Seasonal variation in physiochemical properties of Khutaghat dam, Bilaspur, Chhattisgarh, Central India.

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Abstract

The present study is an approach to assess the water quality status of Khutaghat dam Bilaspur, Chhattisgarh, Central India. From the point view of monitoring water quality and to obtain update information on associated changes in the physico-chemical parameters in the habitat, analysis of the water was carried out. The study was carried out for a period of one year (July 2019 to June 2020). In order to discern the water chemistry of the dam the following physico-chemical parameters such as water temperature, pH, Total dissolved solids, Electrical conductivity, Dissolved oxygen, Bioloical oxygen demand, Chemical oxygen demand, Chloride, Alkalinity and Hardness, were measured in three different seasons (Monsoon,Winter and Summer) by following specific protocols. The results indicated a relatively good water quality in the pre- monsoon and the seasonal order of pollution magnitude is monsoon>post-monsoon>pre-monsoon. Water quality conditions were critical during the monsoon, mainly due to the effects of the terrestrial runoff. If the load of pollution and anthropogenic activities increases in the dams in future, then the water quality of this water body will be severely affected thus proper steps are needed to be taken to maintain and manage this ecosystem.

Keywords: Water quality, Physico-chemical parameters, Khutaghat dam, Seasonal variation.

I. INTRODUCTION

The water is an elite component of the nature. Water has played an important role in life from different molecules to man, and the human civilization has originated, evolved and flourished around water resources. In recent years, much concern has been showed for protecting and utilization water resources. Since the fresh water is a finite resource (Wetzel, 1975), comprising only 3 percent (1049400 cubic miles) of the total water on land (Deming, 1978). Thus a prime importance should be given for its conservation. It has been estimated that only 0.00192% of the total water on the earth is available for human consumption Trivedy *et al.* (1998). It has been observed that maximum countries in the world are suffering from fresh water scarcity. Thus it needs to be carefully monitored and utilized. Water resources aren't only used for domestic and irrigation purposes but it's also used for power generation, recreation, fish and wildlife conservation and navigation.

The water bodies often get impurities from various sources. These impurities may be suspended particles, colloidal materials, and dissolved cat-ionic and an-ionic substances. Various kinds of natural and anthropogenic activities such as domestic, industrial, agricultural and others are creating water pollution problem day by day. Thus the freshwater ecosystems are under threat to the life systems. Contamination of toxic metals, acidity or alkalinity of water, contamination with pathogenic microbes and pesticides , presence of oils, grease, high particulates load and hydrocarbons, cause detrimental effects on aquatic biota of the freshwater bodies. Regular and advanced monitoring

of these contaminating pathways and their effective protective action protocol needs to be evolved for better conservation of surface water resources in future (Santra, 2001).

Water is one of the most abundantly available natural resource on earth, which humans have exploited more than any other resource. The conservation, restoration and management of water resources require a good knowledge of the factors which constitute a healthy ecosystem. The regular monitoring and assessment provide core information on the condition of our water bodies. Once the balance of the aquatic ecosystem is disturbed, it directly or indirectly influences the human beings. Though the advance knowledge of the water bodies is necessary, for their effective management and utilization. Thus the present work deals with the study of seasonal variation in physio-chemical properties of Khutaghat dam, Bilaspur, Chhattisgarh. Khutaghat dam serves as domestic water to Ratanpur and Kota areas of Bilaspur, This dam serves as an irrigation source of agricultural land of the outskirt villages. The physio-chemical properties of a water body determine its water quality. The results of present study will provide baseline information of the physicochemical properties of Khutaghat dam and it would be a useful tool for further ecological assessment and monitoring of the water quality of dams.

II. MATERIAL AND METHODS

The present study deals with the investigation of physio-chemical properties of Khutaghat dam of Bilaspur, Chhattisgarh, India. The water samples of the dam were collected in each season (summer, winter and monsoon) from all the sites during July-2019 to June-2020 respectively and the water samples were analyzed by standard methods of APHA (1998).In present research work the following physico-chemical parameters were analyzed.

2.1. Water Temperature

Water temperature will measure by using centigrade mercury thermometer by dipping directly into the water for about one minute on the spot till the mercury column stabilized.

2.2. Transparency

The transparency of the sampled water from each site was measured by a secchi disc, a metallic plate of 20 cm diameter. Average of depth of the sampled water at disc disappearance and reappearance was noted in centimeter and recorded in the field book.

2.3. pH

pH is a measure of hydrogen ion concentration in water. pH of water sample was measured by digital pH meter

2.4.Total Alkalinity (mg/l)

In order to determine the total alkalinity of the sampled water, 20ml of given water sample is pippeted out into a conical flask. Samples were titrated with N/50 sulfuric acid (APHA, 1998).

2.5.Chlorides (mg/L)

The chlorides of a water sample are estimated by using Argentometric Titremetric method (APHA, 1998).

2.6.Total Hardness (mg/l)

Total hardness of a water sample is defined as the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate in mg/L. Total hardness of the water samples of each of the sampled sites was measured by EDTA titrimetric method (APHA, 1998).

2.9.Total Dissolved Solids (mg/L)

TDS is a measure of the amount of material dissolved in water. The Total dissolved solids of water were measured by gravimetric method.

2.11.Water conductivity (µS/cm)

The water conductivity of each water sample from the sampling station was measured by taking direct reading from conductivity meter (systronics) and results were expressed in µs/cm.

2.12.Dissolved oxygen (mg/l)

The basic unmodified method as given by Ellis et al. (1948) was followed for determination of dissolved oxygen in the water samples of each site of sampled station.

2.13.Chemical Oxygen Demand (mg/l)

Chemical oxygen demand was estimated by dichromate reflux method (APHA, 1998). Ferroin was used as an indicator and the result is expressed in terms of mg/1.

2.14.Biological Oxygen Demand (mg/l)

Bio-chemical oxygen demand of water samples was determined by incubating samples for 5 days at 20°C. The results were expressed in mg/1. The BOD is expressed as;

$$Biological\ Oxygen\ Demand\ (mg/l) = D1 - D2$$

Where,

D1 = Intial DO in the sample water

D2= D.O after 5 days

2.15. Data Analysis

The data were tabulated and statistically analyzed by the analyses of variance (ANOVA) and the treatment means were compared using the Duncan Multiple Range Test (Duncan,1965) at ($P \leq 0.05$) level of significance.

III. RESULTS AND DISCUSSION

The different physico-chemical parameters of Khutaghat dam , Bilaspur Chhattisgarh were analyzed through Analytical techniques. The obtained results are presented as under

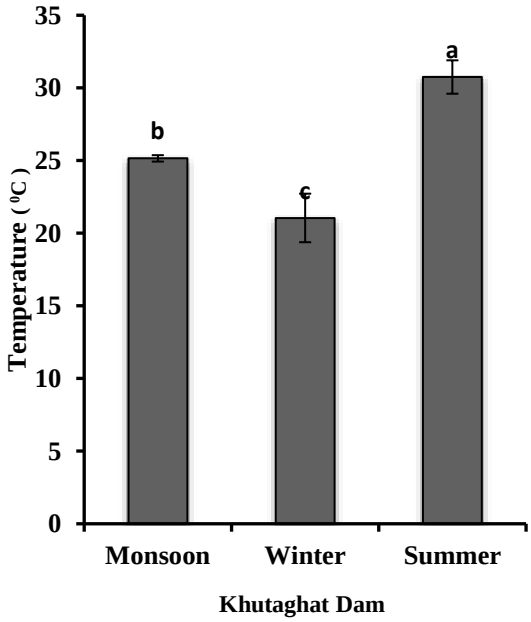

Fig 1. Seasonal variation of water Temperature (°C) of Khutaghat Dam during July 2019 to June 2020. The data shown are mean ± SE of four replicates Means within a bars followed by same letter are not significantly different ($p \leq 0.05$).

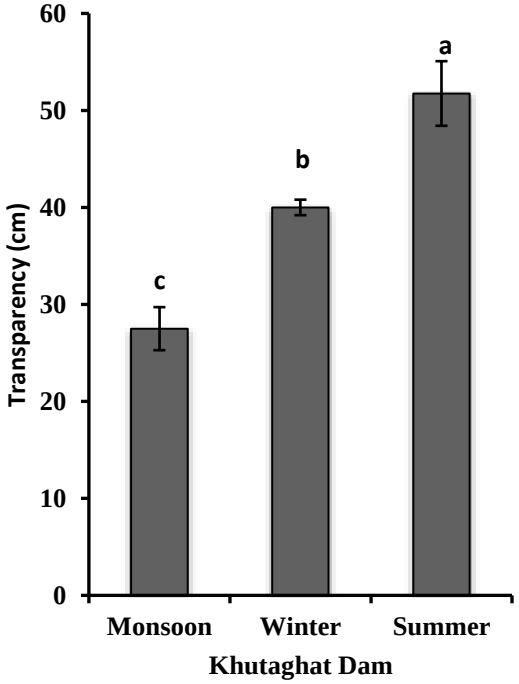

Fig 2. Seasonal variation of water Transparency (cm) of Khuutaghat Dam during July 2019 to June 2020. The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p \leq 0.05$).

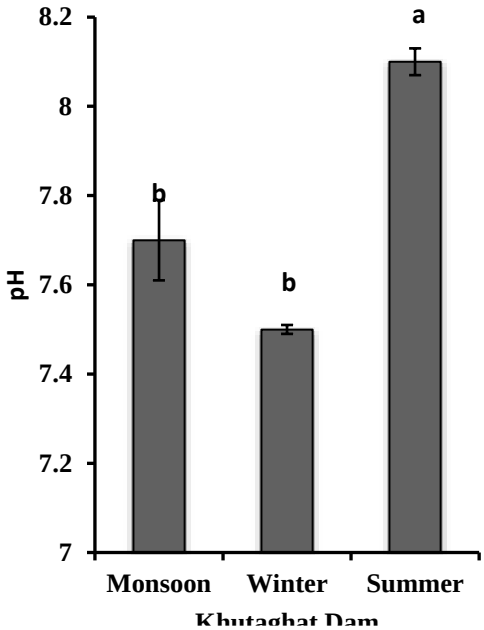

Fig 3. Seasonal variation of water pH of Khutaghat Dam during July 2019 to June 2020. ¶The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p \leq 0.05$).

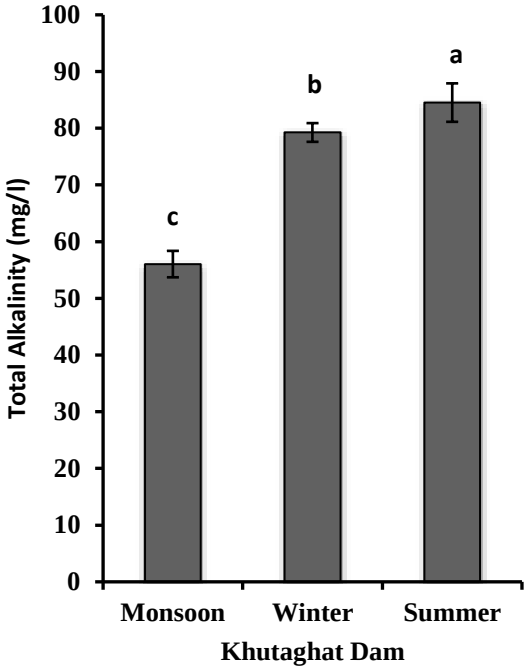

Fig 4. Seasonal variation of water Total Alkalinity (mg/l) of Khutaghat Dam during July 2019 to June 2020. ¶The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p \leq 0.05$).

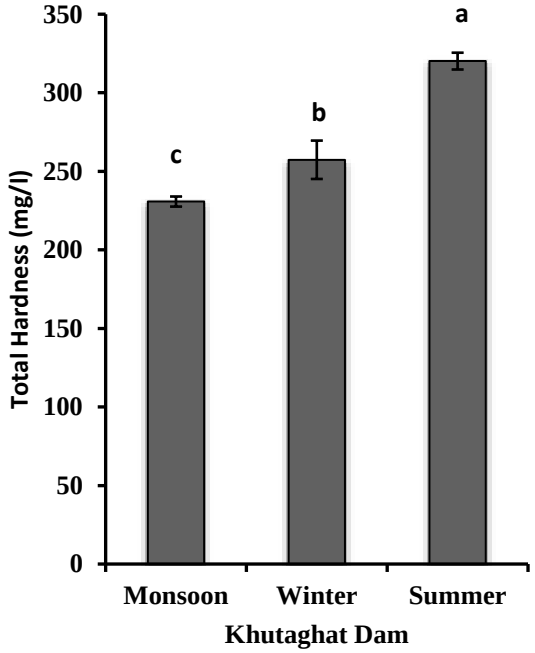

Fig 5. Seasonal variation of water Total Hardness (mg/l) of Khutaghat Dam during July 2019 to June 2020.The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p \leq 0.05$).

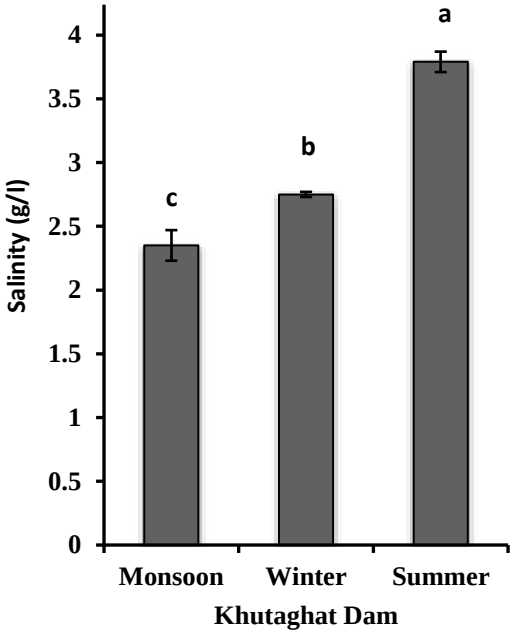

Fig 6. Seasonal variation of water Salinity (g/l) of Khutaghat Dam during July 2019 to June 2020. The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p \leq 0.05$).

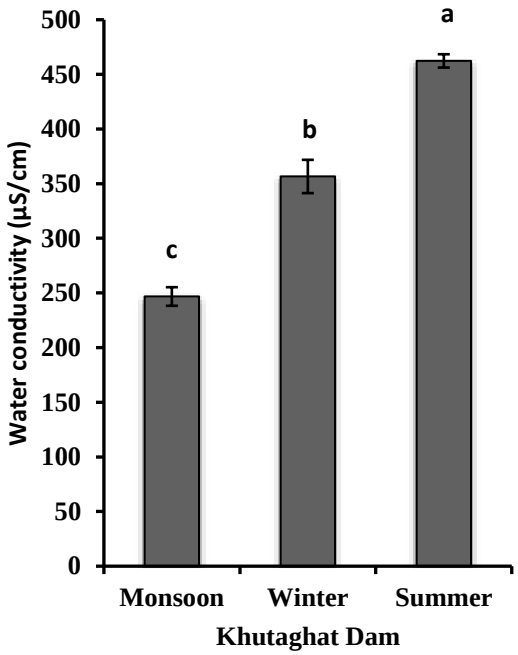

Fig 7. Seasonal variation of water conductivity (µS/cm)of Khutaghat Dam during July 2019 to June 2020. ¶The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p< 0.05$).

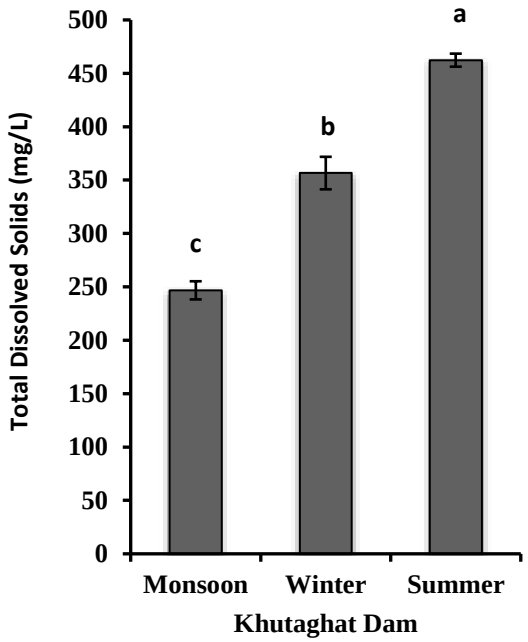

Fig 8. Seasonal variation of Total Dissolved Solids (mg/L) of Khutaghat Dam during July 2019 to June 2020. ¶The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p\leq 0.05$).

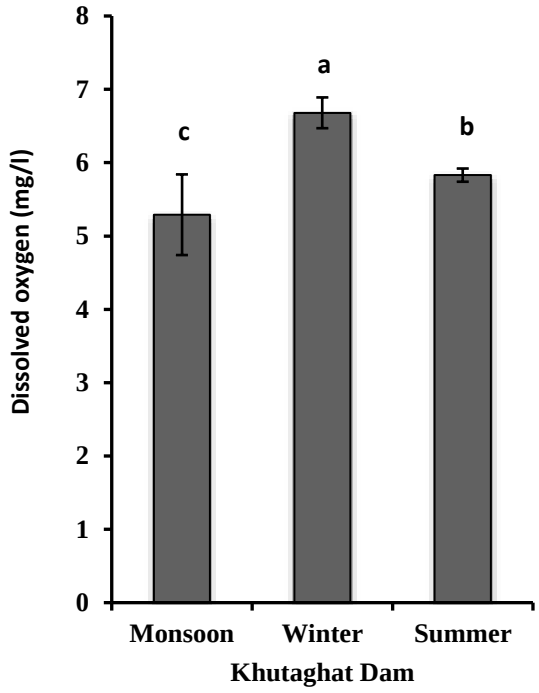

Fig 9. Seasonal variation of Dissolved oxygen (mg/l) of Khutaghat Dam during July 2019 to June 2020. ¶The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p\leq 0.05$).

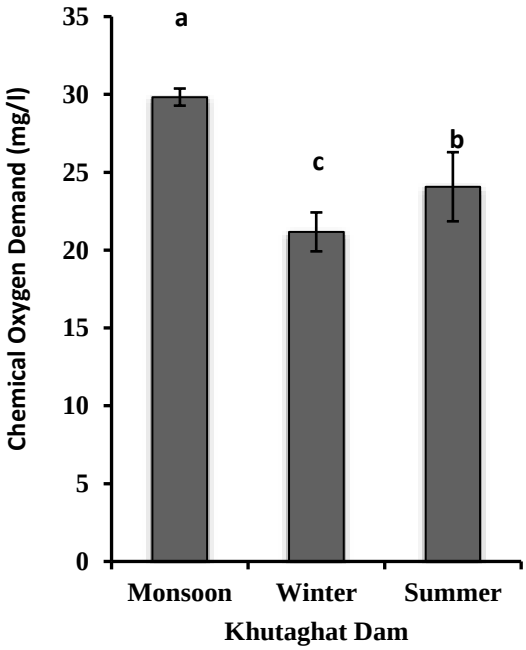

Fig 10. Seasonal variation of Chemical Oxygen Demand (mg/l) of Khutaghat Dam during July 2019 to June 2020. ¶The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p\leq 0.05$).

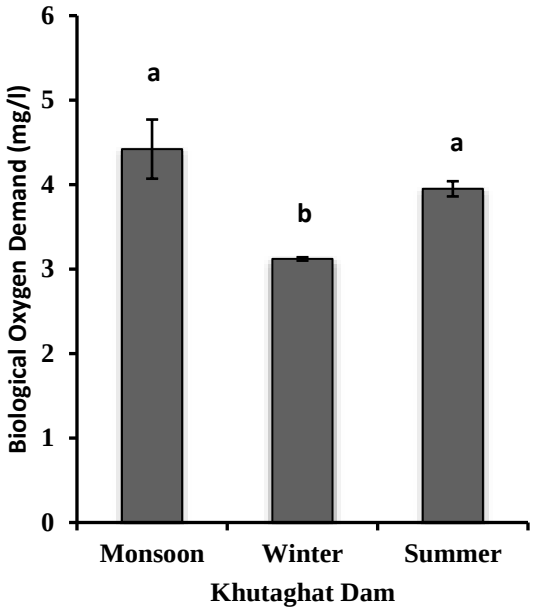

Fig 11. Seasonal variation of Biological Oxygen Demand (mg/l) of Khutaghat Dam during July 2019 to June 2020. ¶The data shown are mean ± SE of four replicates Means within bars followed by same letter are not significantly different ($p \leq 0.05$).

3.1. Water Temperature (ºC)

Temperature is a physical factor which indicates the quality of water of a particular water body, and it has effect on growth and distribution of aquatic life, concentration of dissolved gases and chemical solutes. The water temperature is an important environmental factor that determines the zooplankton distribution and diversity of the water bodies. A slight variation in the average water temperature was observed in different seasons (Monsoon, Winter and Summer) at Kori dam and Khutaghat dam, Bilaspur, Chhattisgarh The maximum water temperature in Khutaghat dam (35.6 ± 1.33^0C) was recorded in summer and the minimum water temperature in Khutaghat dam (18.7 ± 1.09^0C) was recorded during winter season (fig 1). The temperature is one of the important factors in aquatic environment since it regulates physicochemical as well as biological activities (Kumar et al., 2003). The metabolic rate of aquatic organisms of a water body is related to temperature and in warm waters, the respiration rates increase leading to increased oxygen consumption and increased decomposition of organic matter (Chapman and Kimstach, 2006). Fish, insects, zooplankton, phytoplankton and other aquatic organisms all have a specific threshold of temperature ranges. As temperature gets above or below to that threshold, the number of individual species decreases until finally there are few or none (Moore, 1989; Michaud, 1991).

3.2. Water Transparency:

The actual idea of water transparency can be correlated as a measure of the depth of light penetration into the water. The water transparency depends on the amount of particles in the water. In the present study we observed that the water transparency of Khutaghat dam Fluctuates from 25cm to 71cm from July-2019 to June-2020 respectively. In the present study we observed that the water transparency of Khutaghat dam fluctuates significantly ($p \leq 0.05$) from 25cm to 71cm from July-2019 to June-2020 respectively(fig 2). The average transparency values recorded a significant variation across different seasons(Monsoon, Winter and Summer) at Khutaghat dam.

3.3. pH

The seasonal (Monsoon, Winter and Summer) pH variation was found to be significant in Khutaghat dam (Fig 5.5 and Fig 5.6). Across different seasons (Monsoon, Winter and Summer) the highest pH values were recorded in summer(Khutaghat: 8.1±0.03). The lowest pH values were recorded in summer(Khutaghat: 7.5±0.01) respectively(fig 3). However, the winter recorded the moderate values in Khutaghat dam(7.8±0.09). The variation of pH in the dams reflects the exchange of nutrients between sediment and water. The pH of an aquatic ecosystem is important because it is closely related to biological productivity (Carr and Neary, 2006). The smaller difference in pH of the water can change the composition of the zooplanktons in a water body. Most surface waters of different water bodies have a pH between 6.0 and 8.5, and values lower than 6.0 can be hazardous to aquatic life (Mohan and Kumar, 1998) while the optimum value of pH is between 7.5 and 8.5 (Boyd, 1979).

3.4. Total Alkalinity (mg/l)

Alkalinity of a water body is the base neutralizing or buffering capacity of water. Total alkalinity is a measure of the net effect of all cations and anions in a water body. The alkalinity of Khutaghat dam altered significantly across different months (fig 4) during July-2019 to June-2020. A significant variation in the total alkalinity (mg/l) was noted across different seasons (Fig 4) Khutaghat dam during July-2019 to June-2020. The minimum values (56.04±2.33mg/l) of alkalinity in Khutaghat dam were recorded in monsoon. The alkalinity(mg/l) increased significantly from monsoon to summer and reached to its maximum values (Khutaghat dam: 84.52±3.39mg/l) in summer season. This increase in values may be due to dissolution of calcium carbonates. Spence (1964) had classified water bodies into three major categories based on the values of alkalinity viz., (i) nutrient poor (from 1.0-15.00 mg/l), (ii) moderately rich nutrient (from 16.0-60.0 mg/l), and (iii) nutrient rich (>60.0 mg/l). According to the results of present study the Kori dam and Khutaghat dam falls between moderately rich nutrient and nutrient rich water body. Generally, the Indian water bodies are reported to have minimum alkalinity during winter and maximum during monsoon (Garg *et al.,* 2006, Jayabhaye *et al.,* 2008, Telkhade *et al.,* 2008).

3.5. Total Hardness (mg/l)

The variation of hardness in different months of the year differs significantly. The summer season noted highest total hardness (mg/l) values (Khutaghat dam: 320.15±5.35mg/l) than winter (Khutaghat dam: 257.33±12.22mg/l) and monsoon (Khutaghat dam: 230.74±3.21mg/l). Hardness of Khutaghat dam decreased from July to December due to the entry of freshwater while higher values were found in dry months (March to June), this may be due to the discharge of water through outlets and evaporation(fig 5).

3.6. Salinity (g/l)

The salinity (g/l) of Khutaghat dam altered across different months during July-2019 to June-2020. A significant variation in the total salinity (g/l) was noted across different seasons(fig 6). The minimum values (2.35±0.12g/l and 2.65±0.08g/l) of salinity in Khutaghat dam were recorded in monsoon. The salinity (g/l) increased significantly from monsoon to summer and reached to its maximum values (Khutaghat dam: 3.79±0.08mg/l) in summer season.

3.7. Water conductivity

In Khutaghat dam the water conductivity recorded an increasing trend from monsoon season to summer season during July-2019 to June-2020 respectively(fig 7). The minimum values of water conductivity (246.76±8.5µS/cm) in Khutaghat. dam were recorded in monsoon.

3.8. Total dissolved salts (TDS)

The average total dissolved salts (TDS) was found significantly different in Khutaghat dam. We observed a significant variation in TDS across different seasons. The TDS(mg/l) increased significantly from monsoon to summer season. The highest value of TDS in Khutaghat dam was 408.30±6.33mg/l, it was followed by 314.94±9.45mg/l in winter and 247.74±12.75mg/l respectively(fig 8). High values of TDS during rainy seasons may be attributed to the runoff and catchments watershed and also due to leaching of substances from rocks in surrounding area. Almost same observations were obtained from Minor reservoir (Rajashekhar et al. 2007), three

dams in Nanded (Pawar & Kanvate 2010) and Mansagar lake of Jaipur (Singh et al. 2010). Jemi and Balasingh (2011) observed the TDS to be more during summer and less during monsoon.

3.9. Dissolved Oxygen

The change in the dissolved oxygen content of a water body is of great limnological significance. Oxygen plays a vital role on the metabolic and physiological activities of the organisms in a specific water body. The oxygen supply for the aquatic animals in a water body comes primarily by diffusion from air and oxygen released during photosynthesis by the aquatic plants. The present investigation showed that the dissolved oxygen record a highly significant seasonal variations ($p \leq 0.05$) in Khutaghat dam during July-2019 to June-2012(fig 9). The Maximum value of DO recorded in winter (Khutaghat dam: 6.68±0.20mg/l) and the minimum value were recorded in monsoon (Khutaghat dam: 5.29±0.55mg/l). Ali *et al.* (2005) noticed that the DO of the water bodies show maximum value in winter season due to temperature variation in the study area. Similar results were also observed by Salam *et al.* (2000) and Ali *et al.* (1994). Jemi and Balasingh (2011) reported that the DO was maximum in Padmanapapuram temple pond and minimum is Parvathipuram temple pond. It also showed an inverse relationship with temperature which might be due to oxidation of oxygen as reported by Patil and Dongare (2006). Joshi and Bhalla (2012) observed the reduction of DO as a result of sewage outfall in to the river. Rameshbabu and Selvanayagam (2013) reported dissolved oxygen values upto 10.2 mg/l in summer season at the sampled water body.

3.10.Chemical oxygen demand (mg/l)

A significant variation ($p \leq 0.05$) in the chemical oxygen demand (mg/l) across different seasons was recorded in Khutaghat dam. The Maximum value of COD was recorded in monsoon (Khutaghat dam: 29.83±0.55mg/l) and the minimum value were recorded in winter (Khutaghat dam: 21.17±1.25mg/l) respectively(fig 10).

3.11. Biological Oxygen Demand (mg/l)

Biological Oxygen Demand (mg/l) is the amount of dissolved oxygen demanded by microorganisms of a water body in the biological process of metabolizing organic matter in water. The more organic matter there is in the water body the greater will be the BOD, and the greater the BOD, the lower the amount of dissolved oxygen available for higher animals such as fishes. The BOD is therefore a reliable gauge of the organic pollution of a water body. In the present study the BOD values of Khutaghat dam during July-2019 to June-2020 alter significantly across different seasons(Fig 5.25 and Fig 5.26). The Maximum value of BOD in Khutaghat dam was highest in Monsoon(4.42±0.35mg/l) .the lowest BOD values were recorded in winter (Khutaghat dam:3.12±0.02mg/l) respectively(fig 11).

IV.CONCLUSION

The different physicochemical properties of the surface water of the Khutaghat dam record a significant variation across different seasons. The variation in these physicochemical properties confirms the nutrient dynamics of this water body. The all physicochemical properties of these water bodies were seen to be correlated with each other. Thus one physicochemical factor modifies the other factors. The overall results confirm that the physicochemical factors of these water bodies were under normal ranges, except some of them, which trend to be increased. The proper management and conservation of these water bodies are required, if it falls short may be these water bodies in future may trend towards severe deterioration.

V. CONFLICT OF INTEREST

The author would like to undertake that the above mentioned manuscript has not been published elsewhere, accepted for publication elsewhere or under editorial review for publication elsewhere. The authors declare that they do not have any conflict of interest with the submission of this manuscript.

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