Physico-Chemical Characteristics of Vena River in Hinganghat Area of Wardha District

B. M. Rajurkar[1], L. P. Dalal[2]

[1]Department of Botany, R. S. Bidkar College, Hinganghat Dist. Wardha, Maharashtra, India

[2]Department of Botany, Jankidevi Bajaj College of Science, Wardha, Maharashtra, India

Abstract: ***The present work is a part of survey conducted to study the physico-chemical characteristics of fresh water of Vena River in Hinganghat area of Wardha District (Maharashtra State). Four study sites i. e. SW_1, SW_2, SW_3 and SW_4 were selected for present study. The physico-chemical characterstics like, temperature, pH, alkalinity, Total hardness (Calcium, Magnesium), Phosphates, Nitrates, Dissolved oxygen (DO), Free carbon dioxide and Total dissolved salts (TDS.) were studied. The tenure of study was June 2011 to May 2013. Seasonal fluctuations in physico-chemical parameters were observed and report findings shows some variations due to nearby industries and water discharge from Rama Dam in the month of June.***

Keywords: Physico-chemical, Rama Dam, Vena river. Hinganghat, Fresh water

1. Introduction

Hinganghat is one of the tehsils of Wardha District situated in $20^0 18'$ to 20^0 and $49'$ N and $78^0 32'$ to $79^0 14'$ E latitude. The town is located on the bank of Vena river, a tributary of the Wardha river which joins the big river Pranhita, which ultimately merges into the Godavari river. In British India, Hinganghat was the centre of India, but after the partition of Hindusthan into India and Pakistan, the Nagpur is considered as the center (heart place) of India. At vena river pump house there is an historical old stone, on which it was mentioned that Hinganghat is the centre of India. The major portion of the total annual rainfall is received during June to September of each year. The average rainfall of Hinganghat Tahsil is 1071.70 mm and has a dry tropical weather climate. The climate is hot and dry. Max temp in ^{0}C were noted as 47.9^0C and Min temp in ^{0}C were noted as 10.2^0C. The seasons of a year were divided climates into three season namely cold, hot and monsoon.

Wardha District has a typical seasonal monsoon, where people are engaged in agriculture. Hinganghat city lies in the south east of Wardha District. Its South East border touches Chandrapur District and South west border touches to Yeotmal District. The land scape of the city faces towards the south. There are fast running streams and Vena River bordering the north, west and south sides of the city. The city is rich in fauna and flora and water sources.

Physico-chemical characteristics of water are very important since they have a profound effect on the diversity of living organisms dwelling in it. The water regulates the structural and functional processes in an ecosystem. The chemistry of water determines the presence, absence and also the type of Biota. The biological compositions of an ecosystem in different climatic conditions are different because of differentiation in their physico-chemical characteristics. Therefore the study of physico-chemical properties is necessary to understand the phytoplanktons in an ecosystem.

In the present study, APHA (1989) was followed for the estimation of all physico-chemical characteristics of Vena river in Hinganghat area of Wardha district. The monthly variations in the physio-chemical parameters such as temperature, pH, dissolved oxygen, free CO_2, alkalinity, calcium, magnesium, hardness, phosphate, nitrate and total dissolved solids were studied.

2. Materials and Methods

For, the experimental study samples were collected from June 2011 to May 2013 in plastic tubes from different stations like Under bridge (SW_1), Kawalghat (SW_2), Smashanbhoomi (SW_3) and Shahalangadi (SW_4) between 9.00 AM to 11.00 AM. All the samples were preserved in 4% formaldehyde solution on the spot. Geographical position, sample number, date of collection etc. of each locality was also enlisted in the field diary and was brought to the research laboratory for further investigation. All the samples have been deposited in the repository of Department of Botany, J. B. College of Science, Wardha (M.S.). Extensive samples were undertaken personally from various stations of Vena river of Hinganghat area in order to understand the Physico-chemical characteristics. The information was collected from available literature from books, internet and various scientific journals. Repeated queries were made to get the information confirmed.

Observation:
Following were the observations recorded in following tables.

Tables 1: Monthly variation in Parameters at SW1 (June 2011 to May 2012).

Month and Year	Temp (^0C)	pH	DO (mg/l)	free CO_2 (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Total alkalinity (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	TDS ppm
June 2011	32.2	7.31	24.16	0	45.69	36.87	28.05	0.08	0.62	0.919
July2011	27.9	7.8	16.1	299	60.12	18.43	25.65	0.11	1.24	0.468
August2011	27	8.7	16.51	506	40.88	31.26	33.66	0.15	4.6	0.691
September2011	27.5	8.2	16.1	330	36.07	52.1	129.8	0.22	0.25	0.537
October2011	26.4	7.35	20.94	176	97.79	6.41	90.58	0.17	2.9	0.698
November2011	23	8.64	13.29	165	55.31	16.83	75.35	0.14	0.54	0.181
December2011	20.7	7.68	8.86	341	40	40.08	40.08	0.11	1.8	0.603
January2012	21.6	8.57	11.27	66	72.14	16.03	92.18	0.11	2.3	0.697
February2012	24.5	8.2	6.84	125.4	100.02	40.08	84.96	0.14	1.49	0.832
March2012	28.7	7.79	2.416	215.6	96.19	8.817	48.09	0.12	1.9	0.849
April2012	32.9	8.21	9.66	22	129	8.817	70.54	0.11	2.7	0.881
May2012	35.2	7.46	10.06	140.8	26.45	37.71	60.12	0.1	0.23	0.698

Tables 2: Monthly variation in Parameters at SW2 (June 2011 to May 2012)

Month and Year	*Temp (^0C)*	*pH*	*DO (mg/l)*	*free CO_2 (mg/l)*	*Calcium (mg/l)*	*Magnesium (mg/l)*	*Total alkalinity(mg/l)*	*Nitrate (mg/l)*	*Phosphate (mg/l)*	*TDS ppm*
June 2011	32.1	7.21	24.16	0	41.88	25.65	32.06	0.11	0.56	0.953
July2011	27.8	7.1	16.1	308	56.11	13.62	25.65	0.11	1.84	0.467
August2011	27.1	8.35	18.21	528	47.29	32.86	43.28	0.13	6.2	0.715
September2011	27.4	8.21	14.9	180.4	36.87	28.05	131.4	0.07	2.7	0.564
October2011	26.5	7.3	22.15	132	80.16	12.02	92.98	0.32	3.35	0.715
November2011	23.1	8.53	13.39	110	56.91	18.4	48.09	0.16	0.52	0.196
December2011	20.6	7.71	6.84	429	40.88	40.88	40.58	0.12	1.2	0.602
January2012	21.7	7.03	10.06	55	77.75	8.8	90.58	0.12	1.62	0.733
February2012	24.6	7.11	6.84	44	96.99	32.86	107.41	0.12	1.49	0.804
March2012	28.8	7.23	2.013	169.4	89.77	9.619	59.31	0.1	3.8	0.878
April2012	33	7.3	9.66	26.4	140.28	9.619	77.75	0.16	9.8	0.93
May2012	35.1	7.33	11.67	66	20.04	76.15	63.32	0.26	1.37	0.719

Tables 3: Monthly variation in Parameters at SW3 (June 2011 to May 2012).

Month and Year	Temp (^0C)	pH	DO (mg/l)	free CO_2 (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Total alkalinity (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	TDS ppm
June 2011	32.1	7.8	24.16	0	31.26	34.46	32.06	0.18	0.94	0.989
July2011	27.7	8.02	16.1	369	48.09	20.04	21.64	0.22	1.2	0.452
August2011	26.9	8.54	18.92	572	52.1	26.45	84.16	0.34	0.56	0.717
September2011	27.6	8.33	14.49	308	40.08	36.07	121.68	0.09	4.85	0.57
October2011	26.3	7.45	20.94	154	81.76	16.83	98.59	0.28	3.1	0.725
November2011	23.2	8.65	14.9	143	52.1	34.46	93.78	0.11	0.33	0.181
December2011	20.8	8.11	8.056	407	44	44.08	34.46	0.28	1.5	0.611
January2012	21.5	7.04	14.06	77	81.76	8.016	70.54	0.15	1.95	0.813
February2012	24.5	7.33	5.63	33	96.19	40.08	115.4	0.18	1.49	0.777
March2012	28.6	7.33	2.013	369	60.12	14.42	64.12	0.14	2.7	0.951
April2012	32.8	7.85	10.06	418	132.2	13.62	72.14	0.14	11.25	0.936
May2012	35.1	6.69	11.27	66	25.65	82.56	63.32	0.13	1.49	0.871

Tables 4: Monthly variation in Parameters at SW4 (June 2011 to May 2012).

Month and Year	Temp (^0C)	pH	DO (mg/l)	free CO_2(mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Total alkalinity (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	TDS ppm
June 2011	31.9	6.25	34.23	0	24.04	28.05	20	0.18	0.59	0.147
July2011	28.1	9.03	11.27	55	31.26	25.65	25	0.03	1.96	0.172
August2011	26.9	8.8	2.41	0	20.04	33.66	20	0.05	5.2	0.187
September2011	27.3	7.52	10.06	66	21.64	129.8	45	0.03	2.9	0.189
October2011	26.9	8.71	3.22	8.8	29.65	90.58	30	0.07	3.4	0.197
November2011	22.8	8.61	13.29	94.6	28.05	75.35	25	0.02	0.45	0.198
December2011	21.1	8.53	10.06	88	32.04	40.08	25	0.08	1.4	0.618
January2012	21.8	6.7	12.08	0	21.64	92.18	40	0.29	2	0.365
February2012	23.9	6.36	21.74	0	33.66	84.96	35	0.06	1.49	0.309
March2012	29	7.1	20.13	0	39.27	48.09	35	0.01	2.9	0.29
April2012	33.1	8.4	11.67	0	12.02	70.54	30	0.12	9.7	0.25
May2012	34.8	8.56	18.92	0	13.62	60.12	35	0.06	0.9	0.215

Tables 5: Monthly variation in Parameters at SW1 (June 2012 to May 2013).

Month and Year	Temp (^{0}C)	pH	DO (mg/l)	free CO_2(mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Total alkalinity (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	TDS ppm
June 2012	32	7.44	24.16	0	42.1	25.6	32.06	0.11	0.59	0.953
July2012	28	7.64	16.1	334	55.9	13.65	25.65	0.11	1.2	0.466
August2012	27.2	8.53	17.88	535	46.29	31.85	42.28	0.12	4.7	0.714
September2012	27.5	8.24	15.16	272	35.87	28	130.4	0.06	0.5	0.563
October2012	26.6	7.36	21.34	154	91.16	12.27	91.98	0.33	2.9	0.714
November2012	22.9	8.6	13.86	139	55.96	17.45	47.09	0.16	0.52	0.197
December2012	20.7	7.83	7.91	392	41.02	39.81	40.05	0.13	1.7	0.601
January2013	21.6	7.54	11.79	66	78.75	8.9	89.9	0.13	2.3	0.732
February2013	24.4	7.54	6.43	67	95.99	31.81	106.95	0.11	1.45	0.801
March2013	28.7	7.45	2.147	169.4	88.77	9.569	58.9	0.09	1.8	0.876
April2013	32.9	7.78	9.79	26.2	139.8	9.619	76.75	0.15	2.6	0.925
May2013	35	7.16	11	67	21	76.15	63.12	0.12	0.25	0.72

Tables 6: Monthly variation in Parameters at SW2 (June 2012 to May 2013).

Month and Year	Temp (^{0}C)	pH	DO (mg/l)	free CO_2(mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Total alkalinity (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	TDS ppm
June 2012	31.8	6.1	19.73	0	24.04	32.06	20	0.19	0.57	0.154
July2012	28.2	9.09	10.06	13.2	32.06	25.65	30	0.055	1.8	0.17
August2012	26.8	10.8	2.01	13.2	19.23	43.28	20	0.07	6.3	0.163
September2012	27.4	7.46	2.41	88	20.84	131.4	45	0.11	2.5	0.157
October2012	26.8	8.61	16.91	74.8	35.27	92.98	35	0.07	3.1	0.195
November2012	22.9	8.65	11.67	114.4	52.1	48.09	40	0.05	0.5	0.199
December2012	21	8.1	8.45	110	36.07	40.58	40	0.06	1.1	0.637
January2013	21.9	6.75	12.88	0	32.06	90.58	40	0.5	2	0.398
February2013	23.8	6.23	35.44	0	4.008	107.41	35	0.09	1.45	0.313
March2013	29.1	7.15	34.63	0	31.26	59.31	35	0.02	3.7	0.3
April2013	33.2	8.26	8.84	0	12.82	77.75	35	0.07	9.7	0.245
May2013	34.9	8.5	30.2	0	12.02	63.32	30	0.15	1.4	0.21

Tables 7: Monthly variation in Parameters at SW3 (June 2012 to May 2013)

Month and Year	Temp (^{0}C)	pH	DO (mg/l)	free CO_2 (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Total alkalinity (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	TDS ppm
June 2012	31.8	6.2	6.84	0	24.04	32.06	20	0.18	0.9	0.155
July2012	28	8.75	10.47	17.6	40.08	21.64	30	0.02	1.1	0.172
August2012	26.7	9.5	2.41	16.8	16.03	84.16	25	0.13	0.58	0.189
September2012	27.2	7.47	4.83	83.6	43.28	121.68	45	0.03	4.9	0.19
October2012	27	7.69	15.3	46.2	33.66	98.59	35	0.07	3.2	0.197
November2012	22.7	8.65	8.86	145.2	8.81	93.78	50	0.05	0.39	0.199
December2012	21.2	8.37	10.06	99	33.66	34.46	25	0.1	1.4	0.643
January2013	21.7	7.8	16.1	0	32.06	70.54	50	0.42	2.05	0.535
February2013	24	6.34	17.72	0	4.008	115.4	35	0.08	1.4	0.313
March2013	29.2	7.29	10.47	0	26.45	64.12	35	0.015	2.8	0.289
April2013	33	8.21	4.02	0	9.619	72.14	50	0.15	11.3	0.26
May2013	34.7	8.34	14.09	0	11.22	63.32	30	0.1	1.5	0.25

Tables 8: Monthly variation in Parameters at SW4 (June 2012 to May 2013).

Month and Year	Temp (^{0}C)	pH	DO (mg/l)	free CO_2 (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Total alkalinity (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	TDS ppm
June 2012	31.9	6.18	20.26	0	24.01	32.06	20	0.19	0.6	0.156
July2012	28.2	8.95	10.6	13.1	31.06	25.65	25	0.05	1.98	0.175
August2012	27	9.7	2.27	13.1	20.01	42.28	25	0.07	5.1	0.163
September2012	27.3	7.48	5.76	87	21.84	130.4	45	0.11	2.8	0.156
October2012	26.8	8.33	11.81	73.8	34.25	91.98	30	0.07	3.3	0.196
November2012	22.8	8.63	11.27	115.4	51.9	47.09	40	0.02	0.46	0.198
December2012	21.3	8.33	9.52	109	35.07	40.05	40	0.06	1.5	0.637
January2013	21.9	7.08	13.68	0	31.06	89.9	50	0.5	2	0.396
February2013	23.9	6.31	24.96	0	3.006	106.95	35	0.09	1.5	0.315
March2013	28.9	7.18	21.74	0	31.26	58.9	35	0.02	3	0.301
April2013	33.2	8.29	8.17	0	12.86	76.75	40	0.07	9.8	0.246
May2013	34.8	8.46	21.07	0	12.5	63.12	35	0.15	1	0.208

3. Results and Discussion

1) Temperature

From the observations and analysis it was reported that during June 2011 to May 2012 the Vena river showed (Table: 1 to 4) maximum temperature as 35.2^0C at SW_1 and minimum 20.6^0C at SW_2. The minimum temperature i. e. 20.6^0C at SW_2 was recorded only for one month i. e. in the month of December at all the stations. From January onwards gradual increase in temperature was recorded. The maximum temperature was recorded as 35.2^0C at SW_2 in the month of May and it was maintained for a period of three months i. e. April, May and June. In August mercury level slipped little bit to lower 26.9^0C at SW_3. August onwards temperature continues to decrease in till 20.6^0C at SW_2.

During June 2012 to May 2013 the Vena river showed (Table: 5 to 8) recognizable deviation in the highest and lowest limits of temperature. The minimum temperature of 21^0C at SW_2 was recorded in the month of December and highest as 34.9^0C at SW_2 in the month of May. The minimum level of temperature was recorded in December at all the stations and then in January it raised suddenly to 21.9^0C at SW_4 to increase by two degree in the month of February. In March suddenly temperature increase up to 29.2^0C at SW_3, and again rose by four degree in next month i. e. April. Again in May mercury reached higher level. Then for successive three months i. e. June, July and August there was again fall back. September and October were recorded as the months of moderate warmth.

Edges of water bodies showed shallow water, it responded quickly to atmospheric fluctuations. Therefore, water samples were collected from the edges of the water bodies. Welch, (1952) reported that shallow water reacts more quickly with atmospheric temperature. The gradual increase in air and water temperature from January to September was attributed to longer days and increase in the intensity of solar radiations. Similarly, the decreases in temperature from September to December were due to decrease in length of days and decrease in the intensity of solar radiations. Munawar (1970) and Harshey, *et al.*, (1982) reported a direct relationship between water temperature and intensity of solar radiation. Sahu, *et al.*, (1995) observed the lowest temperature at 6 am and highest at 3 pm, which was in accordance with changes in air temperature. The relationship between air and water temperature shows diurnal variation at different places differently.

Maximum and minimum temperature recorded for all the sites of Vena river were distinctly different during the study period. The reasons possibly lie in urbanization of Hinganghat, air pollution, discharge of textile mills, sugar factory, oil refineries, and forests of cement concrete buildings which were responsible for increase in radiation heat in atmosphere. All together were the cause of higher temperature throughout the year.

2) pH

Observations of Vena river confirmed the fact that all the Indian rivers were slightly alkaline. The recorded pH values for Vena river during June 2011 to May 2012 (Table 1 to 4) showed that the minimum value i. e. 6.69 was recorded at SW_3 in the month of May. While highest pH value i.e, 8.7 was recorded at SW_1 in the month of August. The observed pH range appears to be narrow. pH fluctuations for 21 major rivers of India were recorded by Sabata, and Nayar., (1995) and they pointed out that Indian rivers show narrow range of variations and fluctuations. The present study showed similarity with the above findings. The water of Vena river was slightly acidic at Station SW_3 in the month of May due to high pollution level. These observations showed similarity with slightly acidic conditions of Bramhaputra, Ganga, Hoogly, Kshipra, and Yamuna recorded previously.

Overall, it was found that pH of water during June 2011 to May 2012 at all stations on an average varied within the range of 6.69 (SW_3)-8.7 (SW_1). Of the four stations studied, SW_3 was severally polluted while SW_1 and SW_4 received only domestic pollutants. This was in contrast with the observations made by Singh, *et al.*, (1999) where pH was noted at low values at effluent receiving point. The increase and decrease in pH is directly related to water temperature. Sahu, *et al.*, (1995) observed diurnal variation of pH of water and reported that pH increased from 6 am to 3 pm and decreased from 3 pm to 6 am where the water is free from pollutants. Sreenivasan, (1964); and Vyas, and Kumar., (1968) have reported seasonal fluctuation in pH.

During June 2012 to May 2013 Vena river (Table 5 to 8), showed minimum or lowest pH value 6.1 in the month of June at SW2 station. This value was towards acidic nature of water. The maximum value of 10.8 was recorded at the same station during August.

Sahai, and Sinha., (1969), Sharma, *et al.*, (1978 a,b), and Sharma, *et al.*, (1981) have reported that most of the small water bodies were alkaline in nature. In most of the period of the year the water remains alkaline, except flowing water. At all stations except at SW3 in January higher pH values were recorded during July and August. Tripathi, and Pandey., (1990) also observed maximum pH values during rainy season in pond water of Kanpur. Blum, (1957)., Singh, (1960)., Venkteswarlu, (1969a)., and Jana, (1973) have also reported the same findings. Low pH in the month of June attributed to temperature condition stimulating the early summer. Rice, (1938) recorded such conditions in summer. However, acidic nature of water during January and February was not explained on the basis of work done by earlier workers. The range of pH value recorded during June 2011 to May 2012 and June 2012 to May 2013 was almost equal. Kodarkar, (1995) reported that in urban centers pH of water was also highly influenced by the nature of pollution in the form of sewage and industrial effluents. Generally pH of water is influenced by geology of catchment and buffering capacity of the water.

3) Dissolved Oxygen (DO)

During June 2011 to May 2012, the station SW_1 of Vena river showed dissolved oxygen value was lowest i. e. 2.41 mg/l in the month of August and the highest value as 34.23 mg/l in June. At the station SW_2 dissolved oxygen value was lowest 2.01 mg/l and the highest 35.44 mg/l, SW_3 at its lowest reported were only 2.41 mg/l, and the highest reported were only 17.72 mg/l, whereas, SW_4 at its lowest reported were only 2.27 mg/l and at its highest reported were only 24.96 mg/l in the month of August and February respectively. But uniformly the minimum level of dissolved oxygen was shown by all the four stations in the month of August (Table 1 to 4). In the month of August dissolved oxygen decreased because of higher water temperature. As solubility of oxygen decrease with increase in temperature was reported by Sabata, and Nayar., (1995). Similarly increase in dissolved oxygen was obviously related to decrease in temperature as was recorded for the month of February. The lowest figure in the tally of maximum was reported at SW_2. This can be attributed to the higher pollution of the station.

During June 2012 to May 2013 all the four stations reported (Table 5 to 8) uniform changes in dissolved oxygen throughout the year. The lowest dissolved oxygen concentration at all the four sites, in the range of 2.013 mg/l to 2.416 mg/l was noted in March. The highest concentration was found to be 24.16 mg/l in the month of June. The observations during June 2011 to May 2012 and June 2012 to May 2013 were almost similar.

4) Free Corbon Dioxide

The variations in free carbon dioxide showed direct relationship with the day and night. During day time, the concentration of free CO_2 were used up for photosynthesis, if the free CO_2 was measured throughout the day, during mid-day concentration may be even zero (Sahu, *et al.*,1995; and Jindal, and Gheta.,1991).

During June 2011 to May 2012 (Table 1 to 4), the maximum free CO_2 concentration was found in August at all the four stations of Vena river i. e. SW_1, SW_2, SW_3, and SW_4, of which SW_3 being highest with 572 mg/l. The total absence of free CO_2 was reported in the month of June for all the stations. Wide range of fluctuations in the concentration of CO_2 was not apparently related to temperature or rainfall. The wide range of fluctuation was related to the growth of phytoplankton and algae. The large floating patches of algal blooms prevent upward movement of dissolved gases resulting in accumulation of CO_2 in water in morning hours. The wide fluctuations in CO_2 concentration was explained easily when we take into consideration the periodic water release from Rama Dam, Wadgaon of District Nagpur.

During June 2012 to May 2013 (Table 5 to 8), the maximum free CO_2 concentration was 418 mg/l found in April at station SW_4. In SW_1, SW_2 and SW_3 the maximum CO_2 concentration was found in March of which SW_3 being highest at 145.2 mg/l followed by SW_2 at 114.4 mg/l and SW_1 with 94.6 mg/l. The total absence of free CO_2 was observed during June for all the stations. The wide range of fluctuation may be related to growth of phytoplankton and algae.

5) Calcium

Calcium plays very important role in metabolism and growth of flora of ecosystem. It directly affects the pH and carbonate content of the system.

Data depicted in Table 1 to 4 indicates that, during June 2011 to May 2012, of all the stations of Vena river, highest calcium concentration shown in the month of April for SW_2. For SW_1, SW_2, SW_3 and SW_4. Calcium concentrations were 129 mg/l, 140.28 mg/l, 132.2 mg/l and 139.8 mg/l respectively. There was drastic change in calcium concentrations from the month of May and the values being 26.45 mg/l, 20.04 mg/l, 25.65 mg/l and 21 mg/l respectively. From June onwards the concentration was found to rise consistently though there were some monthly variations. The highest Calcium concentrations during summer upto April at various places was recorded by Sreenivasan, *et al.*,(1974); Tripathi, and Pandey.,(1990), and Salodia (1996). The present study also revealed consistent increase in Calcium ion concentration. The minimum value which was recorded in the month of May was not even surprising as periodically water were released from Rama Dam, Wadgaon, Disrict Nagpur. The samples were collected just after the river was flooded by Dam water.

Calcium values at their highest in the month of April reported that SW_2, SW_3 and SW_4 were having more calcium hardness than SW_1. As SW_2, SW_3 and SW_4 received the sewage from the city and also from the nearby industries and naturally became more polluted. Similarly, increased Calcium hardness can also be due to sewage has been earlier recorded by Trivedi, and Goel., (1984) and Kaur, *et al.*, (1996), concludes that high values of hardness can also be due to regular addition of detergents along with sewage. Again high values of 100.02 mg/l recorded in February for SW_1; 96.99 mg/l for SW_2; 96.19 mg/l for SW_3 and 95.99 mg/l for SW_4. The correlation between increase in Calcium hardness and its pollution status has been shown by Prasad, and Saxena., (1980). High values of total hardness in the month of February for Kultadi Lake was recorded by Abbassi, *et al.*, (1996).

Data depicted in Table 5 to 8 indicates that during June 2012 to May 2013, the highest values of Calcium concentration of the station SW_1, SW_2, SW_3, and SW_4, in different months was different The maximum Calcium ion concentration of 52.1 mg/l was observed at SW_2 in the month of November. SW_3 had the maximum value of 43.28 mg/l in the month of September, SW_1 was at its highest Calcium concentration of 39.27 mg/l in the month of March and SW_4 was at its highest Calcium concentration in the month of December. The minimum values for Calcium ion concentration for SW_2, and SW_3 were 4.008 mg/l during February and for SW_4 it was 3.006 mg/l in the same month and for SW_1 it was 12.02 mg/l during April. Month wise fluctuations in Calcium concentration were much drastic. There was no correlation was found between calcium ion concentration and temperature. April, and May were the months of low calcium ion concentration for all the four stations. This could be correlated to the dilution resulted from the release of water from Rama Dam, Wadgaon, District Nagpur. Usually during the month of March water level reduces and to restore the water level water is released from Dam to Vena river. The calcium values above 25.0 mg/l were considered to be calcium rich (Ohle, 1934). According to this standard, water of Vena river is Calcium rich.

6) Magnesium

Like Calcium, Magnesium also affects the algal population. Generally it was seen that Magnesium concentration exhibit positive relationship with total phytoplankton. Table 1 to 4 shows the record of Magnesium content during June 2011 to May 2012 and table 1 to 4 shows the record of Magnesium content of stations studied during June 2012 to May 2013.

Of the four stations of Vena river during June 2011 to May 2012, SW3 was reported to have the maximum Magnesium concentrations valued 82.56 mg/l during May. The minimum concentration of Magnesium, 6.41 mg/l, was recorded at SW_1 station during October. Stations SW_1, SW_2, and SW_4 also exhibited highest concentration (during May 37.71 mg/l, 76.15 mg/l and76.15 mg/l respectively). However the lowest value for SW_2, SW_3, and SW_4 (8.8 mg/l, 8.016 mg/l, and 8.9 mg/l) were found in January. The highest value can be easily correlated with the reducing water level during summer. The lowest value for SW2, SW3 and SW4 in January can be explained if we take into consideration the periodic water release from Rama Dam, Wadgaon of District Nagpur.

Table 5 to 8 showed that, maximum concentration was in September at all the four stations during June 2012 to May 2013. Highest values for SW_1, SW_2, SW_3, and SW_4 were not much different though SW_2 exhibited the highest concentration i. e. 131.4 mg/l. Similarly, the lowest Magnesium concentration at all the four stations was again recorded in one and the same month i. e. July. Lowest values at four stations were not much different in concentration though SW_3 exhibited the lowest concentration of Magnesium i. e.21.64 mg/l.

7) Alkalinity

Alkalinity and acidity play an important role in controlling enzyme activity. Sverdrup, *et al.*, (1942) reported that water alkalinity was a measure of acid present in the water and of the cations balanced against them. In water cations of weak bases are present in negligible concentrations and the only anions that need to be considered are carbonic and boric acid. However, in polluted system OH^- release from industries plays an important role in increasing the alkalinity of the water system.

Alkalinity of water at four stations of Vena river during June 2011 to May 2012 and June 2012 to May 2013 were recorded in table 1 to 4 and5 to 8 respectively.

All the stations of Vena river during June 2011 to May 2012 constantly showed absence of OH^- alkalinity (i. e. Phenolphthalein alkalinity). However, alkalinity had a wide range of fluctuations. The minimum value 21.64 mg/l was noted at SW_3 station in the month of July. The maximum of 131.4 mg/l was noted at SW_2 in the month of September. As far as different stations of the Vena river are concerned, individual station reported different values of alkalinity in different months.

Amongst higher values SW_2 ranks first with alkalinity 131.4 mg/l followed by SW_4 with alkalinity 130.4 mg/l; SW_1 with alkalinity 129.8 mg/l, and SW_3 with alkalinity 121.68 mg/l. Robert, (1977) reported that high concentration of sewage results into increase in alkalinity. This contradicts our findings as station SW_2 was less polluted than SW_4, SW_1, and SW_3. The possible explanation lies in the fact that Vena river receives effluents from textile industries at SW_4, $SW_1$and SW_3 and may be that the chemical present in the effluents interact with sewage ultimately reducing the carbonates and bicarbonates in the water.

Data depicted in Table 5 to 8 showed the alkalinity of four stations of Vena river during June 2012 to May 2013. Observations on Vena river conspicuously showed the absence of OH^- alkalinity (Phenolphthalein alkalinity) but carbonate and bicarbonate alkalinity, (Methyl orange alkalinity) however, it exhibited a wide range of fluctuations. The minimum value 19.66 mg/l was recorded at SW_3 station in the month of July. The maximum of 129.6 mg/l was noted at the station SW2 in the month of September. As far as other stations were concerned individual station showed different values of alkalinity in different months.

From the above observations it was clear that alkalinity during the months of June, July and August remains at lower magnitude. While, it swings to maximum in September. Consistent low alkalinity during the months of June, July, and August was because of heavy rainfall leading to dilute ionic content of the water body (Bisop, 1973: Ray, *et al.*, 1966; Pahwa, and Mehrotra., 1966, and Singh, *et al*., 1999).

However, during the present study alkalinity sharply dropped in March, and May due to release of water from Rama Dam, Wadgaon to Vena river stimulating the conditions of June, July and August. George, *et al.*,(1966) suggested that in an ecosystem with pH range of 7-9 alkalinity remains high. This is not true to the present study where even though alkalinity had decreased and pH remains within the range of 6-8.65. Massod Ahmad, and Krishnamurthy., (1990) recorded maximum bicarbonate alkalinity in the month of June, July, and August and least in October, November, and December in second year of their observations on Wohar reservoir Aurangabad. Though no climatological conditions were reported by them, possibly water level might have depleted that year due to some or the other reasons during this month. High alkalinity values are the indicators of eutrophic nature of water bodies. Philipose, (1960) suggested that water bodies with alkaline values more than 100 mg/l were nutritionally rich. By this standard in some of the months, water of Vena river was oligotrophic.

8) Nitrate

Nitrate is a factor governed by biotic and environmental parameters. Its concentration depends mainly on the activity of nitrifying bacteria which inturn were influenced by the presence of dissolved oxygen. It was appears that, during entire study tenure Vena river showed quite low concentration of nitrates. Sabata, and Nayar., (1995) reported that Adyar river reprsents nitrate concentration varies from 11.10 mg/l to 15.20 mg/l. The lowest concentration i. e. no presence of nitrate concentration was recorded for Moosi and Vaigai rivers. Earlier studies regarding Indian rivers reported very low concentration of nitrates.

During the period of June 2011 to May 2012, the highest values for nitrate was 0.34 mg/l in the month of August at SW_3 station, and lowest of 0.06 mg/l in the month of September at SW_4 station (Table 1 to 4). All the four station showed variations within this range only. The highest concentration in the month of August has been earlier observed after the onset of rains by Prasad, and Saxena., (1980).

During the period of June 2012 to May 2013, study stations of Vena river showed (Table 4 to 8) highest nitrate concentration during January for SW_2 and SW_4 was 0.5 mg/l and it was 0.42 mg/l for SW_3 and 0.29 mg/l for SW_1. These values were comparatively higher, may be due to increased human activities. High nitrate level on account of pollution due to domestic sewage was reported by Chandrashekhar (1997) in Saroor Nagar Lake, Hyderabad. The lowest value of nitrate concentratation i. e. 0.01 mg/l was found for SW_1 and for SW_3 it was 0.015 mg/l in the month of March and 0.02 mg/l for SW_2 in the month of March, while, SW_4 showed 0.02 mg/l again in the month of March, and November.

The nitrate concentration increased for Zhelum river due to human activities as reported by Raina, *et al.*,(1984). The higher nitrate content from organically polluted water was reported by different workers like, Brinley, (1942)., Lackey, (1942)., Butcher, (1949)., and Blum (1957). However, Blum, (1957) reported that, the unpolluted stations of the Saline river richer in nitrate content.

Therefore, it appeared that factors contributing to concentration of nitrate were not clearly understood. However, our results support the view that organic pollution was the cause of higher nitrate.

9) Phosphates

The phosphates are the essentials for the growth of algae and their concentration controls algal growth in the ponds and river. The phosphates was a primary limiting nutrients in ponds and river (Schindler, 1971). They were usually present in low concentrations in naturally unpolluted water.

Observations on Vena river during June 2011 to May 2012 (Table 1 to 4) reveals that SW_2, SW_3, and SW_4 were richer in phosphates content than SW_1. The highest concentration of phosphate was during April at all the three stations except SW_1. SW_3 station had the value of 11.25 mg/l; at SW_2 value was a little less i. e. 0.8 mg/l; at SW_4 value was again lesser i. e. 9.7 mg/l and at SW_1 value was found to be only 6.7 mg/l. During November SW_2, SW_3, and SW_4 stations showed lowest phosphate level i. e. 0.52 mg/l, 0.33 mg/l and 0.45 mg/l respectively. However, lowest value for SW_1 was found during May (0.23 mg/l). Observations at the station SW_2, SW_3, and SW_4 made during May showed drastic decrease in phosphate. Over all the water of Vena river showed much fluctuations in the phosphates level during different months.

Sabata, and Nayar., (1995) showed phosphate concentrations of different rivers. The highest phosphate value was reported for Ganga at Kanpur were 7 mg/l and lowest for river Moossi were 0.2 mg/l. The phosphate level fluctuations showed by Vena river were of great range. The maximum concentration i. e. 11.25 mg/l was much higher than 7.0 mg/l. The higher concentration of phosphate can be attributed to the pollutants that were poured in Vena river. The increase in phosphate level as a result of sewage contamination was reported by Welch, (1952), and Hitchinson, (1957). The authors like Ganzalves, and Joshi., (1946), Singh, (1960) and Zafar., (1966) had noted the changes in phosphate concentrations season-wise. They reported the highest phosphate concentration level during summer followed by rainy season, and lowest during winter. However, in our observations it was reported that from September to March, though, there was slight increase in phosphate concentrations. While, it was remained at lower mark as compared to the concentrations in March, and April. April was the month of higher concentration. There was sudden decrease in phosphate concentration in May which can be attributed to the release of water from Rama Dam, Wadgaon of Nagpur district to Vena river and there was a gradual increase in June and July.

During June 2012 to May 2013 the maximum concentration was noted to be 11.3 mg/l at SW_3 station during April. All the values remained below this mark reaching 0.39 mg/l during November. Such a low concentration of phosphate in the water indicates its unpolluted nature. Sabata, and Nayar., (1995) states that usually phosphates were present in low concentration in naturally unpolluted rivers. Ganpati, (1960) on the contrary was of the opinion that in tropical waters phosphates were always present in sufficient quantities. Our observations on the Vena river do not agree with him.

10)Total Dissolved Salts (TDS)

The turbidity of water increases with suspended particles, soil particles and disposed organic matter which interfere with penetration of light. It affects the growth of microorganisms growing at depths. High values of total dissolved solids in water bodies indicate that the water is not suitable for human use. The water of Vena river under study area were used for drinking purposes. Therefore from public health point of view the Total dissolved Solids (TDS) values were important. The TDS values were shown in table 1 to 4 and table 5 to 8 for two years of study.

During the tenure of June 2011 to May 2012 (Table 1 to 4), the Vena river showed highest values of (0.919 ppm, 0.953 ppm, 0.989 ppm, and 0.953 ppm) at all the four stations were recorded in the month of June for SW_1, SW_2, SW_3, and SW_4 respectively. The lowest values were found in the month of November (0.181 ppm, 0.196ppm, 0.181 ppm and 0.197 ppm) at SW_1, SW_2, SW_3, and SW_4 respectively. From the month of November onwards increase in TDS was observed up to the month of April. During May, the values decreased because water was released from Rama Dam, Wadgaon of District Nagpur to the Vena river. In the month of June, the TDS concentration was highest which immediately was brought down to half during July by heavy rains. From July to October, the fluctuations noted were in accordance with the rainfall received during respective months. The minimum values of TDS during November were again because of the water release from Rama Dam, Wadgaon of District Nagpur.

During June 2012 to May 2013 (Table 5 to 8), highest values for all the four stations of Vena river were recorded in the month of June (0.909 ppm, 0.95 ppm, 0.978 ppm, and 0.945 ppm for SW_1, SW_2, SW_3, and SW_4 respectively). The minimum values recorded were 0.17 ppm, 0.18 ppm, 0.179 ppm, and 0.189 ppm respectively for SW_1, SW_2, SW_3, and SW_4 in November. The table 4 to 8 showed a very narrow but steady range of increase in values from November to April. During May values decrease due to water released from Rama Dam to Vena river. In June, concentration was highest which became half during July due to heavy rain. During July to October fluctuations were reported because of variations in rainfall during these months. The minimum values of TDS were noted in the November again because of water release from Rama Dam to Vena river.

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