8.3. The high range of pH may be due to the biological activity and temperature changes. Significant changes in pH also occur due to disposal of drainages, seasonal variation may be due to variation in the photosynthetic activity which increases pH due to consumption of carbon dioxide in the photosynthetic process. These results are identical to those reported by Muley and Patil, (2006) from Pauna river, Pune district, Sharma and Shrestha, (2001) from Tinau river Western Nepal. Tripathi Namrata Nath *et al.*, (2008) from Sikandrapur reservoir, Basti (U.P.), Shahnawas *et al.*, (2009) from

Bhadra river of western Ghats (India), Ashashree *et al.*, (2008), Korai *et al.*, (2008) from Keenjhar Lake district, Thatta, Sindh, Pakistan. According to Swingle, (1969) water pH within the range of 6.5 to 8.5 is most suitable for pond aquaculture. (Sinha, 2000; Singh, 2002) reported pH range between 7.0 to 8.6 in different water bodies of North Bihar, where fish production has been recorded to be maximum. The high range of pH indicates higher productivity of water, Khan and Khan, (1985).

4. **T.S. (Total Solids)** : During the study period from June 2006 to May 2008 it was observed that site IV had total solids ranged between 193 mg/L and 351.5 mg/L. The average minimum total solids was 193 mg/L in November 2006 and 215.5 mg/L in December 2007 and maximum was 346.5 mg/L in July 2006 and 351.5 mg/L in August 2007 (Table 01 and 02). Thus the results in the present investigation show that the T.S is within limits.
5. **T.D.S. (Total Dissolved Solids)** : During the study period from June 2006 to May 2008 it was observed that site IV had total dissolved solids ranging between 167.5 mg/L and 302.5 mg/L. The average minimum total dissolved solids was 167.5 mg/L in November 2006 and 183.5 mg/L in November 2007 and maximum was 287.5 mg/L in June and July 2006 and 302.5 mg/L in August 2007 (Table 01 and 02). In the present investigation the results shows that the TDS was maximum in monsoon season which may be due to an increased run off of bicarbonate and carbonate and minimum in summer season. In the present study it was observed that the TDS values are within safe limits. Similar result was observed by Jahangir *et al.*, (2000) from at Keenjhar and Haligi Lakes of district, Thatta, Sindh, Pakistan. Jayabhaye *et al.*, (2006) from minor reservoir Sawana, Hingoli district Maharashtra, Chandanshive *et al.*, (2008) from river Mula-Mutha at Pune district, Maharashtra, Dhindhime and Ambhore (2004) from Siddheshwar dam, Parbhani district reported similar results. The permissible levels of T.D.S are 500 mg/liter in drinking water. The increase in T.D.S in winter as compared to rainy and summer is due to increase in salts

containing carbonate, bicarbonate, chloride, sulphate, phosphate, nitrate, iron and manganese (Mittal. *et al.*, 1994, Gonzale *et al.*, 2004).

6. **T.S.S. (Total Suspended Solids)** : Concentration of total suspended solids at site IV from June 2006 to May 2008 ranged between 25.5 mg/L and 61.5 mg/L. The average minimum total suspended solids was 25.5 mg/L in November 2006 and 28.0 mg/L in December 2007 and maximum was 61.5 mg/L in August 2006 to 49 mg/L in August 2007 (Table 01 and 02). In the present investigation TSS was maximum in rainy season which may be due to increase in runoff of organic matter and results show that the total suspended solid are within safe limits. In the present investigation during the study period it was observed that TSS was maximum in rainy season and minimum in summer season. Similar results are observed by Jayabhaye *et al.*, (2008) from minor reservoir Sawana, Hingoli district Maharashtra, Chandanshive *et al.*, (2008) from river Mula-Mutha Pune, Maharashtra, Dhindhime and Ambhore, (2004) from Siddheshwar dam Parbhani district. The suspended solids occur naturally in water, human activities can greatly increase their concentration (Gonzale, *et al.*, 2004).
7. **Free CO₂** : During the study period from June 2006 to May 2008 it was observed that site IV had free CO₂ ranging between 3.0 mg/L and 7.4 mg/L from June 2006 to May 2008. The average minimum free CO₂ was 3.0 mg/L in November 2006 and 3.1 mg/L in December 2007 maximum was 6.95 mg/L in May 2007 and 7.4 mg/L in May 2008 (Table 01 and 02). The free CO₂ concentration was minimum in winter, this might be due to high photosynthesis activity and maximum in summer which may be due to less photosynthetic activity because of low phytoplankton population. In the present investigation maximum carbon dioxide was observed in summer season and minimum in winter season. Similar result have been recorded by Muley and Patil, (2006) from Pauna river, Pune district Maharashtra. Sharma and Shrestha, (2001) from river Tinau Western Nepal. Salve and Hiware, (2006) from Wanparakalpa

Reservoir, Nagapur, near Parli-Vaijanth, district Beed, Marathwada, Ashashree *et al.*, (2008) from Savalanga pond Davangere district Karnataka. Dutta *et al.*, (2001) from river Basantar Chandigarh also reported similar results. The lower values of free carbon dioxide observed during rainy and winter season is due to complete utilization of free carbon dioxide by the phytoplankton's (Rawson, 1939).

8. **DO (Dissolved Oxygen) :** Concentration of dissolved oxygen at site IV from June 2006 to May 2008 was between 3.65 mg/L and 8.15 mg/L. The average minimum DO was 3.65 mg/L in May 2007 and 3.95 mg/L in April and May 2008 and maximum was 8.15 mg/L in January 2007 and 7.95 mg/L in January 2008 (Table 01 and 02).

In the present investigation it was observed that dissolved oxygen is maximum in winter season and minimum in summer season. These results are identical to those reported by Mulay and Patil, (2006), Korai *et al.*, (2008); Sharma and Shrestha, (2001); Tripathi Namrata Nath *et al.*, (2008); Shahnawaz, (2009) from Bhadra River of western Ghats India, Martin, (2004) from South Indian River Tamiraparani, Munwar, (1970) from freshwater ponds of Hydrabad, Boyd, (1982) from water quality management of pond fish culture, Pandey *et al.*, (1999) studied Do from river Ramjan (Klshanganj) in relation to its impact on biological components. The 6 mg/L to 9 mg/L range of DO is supported for potability and aquaculture, Yogesh and Pendse, (2001).

9. **BOD (Biological Oxygen Demand) :**

BOD is defined as the quantity of oxygen required by bacteria and other micro-organisms in the biological degradation and transformation of organic matter under aerobic condition present in water De, (1986). The BOD test is widely used to determine the degree of pollution. In the study period from June 2006 to May 2008 it was observed that site IV had biological oxygen demand ranging between 2.05 mg/L and 6.0 mg/L. The average minimum biological oxygen demand was 2.6 mg/L in February 2006 and 2.05 mg/L in December 2007 and maximum was 5.9 mg/L in May

2007 and 6.0 mg/L in May 2008 (Table 01 and 02).

In the present investigation BOD had higher values in summer. This may be due to high rate of organic decomposition the gradual decline of BOD from rainy season to winter season which may be due to decrease in temperature which decreases the rate of organic decomposition. Similar results are reported by Salve and Hiware, (2006) from Waprakalpa, Nagapur near Parli Vaijanath in Beed district. Martin, (2004) from South Indian river Tamiraparani, Shahnawas *et al.*, (2009) from Bhadra river of western Ghats India and Muley and Patil, (2006) from river Pauna, Pune district, Maharashtra.

10. **COD (Chemical Oxygen Demand) :** Concentration of chemical oxygen demand at site IV from June 2006 to May 2008 ranged between 4.95 mg/L and 14.35 mg/L. The average minimum chemical oxygen demand was 5.7 mg/L in November 2006 and 4.95 mg/L in December 2007 and maximum was 14.35 mg/L and 12.05 mg/L in May 2007 and 2008 (Table 01 and 02).

In the present investigation COD was maximum in summer which may be due to less quantity of water, depth and decay of aquatic flora and fauna and minimum values of COD in winter may be due to settlement and dilution effect. Similar results are reported by Salve and Hiware, (2006) from Waprakalpa, Nagapur near Parli Vaijanath in Beed district of Marathwada region, Maharashtra, India, Gyananath *et al.*, (2000) from river Godawari during holimela at Nanded, Mini *et al.*, (2003) from lotic ecosystem Vamanapuram river Thirvanathapuram, Kerala South India. Surve *et al.*, (2005) from Baral dam, district Nanded (M. S.) India. Pulle, (2000) recorded COD values in the range between 62 to 148 mg/L at Issapur dam. Deshmukh *et al.*, (1998) recorded COD values from Godavari river water, ranging from 22.0 to 30.0 mg/L, where maximum COD values are recorded in summer and minimum values in winter seasons.

According to Moyle, (1949) the COD values fluctuated between 33.55 and 60.33 mg/L, which are likely due to addition of sewage bringing in organic matter. The COD values

of drinking water should not exceed more than 10 mg/L as per the guide lines of WHO.

Total Alkalinity

In the study period from June 2006 to May 2008 it was observed that site IV had total alkalinity ranging between 110.5 mg/L and 200 mg/L. The average minimum total alkalinity was 110.5 mg/L in July 2006 and 125 mg/L in September 2007 and maximum was 197.5 mg/L in May 2007 and 200 mg/L in May 2008 (Table 01 and 02).

In the present investigation results show that the total alkalinity was low in rainy season and high in summer due to evaporation of water and increase in biological activity. Similar findings have been recorded by Muley and Patil, (2006); Korai *et al.*, (2008); Salve and Hiware, (2006); Singh, (2000); Mishra *et al.*, (1989); Jhingran, (1982); Sakhare and Joshi (2002); Surve *et al.*, (2005). Bhatt *et al.*, (1999) has mentioned lower range of total alkalinity during different seasons of Taudaha Lake in Nepal. Mohanta and Patra, (2000) recorded total alkalinity ranging from 37.35 to 87.25 mg/L in the river water Sanamachhanandana at Karpogarh. Deshmukh *et al.*, (2008) reported alkalinity ranging from 78 to 230 mg/L in the river Godavari.

Thus it shows that in the rainy season total alkalinity was low and high in summer season and the total alkalinity throughout the year is above 100 mg/L and within permissible limit these study site is highly productive and suitable for the growth of ichthyofauna.

11. **Chloride:** During the study period from June 2006 to May 2008 it was observed that site IV had chloride ranging between 56 mg/L and 162.5 mg/L. The average minimum chloride was 56 mg/L in January 2007 and 60 mg/L in January 2008 and maximum was 157 mg/L in May 2007 and 162.5 mg/L in May 2008 (Table 01 and 02). The maximum values of chloride were recorded during summer season because of scanty rain and high rate of evaporation. It has significant positive correlation with water temperature and electrical conductance. It was also observed that high level of chloride is an indication of higher

degree of pollution and low level chloride content indicates absence of any substantial pollution.

Similar findings were reported by Muley and Patil (2006) from Pauna river Pune district. Korai *et al.*, (2008) from Keenjhar Lake district, Thatta, Sindh, Pakistan. Sakhare and Joshi, (2003) from minor wetland Tuljapur, Maharashtra. Sehgal, (1980) from Lake Sruinsar, Jammu and Kashmir. Adarsh Kumar *et al.*, (2006) from Ranjit Sagar reservoirs, Jammu & Kashmir. Mane and Pawar, (2007) from Manar River of Nanded district Maharashtra. According to Goal *et al.*, (1988) 250 mg/L of chloride in water makes water salty in taste, how ever a level up to 100 mg/L is safe for human consumption.

12. **Sulphate** : Concentration of sulphate at site IV from June 2006 to May 2008 ranged between 12.75 mg/L and 18.75 mg/L. The average minimum sulphate was 12.75 mg/L in August 2006, and June 2007 and maximum was 18.75 mg/L in May 2008 and 17.75 mg/L in April 2008 (Table 01 and 02). In the present investigation higher values of sulphate are recorded in summer and lower values are recorded in rainy season. The sulphate is used as source of oxygen by bacteria under an anaerobic condition, (Nath and De. D. K , 1998). The minimum and maximum sulphate concentration are within permissible limit, which are prescribed by WHO, (2004). Rajalakshmi and Sreelatha, (2005) reported similar results from river Goutami Godavari Yanam. Ajmal *et al.*, (1984) studied pollution in river Ganga and reported the similar findings. Similar result was observed by Mane and Pawar, (2007); Aher *et al.*, (2007) with maximum sulphate in summer season and minimum in rainy season. Ravikumar *et al.*, (2005) observed same trend in Ayyanakere tank Harapanahallitown, Davangre district of Karnakata.
13. **Total Hardness:** :During the study period from June 2006 to May 2008 it was observed that site IV had total hardness ranging between 110 mg/L and 196 mg/L. The average minimum total hardness was 117.5 mg/L in November 2006 and 110 mg/L in February 2008 and maximum was

196 mg/L in January 2007 and 195 mg/L in May 2008 (Table 01 and 02).

In the present study it was found that low values of hardness were during rainy and winter season and higher values were observed during summer season. The total hardness is a contribution of calcium and magnesium salts dissolved in water. Normally these ions are not problematic but at higher concentration increases hardness. The high value of hardness in summer and low value in monsoon show that the water may be suitable for the growth of the fish. Hardness is more than 20 mg/L is satisfactory for the aquatic productivity and helps to protect fishes against harmful effects pH fluctuations, Das and Das, (1997). The high value of hardness in summer and low values in monsoon season was observed by Kannan, (1991). Rath *et al.*, (2000) reported similar results from Nandira Brahmani River, Angul-Talcher Belt Orissa, India. Muley and Patil, (2006) from Pauna river Pune district, Korai *et al.*, (2008) from Keenjhar lake, Thatta district, Sindh, Pakistan, Salve and Hiware, (2006) from Wanparkalpa reservoir, Nagapur Parli Vajjanath district, Beed, Marathwada region also reported similar results. Hiware and Jadhav, (2001) reported maximum total hardness in summer season and minimum in rainy season from Manjra river, near Kallam, district Osmanabad.

14. **Calcium** : Concentration of calcium at site IV from June 2006 to May 2008 ranged between 26.5 mg/L and 56 mg/L. The average minimum calcium was 38 mg/L in November 2006 and 26.5 mg/L in February 2008 and maximum was 56 mg/L in January 2007 and 48 mg/L in May 2008 (Table 01 and 02).

The desirable limits of calcium and magnesium for drinking water are 75 mg/L and 30 mg/L respectively (BIS, 1991). Calcium is helpful for the shell construction and bone building of aquatic organism the value of calcium is highest in summer season, lowest in monsoon season, Rajana *et al.*, (2002). Similar results are reported by Adarsh Kumar *et al.*, (2006) from Ranjit Sagar reservoirs, Jammu & Kashmir. Wagh, (1998) from Harsul Dam Aurangabad. Kulkarni *et al.*, (2002) from river Khushavali

at Quepem Goa. Patil *et al.*, (2004) from Padmalaya lakes, Erondal at Jalgaon district. Zafar, (1964) from certain fish ponds of Hyderabad, India reported similar results. Singh and Swarup, (1979) reported that concentration of calcium promotes growth of microorganism.

15. **Magnesium** : Concentration of magnesium at site IV from June 2006 to May 2008 ranged between 4.45 mg/L and 14.45 mg/L. The average minimum magnesium was 5.8 mg/L in November 2006 and December 2006 and 4.45 mg/L in February 2008 and maximum was 14.45 mg/L in August 2006 and 9.9 mg/L in November 2007 (Table 01 and 02).

In the present investigation it was observed that magnesium concentration was maximum in summer season and minimum in winter season. The magnesium concentration was within the permissible limit and helpful for the growth of fish. Magnesium occur in all kinds of natural water with calcium but its concentration remains generally lower than calcium because dissolution of magnesium reach minerals is a slow process and calcium is more abundant in earths crust, Dakshinini and Soni, (1997) .

Mohanta and Patra, (2002) reported maximum magnesium in summer season and minimum magnesium in winter season from river Sanamachhakandana at Keonijhar Garh Orissa, Gyananath *et al.*, (2000) studied river Godawari during holimela at Nanded. Shastri, (2000) studied river Mosam. Chawan *et al.*, (2004) from Manjara project reservoir in district Beed, Maharashtra reported similar results. Similar results were reported by Thilaga *et al.*, (2005) studied from Ooty Lake, Ooty. Jakher and Rawat, (2003) from tropical lake, Jodhpur Rajasthan, India, Jayabhaye *et al.*, (2006) from minor reservoir Sawana, Hingoli Maharashtra. Rath *et al.*, (2000) reported that the decrease value of magnesium may be due to plankton and algal uptake

Reference:

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