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RESEARCH ARTICLE

DIFFERENT PHYSICO-CHEMICAL PARAMETERS OF TWO WORLD FAMOUS WATERBODIES OF KASHMIR(INDIA)

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Abstract

Kashmir valley water bodies have water with alkaline character (Ph 7.1-8.9), the high values of pH being the result of photosynthetic activity from phytoplanktons. The vertical gradient of dissolved oxygen concentrations differs from one waterbody to another throughout the year. These waterbodies have highest Ionic conc. with reference to Calcium and Phosphate dominating among Anions and Cations and high conc. of Mg 3.9-8.1mg/L with alkalinity values of 4-376mg/L. Conductivity was 100-230 μ S. Due to increased abundance of phytoplanktonic activity there was an increase in Oxygen saturation and pH but there was a depletion of conductivity (due to precipitation of calcium carbonate), nutrients like NO₃, N and reactive silica. The variations in time and depth of other chemical species confirm the periods of water mixing indicated by oxygen and temperature and pH values.

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Introduction:-

Waterbodies in Kashmir Valley (Jammu and Kashmir), situated at an altitude of 1550 to 1595 m, are the major coldwater fishing water bodies in the Asia. In both types of water bodies (Lentic as well as Lotic) there is an effective fisheries system, based on exotic and indigenous fish species. The large water bodies river Jehlum and Dal in Kashmir Valley have an average annual fish yield of 20.5 kg ha⁻¹ and 24 kg ha⁻¹ respectively. These water bodies in Kashmir Valley are rapidly ageing, with the effect of encroachment of agricultural practices on their margins and by aquatic plant growth, which is enhanced by pollution from the surrounding lands. Early studies on the water bodies of Kashmir were mainly on the biology and the geographical distribution of the various species; to these were added, in the 80s, the evaluation of pollutant loads from the atmosphere and their possible effects in terms of acidification or the enrichment of lake waters with nitrogen compounds. Limnological research in the Himalayas has been carried out since the beginning of the century (Sars 1903; Hutchinson 1937). Up to the seventies studies were sporadic (Hirano 1955; Hirano 1963; Ueno 1966; Löffler 1969; Zutshi & Vass 1970) and oriented towards characterising the biotic communities in lakes and comparing the tropical areas affected by a monsoon climate (Troll 1959; Löffler 1964, 1968) with temperate zones. Recent studies have been focused on the physico-chemical and biological features, and particular emphasis on fish production. Results have generally highlighted the very low concentrations of dissolved minerals and nutrients, and the limited plankton populations in lakes at altitudes above 4000 m a.s.l. As per the latest report of the Fisheries department of Kashmir, the fish production in the waterbodies are depleting day by day. So keeping these things in mind current study was made to study the main Physico-chemical characteristics of these waterbodies and to see its impact on the fish production. For the whole study, two

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well known waterbodies of Kashmir were selected, out of the two water bodies one was lotic (River Jehlum) and the other was Lentic (Dal lake).

Dal Lake:-

The Dal lake one of the beautiful lakes in the world situated at about 10 Km in the north east of Srinagar city at an altitude of 1584 m.a.s.l at a mean latitude of 34° 7' north and longitudes of 74° 52'. It is surrounded in the east by Mahadev mountain range and on the south by the Kohi-Suliman. A total water spread of the lake at the turn of 20th century was 25 km square, but due to encroachment and siltation, the lake has been reduced to 12.4 square km. It is a shallow lake with a depth of 1.5—2 meters, but at certain places like Sonalank and Rupalank the depth exceeds 3.5 meters. The depth of the lake varies seasonally due to the amount

Of rainfall and stream flow agricultural fields. On the Southwestern side the lake discharges the water in to the river Jehlum through a channel called Tsutikol which leaves from Gagribal basin at Dalgate. The lake provides excellent home for *Schizothorax* sps. Carp and other fishes and also provides an opportunity for boating and fishing.

The Jehlum:-

The Jehlum is the largest and longest river of the sub-Alpine region of Asia's Switzerland. Its source is the spring of Verinag. The River is rich in Ichthyofauna throughout its flow containing both the exotic as well as indigenous fishes i.e. Carp and

Schizothorax species The small rivers, Vishau, Rambai, Aru, Romshi, Dudganga, Sukhanag and Ningal, and the mountain streams, Liddar, Arpal, Tsunti Kul, Sind, Arin, Madamati, Pohru and still others, constitute its tributaries. Flowing down the mountains into the eighty-four miles of the fertile alluvial valley, and, then again over foothills and spurs into Pakistan and onward, it sees and hears nature in all her moods. On its serpentine course, it is swept by many a wind and swelled by rain and snow through the many tributaries. The Jehlum River is the great waterway of this mystical land into which lakes, fountains, streams and rivers drop down in a manner forming an arterial system of the valley of Kashmir. The river winds through the valley and expands and deepens into the Wular Lake. The water samples collected from River Jehlum and Dal lake fortnightly were analyzed. The mean physico-chemical readings of water samples are depicted in the table 6 and 7.

Materials and Methods:-

The chemical analysis of the water samples was done in the undergraduate Department of Zoology, Govt Degree College Women Anantnag, Kashmir. At the time of sampling, the temperature was measured by a thermistor and the samples were subdivided and fixed for further analysis. Determinations of conductivity was made by the use of Conductometry (A.P.H.A., 1992), total alkalinity by the method of Gran's Potentiometry; 1952, pH by Westcott's potentiometry method (1978) and dissolved oxygen (Winkler's method) were performed immediately in the laboratory. Total nitrogen and total Phosphate was analyzed by the Valderrama's and A.P.H.A. spectrophotometry method (1981), whereas Silicates were analyzed by Golterman's spectrophotometry method (1978). Samples of Magnesium, Calcium and Chloride were analyzed by the Spectrophotometer (Systronics). All the samples for the inorganic determinations were taken in one and a half litre polyethylene bottles; glass bottles were used for the analysis of dissolved oxygen. The samples were suitably pre-treated so that the analyses could be accurate and true. The samples were divided into subsamples of 25ml and 100 ml, then preserved in different ways according to the determinations to be performed. The sub-samples were treated as follows:

1. For the analysis of the main algae nutrients (total phosphorus, total nitrogen and silica); addition of chloroform 0.3% and preservation at 5 °C was performed;
2. Freezing, for the analysis of alkalinity with potentiometric Gran's titration;
3. For the analyses of chloride, sulphate, calcium, magnesium, with spectrophotometric methods, freezing was done; Those samples containing particulate matter which could interfere with the spectrophotometric analyses, the samples were first filtered with .10 µm filters before the spectrophotometric reading. The containers to be used in the chemical analysis were carefully rinsed with double distilled water; controls were performed on blanks prepared.

Results:-**Dal Lake:****Temperature:**

The mean temperature of water samples collected from various selected sites during the whole study ranged from 5⁰C in the month of January to 29⁰C in the July.

pH: The pH of the water was in alkaline range between 7.1 and 8.9. The minimum pH was recorded in the months of June and July (7.1) and maximum in the month of February (8.9).

Dissolved Oxygen:

Under natural conditions the fresh water typically contained high concentration of DO. The DO value was minimum in the month of July (1.4 mg/l) and maximum in the month of February (15mg/l).

CO₂: The CO₂ was found in the mean value of 7.75 with minimum in the month of January and July (0.8 mg/l) and maximum in the month of April and October (82mg/l)

Alkalinity: Alkalinity is due to bicarbonates, which varied from 4 mg/l in the month of November and maximum in the month of August (376mg/l).

Conductivity:-

The content of the total electrolytes is closely related to the type of water body. In general conductivity values ranged between 100 and 230 μ S. The minimum value recorded was in the month of March and maximum in the month of December.

Magnesium:

The magnesium which forms a constituent of total hardness ranged from the minimum value 3.9 in the month of June and September and the maximum value 8.1mg/l was recorded in the month of January.

Calcium:

The calcium which is the bigger part of the total hardness ranged between 20.1 and 41.9 mg/l. The minimum value was recorded in the month of August and maximum in the month of November.

Chloride:

The lowest concentrations of chloride were recorded in Autumn and winter seasons, while highest concentrations were observed in spring and summer seasons. The chloride content ranged from 6- 43 mg/l.

Po₄: The phosphorus, which is also an indicator of trophic status of the water body ranged between 16.5mg/l and 46.2mg/l. The maximum value was recorded in the month of March and minimum in the month of October.

Nitrogen: (NO₃ -N, NH₃-N, and NO₂-N). NO₂-N is found in low quantities as compared to NH₃-N and NO₃-N. The NO₃-N was greater as compared to NH₃-N. The maximum value of all the three were found in the months of August, June and July and minimum in the months of June, July, and December respectively.

Silicate:

The highest silicate conc. recorded was 9.5mg/l in the month of April and lowest silicate conc. recorded was in the month of July (1.1mg/l)

Sulphate and Iron: The sulphate concentration recorded in the water samples of River Jhelum during the whole study was falling in the range of 9.6mg/l (max) October, to 2.2mg/l (min) July. The Iron content in the river was recorded maximum in the month of June (627.20 μ g/l) and minimum in the month of December (95.25 μ g/l).

Table 6:- Monthly variations in the (mean) physico-chemical parameters in Dal lake from Dec. 2018-Nov. 20019.

Mo	Te	p	O2	CO2	Mg	Alk.	Cl.	Co	Ca.	PO4	NH4	NO2	NO3	Si	Su	
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nth	mp	H	mg/l/	mg/l-1	mg/l	mg/l	mg/l	nd.	mg/l	-P*	-N*	-N*	-N*	l m	l m	Iro
			1											g/l	g/l	n*
Dec	7.6	8	9.2	2.8	6.2	162	9.9	19	34.1	20.2	77.3	1.8	70.3	2.2	6.9	95.3
.		.4						8.2								
Jan	5.4	8	9.3	3.5	8.1	162.	17.8	15	36.7	28.5	80.5	4.9	228	4.8	7.2	26
,		.3				4		8.6								1.7
Feb	8.9	8	9.8	6.2	5.2	145.	16.7	14	35.8	22.8	92.8	8.4	145	3.4	5.9	34
.		.6				6		0.6								1.8
Ma	11.	8	8.4	9.4	4.6	158.	15.9	12	32.4	46.2	138.	10.7	132	7.8	7.3	25
rch	7	.1				4		0.6			9					6.8
Ap	16.	8	6.3	6.3	7.2	166.	12.3	16	29.5	38.9	145.	12.4	212	9.5	6.4	27
ril	5	.3				8		0.4			7					2.4
Ma	18.	8	6.7	11.3	5.8	160.	14.6	19	24.9	26.7	135.	13.5	438	6.2	5.4	58
y	3	.0				5		0.7			8					6.9
Jun	23.	7	6.2	13.4	3.9	135.	13.3	17	27.7	39.3	72.2	8.1	466	3.5	3.8	62
e	2	.6				8		0.0								7.2
Jul	26.	7	4.7	16.7	5.6	164.	12.6	20	33.5	45.0	47.8	5.6	217	1.1	2.2	53
y	2	.6				3		3.3								2.1
Au	22.	7	5.0	12.4	4.8	170.	13.7	20	20.1	40.7	205.	5.3	464	2.1	3.5	14
g.	9	.7				7		4.2			6					7.6
Sep	20.	8	5.9	4.0	3.9	154.	13.2	24	25.5	18.8	155.	4.3	320	4.1	1.8	13
.	3	.2				5		3.1			6					5.2
Oct	19.	8	5.9	4.1	4.7	141.	11.2	24	35.8	16.5	132.	3.5	256	1.5	5.2	12
.	9	.1				6		3.1			1					4.6
No	14.	8	7.8	2.9	4.4	125.	8.6	28	41.9	24.1	133.	3.1	99.3	1.4	9.6	11
v.	3	.4				3		3.0			7					4.5

River Jehlum:

Temperature: The mean temperature of water samples collected from various selected sites during the whole study ranged from 5.4⁰C in the month of January to 26.2⁰C in the July.

pH: The pH of the water was in alkaline range between 7.6 and 8.6. The minimum pH was recorded in the months of June and July (7.6) and maximum in the month of February (8.6).

Oxygen: Under natural conditions the fresh water typically contains high concentration of DO. The DO value was minimum in the month of July (4.7 m g/l) and maximum in the month of February (9.8mg/l).

CO₂: The CO₂ was found in the mean value of 7.75 with minimum in the month of January (2.8 mg/l) and maximum in the month of July (16.7mg/l)

Alkalinity:-

Alkalinity is due to bicarbonates, which varied from 125.3 mg/l in the month of November and maximum in the month of August (170.7mg/l)

Conductivity:-

The content of the total electrolytes is closely related to the type of water body. In general conductivity values ranged between 120.6 and 238 μ S. The minimum value recorded was in the month of March and maximum in the month of November.

Magnesium:-

The magnesium which forms a constituent of total hardness ranged from the minimum value 3.9 in the month of June and September and the maximum value 8.1mg/l was recorded in the month of January.

Calcium: The calcium which is the bigger part of the total hardness ranged between 20.1 and 41.9 mg/l. The minimum value was recorded in the month of August and maximum in the month of November.

Chloride: The chloride content showed a gradual decrease from Jan to December with slight change in the month of April, August, September and November. The maximum value was recorded in the month of January and minimum value was recorded in the month of November.

Po₄: The phosphorus, which is also an indicator of trophic status of the water body ranged between 16.5mg/l and 46.2mg/l. The maximum value was recorded in the month of March and minimum in the month of October.

Nitrogen: (NO₃ -N, NH₃-N, and NO₂-N). NO₂-N is found in low quantities as compared to NH₃-N and NO₃-N. The NO₃-N was greater as compared to NH₃-N. The maximum value of all the three were found in the months of August, June and July and minimum in the months of June, July, and December respectively.

Silicate: The highest silicate conc. recorded was 9.5mg/l in the month of April and lowest silicate conc. recorded was in the month of July (1.1mg/l)

Sulphate and Iron: The sulphate concentration recorded in the water samples of River Jehlum during the whole study was falling in the range of 9.6mg/l (max) October, to 2.2mg/l (min) July. The Iron content in the river was recorded maximum in the month of June (627.20 μ g/l) and minimum in the month of December (95.25 μ g/l).

Table 7:- Monthly variations in the (mean) physico-chemical parameters in River Jehlum from Dec. 2018-Nov. 2019.

Month	Temp	pH	O ₂ mg/l	CO ₂ mg/l	Mg mg/l	Alk. mg/l	Cl. mg/l	Conduct	Ca. mg/l	PO ₄ -P*	NH ₄ -N*	NO ₂ -N*	NO ₃ -N*	Si l. m g/l	Su l. m g/l	Iron*
Dec.	6.42	8.46	8.18	1.07	5.18	123.25	11.22	19.08	22.78	52.2	149.	8.44	111.8	2.5	2.7	411
Jan.	6.30	8.03	8.63	1.76	5.92	114.12	8.60	24.31	32.71	42.5	92.5	2.26	230.8	4.3	1.9	166
Feb.	9.46	8.16	8.17	2.86	3.05	147.75	12.30	22.32	26.36	24.3	48.5	6.4	175.9	4.4	1.4	201
March	13.85	8.23	8.21	1.61	4.56	115.37	13.43	17.88	23.58	46.0	24.2	6.1	251.1	3.7	2.8	189
April	16.63	7.96	8.03	3.37	4.58	110.87	13.95	16.35	35.11	38.7	77.1	4.93	488.9	1.4	4.0	238
May	17.37	7.62	7.51	5.73	5.82	91.00	13.50	20.58	44.64	52.6	57.4	12.80	678.0	3.5	5.1	436
June	20.61	7.42	6.32	7.83	3.87	98.00	17.50	19.13	38.49	50.8	113	10.25	414.3	4.5	5.2	646
Jul	24.	7.	5.36	13.5	6.00	122.	23.7	25	20.8	79.2	152	18.2	475.	5.	4.	68

y	58	28				00	5	0.8	4			1	8	6	4	2
Au	22.	7.	4.95	21.0	3.96	129.	17.1	24	26.4	62.2	126	4.35	544.	5.	4.	43
g.	21	17				87	2	2.2	9				4	7	1	7
Sep	20.	7.	4.78	17.72	2.61	126.	13.7	22	32.2	48.6	62.1	11.3	712.	4.	3.	50
.	31	23				87	8	9.1	6			6	1	9	2	8
Oct	17.	7.	6.51	8.28	5.32	100.	17.3	19	34.4	34.	80.1	17.3	532.	4.	1.	33
.	16	61				75	7	3.3	9			5	0	4	9	7

Discussion:-

Kashmir Valley waterbodies have water with alkaline character (pH 7.1-8.9), the high pH values in summer being the result of an intensive photosynthetic activity from rich phytoplankton. The vertical gradient of dissolved oxygen concentrations differs from one water body to other. In Dal lake, which is mixed throughout the year, oxygen concentrations do not vary much from the surface to the bottom. Zutshi (1989) noted a net positive input of 4.36 t of phosphorus and 39.2 t of nitrogen per annum in Lake Dal. This is the result of a high input of nutrients reaching the lake from human settlements, hotels and arable land surrounding. These waterbodies have the highest ion concentrations with calcium and phosphate dominating among anions and cations, and high concentrations of magnesium (3.9-8.1mg/l), whereas the alkalinity values are quite low (4-376mg/l). Conductivity values are between 100-230 μ S, with a mean of 165 μ S cm⁻¹. In the stable and isolated surface layers in spring and summer, the increased influence of phytoplankton activity is revealed through an increase in the values of variables closely linked with algal abundance and photosynthetic activity (O₂ saturation and pH) and the marked depletion of nutrients, especially NO₃-N and reactive silica. The significant decrease of conductivity values in the warmest months is principally due to the precipitation of calcium carbonate (100 μ S in March and 230 μ S Dec.). Calcite precipitation is a well known phenomenon in lacustrine ecosystems (Stumm & Morgan 1981; Kelts & Hsü 1978) and is determined by a rise in pH (which increases carbonate ions) and temperature values (which decrease carbonate saturation). Guilizzoni, P., V. Libera, M. Manca, R. Mosello, D. Ruggiu & G.A. Tartari. 1992, concluded in the Preliminary results of limnological research in Terra Nova Bay area (Antarctica). Limnology on groups of remote lakes: ongoing and planned activities. Temperature, pH, Dissolved oxygen, Alkalinity and Conductivity are the main part players in the structure of water. The intensity of vertical mixing in spring, when density gradients are at a minimum, is thus the main parameter in determining the redistribution and recycling of the deep waters after the modification of their chemical and physical characteristics by mineralisation processes; moreover, a knowledge of the frequency of the episodes of complete overturn is important in checking the capacity of the lake to isolate stable water masses in depth. The oxygen concentrations during complete mixing varied between 1.4 and 15 mg l⁻¹ over the whole mass of water, with a corresponding saturation of 85-95%; in the 2018 circulation, the mean oxygen concentration was 10.5 mg l⁻¹ (83% saturation). Zutshi, D.P. & K.K. Vass. 1970 has worked on the high altitude lakes of Kashmir and has concluded that pH, Temp., Alkalinity and other ion concentration are in the range of 7.0-9.0, 4°C-31°C, 4-340 mg/l respectively. The variations in time and depth of other chemical species confirm the periods of water mixing indicated by oxygen and temperature, pH values regularly decrease in the deepest water during periods of stagnation and increase on the occasion of mixing. Alkalinity variations are slight, but perceptible. On the basis of the usual trophic parameters (OECD 1982) the Dal lake appears to be in an oligo-mesotrophic condition. This situation is determined by the low phosphorus concentrations in the lake and is confirmed by limited phytoplankton abundance and high transparency. However, bearing in mind the lake's oligomictic character and the high nutrient concentrations in the deep layers, the actual trophic state of the lake is not so easily or unequivocally defined. The decomposing organic matter stored in the deepest waters releases nutrients which replenish the surface waters only in the years of complete mixing. Owing to the influence of other factors (primarily the interannual variability of meteorological conditions during the spring-autumn phytoplankton growth) it is difficult to ascertain exactly the influence of the extent of the overturn on the biological development in the lake.

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