Physico-chemical parameters of Titrigachhi Daha

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Abstract

This paper deals with the physico-chemical parameters of the Titrigachhi daha. The maximum air temperature was recorded in rainy season but the water temperature was maximum in summer and lowest in winter season. Transparency, pH, dissolved oxygen, total alkalinity, total hardness were maximum in winter season. Free carbondioxide, chloride and biological oxygen demand were maximum in summer season. The minimum transparency, total alkalinity, total hardness and chloride were recorded in rainy season. Dissolved oxygen and pH, was minimum in summer season. The minimum carbondioxide and BOD were recorded in winter season. Air temperature, water temperature, free carbondioxide, and biological oxygen demand showed positive and significant correlation with each other. Similarly, transparency, pH, dissolved oxygen, total hardness showed positive and significant correlation with each other. Total alkalinity showed positive and significant correlation with chloride.

Key words: Physico-chemical parameters, Titrigachhi Daha.

Introduction

Titrigachhi daha is an oxbow lake, located within the Koshi Tappu Wildlife Reserve. It lies between 26° 36' 11.7' N latitude and 87° 00' 53.8' E longitude. It covers about 3 ha area (Figure 1). It is rich in aquatic plants and animals. Water enters from the Koshi river in monsoon season and remains throughout the year.

Though vast number of limnological investigations have been carried out in other countries, only a few works have been done in Nepal. However, Lohman *et al*. (1988), McEachern (1994) and Ormerod *et al*. (1996) have contributed on limnological work.

Materials and Methods

Physico-chemical parameters of the Titrigachhi daha were studied for two years from July, 2002-June, 2004. The water samples were collected from three sites between 8 am and 11 pm, once in every month at regular interval. The air temperature and physico- chemical parameters of water were analysed in the field. However, the BOD test after 5 days incubation in the incubator was done in the laboratory of Post Graduate Campus, Biratnagar. Transparency, air temperature and water temperature were recorded between 12 noon and 1 p.m. Air and water temperatures were recorded by a thermometer and pH with the help of a pH meter. The transparency was measured by Secchi disc. Other parameters such as dissolved oxygen, free carbon dioxide, alkalinity, hardness, chloride, and BOD were measured according to APHA (1985).

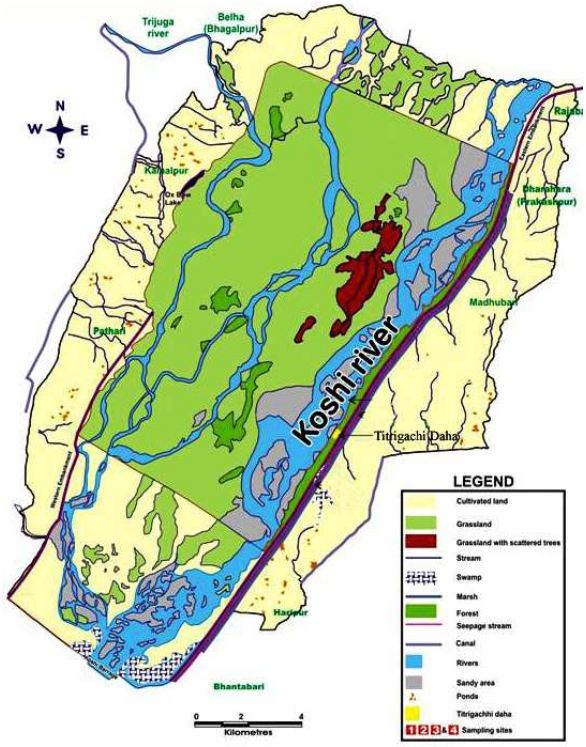

Figure 1. Map showing the location of Titrigachhi Daha in Koshi Tappu Wildlife Reserve.

Results and Discussion

Air temperature

The highest air temperature was recorded in May (Table 1 & 2). When data on monthly air temperature of whole study period (July, 2002-June, 2004) were pooled to seasonal values, the rainy season showed highest air temperature. A gradual increase in air temperature was noticed during summer months in this area. The air temperature showed positive and significant correlation with water temperature ($r = 0.9739$, $P<0.01$), free carbon dioxide ($r = 0.8488$, $P<0.01$) and with biological oxygen demand ($r = 0.6706$, $P<0.01$) (Table 3). Chakaraboty *et al*. (1959), Kant and Anand (1978) and Rawat *et al*. (1995) have also reported strong positive correlation with water temperature.

Water temperature

Generally, water temperature is influenced by air temperature and intensity of solar radiation. It was highest in summer due to high air temperature and greater light penetration (Table 4). Though air temperature was high in rainy season, water temperature comparatively lower at that time in comparison to that during summer. It might be due to high turbidity, high volume of water and greater velocity of water in rainy season. The water temperature showed positive and significant correlation with free carbon dioxide ($r = 0.9020$, $P<0.01$), biological oxygen demand ($r = 0.7416$, $P< 0.01$) but inverse and significant correlation with transparency ($r = - 0.4687$, $P < 0.05$), pH ($r= -0.7587$, $P<0.01$), dissolved oxygen ($r = - 0.8977$, $P<0.01$), total alkalinity ($r = -0.6182$, $P<0.01$) and total hardness ($r = -0.6227$, $P<0.01$) (Table 3). Bose and Gorai (1993) reported negative significant correlation between water temperature and dissolved oxygen. Munawar (1970) has observed that shallower the water body more quickly it reacts to the change in the temperature. Chakaraboty *et al*. (1959), Kant and

Anand (1978) and Rawat *et al*. (1995) also obtained strong positive significant correlation with water temperature.

Transparency

The maximum transparency was recorded in winter followed by summer and rainy season (Table 4). The maximum transparency was in winter due to lesser amount of suspended organic and inorganic materials and absence of rain. Transparency is influenced mainly by suspended organic matter (Green, 1974). Higher transparency during winter months was recorded by Rawat *et al*. (1995), and Mishra *et al*. (1999). Minimum transparency recorded in the rainy season may be due to more sand particles and colloidal soil carried by the rain water. Similar trends were observed by Singh (1995), Rawat *et al. (*1995), and Mishra *et al*. (1998). McCombie (1953) recorded that the transparency shows a direct relationship with the suspended organism and non-living particles in the water. Transparency showed positive and significant correlation with pH (r= 3869, $P<0.10$), dissolved oxygen (r = 0.5565, $P<0.01$), total alkalinity (r = 0. 5869, $P< 0.01$), total hardness (r = 0.8645, $P<0.01$), and chloride (r = 0.6616, $P<0.01$) (Table 3).

pH

The maximum water pH was recorded in winter season followed by rainy and summer season (Table 4). The maximum value of pH in winter season may be attributed to algal blooms because Hutchinson *et al*. *(*1929) and Roy (1955) have shown that the higher pH is associated with the phytoplankton maxima. The minimum pH recorded in summer may be due to low photosynthesis. The pH showed positive and significant correlation with dissolved oxygen (r = 0. 7551, $P<0.01$) and total hardness (r = 0.4263, $P < 0.0.05$) (Table 3).

Dissolved oxygen

The dissolved oxygen ranged between 8.27 mg/l ± 0.254 to 5.83 mg/l ± 0.226 during study period. Seasonally, maximum dissolved oxygen was recorded in winter followed by rainy and summer season. It may be due to low temperature. Similar observations were made by Moitra and Bhattacharya (1966). The minimum dissolved oxygen was found in summer due to high temperature, higher microbial demand for oxygen in decomposition of organic matter (Bhowmick & Singh, 1985). The dissolved oxygen showed positive and significant correlation with total alkalinity (r = 0.4866, $P<0.05$), and total hardness (r = 0.5481, $P<0.01$) but inverse and significant correlation with free carbon dioxide (r = -0. 871, $P<0.01$) and biological oxygen demand (r = -0. 8076, $P<0.01$) (Table 3).

Free Carbon dioxide

The maximum free carbon dioxide was recorded in April. It may be due to high temperature, high rate of decomposition of organic matter, low volume of water etc. Michael (1969) stated that the concentration of carbon dioxide is directly correlated with the amount and nature of biological activity in water. Free carbon dioxide of water showed positive and significant correlation with water temperature and biological oxygen demand and inverse and significant correlation with dissolved oxygen. Pahwa and Mahrotra (1966) observed inverse correlation of free CO_2 with dissolved oxygen.

Total alkalinity

The total alkalinity was maximum in January and minimum in September (Tables 1 & 2). The maximum total alkalinity was found in winter season followed by summer and rainy season (Table 4). Chakraborty *et al*. (1959) and Mishra *et al*. (1998) reported maximum total alkalinity during winter. Water bodies having alkalinity from 40 to 90 mg/l is considered as medium productive and above 90mg/l as highly productive (Jhingran, 1991). This investigation showed that the study area is suitable for aquatic production. Total alkalinity showed positive and significant correlation with total hardness and chloride (Table 3). Barat and Jha (2002) also reported positive and significant correlation of total alkalinity with hardness

Total hardness

The maximum value of total hardness was recorded in March and minimum in July (Tables 1 & 2). The maximum total hardness was recorded in winter followed by summer and rainy season (Table 4). Similar results were obtained by Misra *et al*. (1999). Minimum quantity in rainy season may be due to more dilution of water (Patralekh, 1994). Ruttner (1953) also recorded similar relationship. It showed positive and significant correlation with total alkalinity and chloride (Table 3).

Chloride

The maximum chloride was recorded in March and minimum in July during study period (Tables 1 & 2). The maximum chloride content was recorded in summer followed by winter and rainy season (Table 4). The maximum quantity recorded in summer season might be due to low volume of water, high temperature, and high rate of decomposition of organic matters. Chloride concentration indicates the presence of organic waste of animal origin (Thresh *et al*., 1949). Munawar (1970) suggested that higher concentration of chloride in water is an index of pollution of animal origin and there is a direct relation between chloride concentration and pollution level. Chloride showed positive correlation with biological oxygen demand.

Biological oxygen demand

The maximum biological oxygen demand was in May and minimum in January (Tables 1 & 2). Seasonally the maximum value of BOD was recorded in summer followed by rainy and winter season (Table 4). The maximum value obtained in summer may be due to low volume of water and high content of organic matter and minimum value obtained in winter may be due to low temperature and retarded bacterial activity for the decomposition of organic matters. Similar observations were also made by Singh (1995). Ray and Devid (1966) opined that high BOD value indicates organic waste pollution. BOD showed positive and significant correlation with air temperature, water temperature and free CO_2 and inverse and significant correlation with pH and dissolved oxygen. Ray and David (1966) also reported inverse correlation of BOD with dissolved oxygen.

Table 1. Air temperature and physico-chemical parameters of water of Titrigachhi Daha from July, 2002 - June, 2003. (mean ± SD, N = 9)

Parameters	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**March**	**Apr.**	**May**	**Jun.**
Air temp. (°C)	30.3 ±0.654	31.4 ±0.476	29.6 ±0.325	27.5 ±0.476	23.4 ±0.416	22.4 ±0.464	20.6 ±0.454	27.6 ±0.496	28.4 ±0.424	31.7 ±0.408	32.4 ±0.590	30.2 ±0.432
Water temp. (°C)	26.4 ±0.692	27.1 ±0.473	25.7 ±0.431	24.6 ±0.512	20.3 ±0.374	19.7 ±0.598	18.6 ±0.408	24.2 ±0.394	26.3 ±0.573	28.2 ±0.399	29.4 ±0.388	26.6 ±0.454
Transparency (cm)	19.2 ±0.742	23.4 ±0.700	28.3 ±0.654	29.1 ±0.687	24.2 ±0.725	28.7 ±0.635	30.8 ±0.653	32.9 ±0.710	34.5 ±0.707	21.7 ±0.748	18.4 ±0.630	17.2 ±0.775

pH	7.9 ±0.194	8.1 ±0.169	8 ±0.163	7.8 ±0.141	8 ±0.194	8.1 ±0.149	8.2 ±0.188	7.9 ±0.169	7.6 ±0.182	7.3 ±0.156	7.5 ±0.149	7.8 ±0.221
Dissolve O_2 (mg/l)	6.63 ±0.188	6.85 ±0.343	7.33 ±0.262	7.64 ±0.216	7.82 ±0.245	7.93 ±0.258	8.27 ±0.254	7.46 ±0.225	6.9 ±0.226	6.11 ±0.288	5.83 ±0.226	6.62 ±0.209
Free CO_2 (mg/l)	6.15 ±0.179	6.33 ±0.149	5.92 ±0.161	5.82 ±0.193	5.64 ±0.219	5.46 ±0.228	5.35 ±0.235	6.24 ±0.209	6.45 ±0.169	6.56 ±0.200	6.38 ±0.188	6.27 ±0.143
Total alkali. (mg/l)	73.24 ±0.671	68.45 ±0.728	66.33 ±0.683	93.55 ±1.034	87.44 ±0.768	97.78 ±0.887	112.95 ±1.210	95.43 ±0.840	93.65 ±0.735	87.86 ±0.802	82.81 ±0.819	79.52 ±0.813
Total hard-ness (mg/l)	50.34 ±0.529	61.86 ±0.428	65.95 ±0.522	67.65 ±0.518	72.34 ±0.466	75.25 ±0.417	73.74 ±0.436	74.23 ±0.473	76.34 ±0.589	65.62 ±0.407	61.54 ±0.474	59.35 ±0.404
Chloride (mg/l)	11.33 ±0.141	11.62 ±0.174	12.24 ±0.183	14.83 ±0.176	12.35 ±0.205	14.34 ±0.216	15.53 ±0.169	16.42 ±0.147	16.83 ±0.169	14.15 ±0.156	13.64 ±0.177	15.43 ±0.176
BOD (mg/l)	1.11 ±0.034	1.23 ±0.050	1.1 ±0.032	0.98 ±0.040	0.96 ±0.032	0.92 ±0.036	0.89 ±0.041	1.28 ±0.048	1.78 ±0.064	2.13 ±0.063	2.34 ±0.068	1.35 ±0.057

Table 2. Air temperature and physico-chemical parameters of water of Titrigachhi daha from July, 2003 - June, 2004. (mean ± SD, N = 9)

Parameters	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**March**	**Apr.**	**May**	**Jun.**
Air temp. (°c)	30.2 ±0.457	32.6 ±0.429	29.9 ±0.388	27.4 ±0.480	24.3 ±0.426	22.7 ±0.429	21.6 ±0.454	26.4 ±0.410	29.6 ±0.447	32.4 ±0.388	33.1 ±0.424	31.3 ±0.480
Water temp. (°c)	27.3 ±0.520	27.7 ±0.533	24.8 ±0.565	24.6 ±0.516	19.3 ±0.437	19.6 ±0.418	18.2 ±0.483	24.2 ±0.483	27.3 ±0.471	29.1 ±0.416	29.2 ±0.408	27.2 ±0.457
Transpa-rency (cm)	20.4 ±0.635	24.3 ±0.564	27.4 ±0.724	30.7 ±0.725	25.4 ±0.722	29.6 ±0.771	31.4 ±0.721	34.5 ±0.739	34.2 ±0.644	24.4 ±0.745	19.6 ±0.669	19.4 ±0.668
pH	8 ±0.156	8.1 ±0.141	8 ±0.182	7.9 ±0.221	8.2 ±0.188	8.3 ±0.176	8.4 ±0.152	8 ±0.115	7.9 ±0.188	7.4 ±0.176	7.3 ±0.163	7.8 ±0.226
Dissolve O_2 (mg/ L)	6.92 ±0.246	7.11 ±0.134	7.33 ±0.210	7.53 ±0.209	7.82 ±0.229	7.9 ±0.188	7.92 ±0.249	6.95 ±0.262	6.71 ±0.233	6.66 ±0.235	6.58 ±0.265	6.55 ±0.244
Free CO_2 (mg/l)	6.13 ±0.188	6.24 ±0.153	5.92 ±0.180	5.75 ±0.176	5.55 ±0.208	5.42 ±0.159	5.23 ±0.224	6.35 ±0.191	6.56 ±0.225	6.62 ±0.185	6.25 ±0.149	6.15 ±0.156
Total alkali. (mg/l)	72.32 ±0.816	70.52 ±0.845	68.34 ±0.758	95.47 ±0.847	90.21 ±0.954	102.46 ±1.189	115.37 ±1.191	97.85 ±0.779	95.93 ±0.871	89.79 ±0.725	85.68 ±0.761	82.47 ±0.806
Total hard-ness (mg/l)	53.89 ±0.678	63.43 ±0.589	67.67 ±0.593	68.58 ±0.585	75.73 ±0.442	77.34 ±0.464	79.22 ±0.550	81.36 ±0.496	83.45 ±0.584	61.67 ±0.595	56.46 ±0.612	55.37 ±0.442
Chloride (mg/l)	11.23 ±0.185	12.24 ±0.177	12.25 ±0.208	15.73 ±0.143	13.47 ±0.204	15.23 ±0.166	17.32 ±0.149	17.56 ±0.219	18.14 ±0.172	15.57 ±0.177	14.34 ±0.109	13.45 ±0.191
BOD (mg/l)	1.13 ±0.062	1.32 ±0.068	1.11 ±0.043	1 ±0.041	0.96 ±0.047	0.94 ±0.048	0.87 ±0.041	1.54 ±0.060	1.89 ±0.067	2.14 ±0.072	2.36 ±0.082	1.46 ±0.056

Table 3. Pearson's Correlation Coefficient (r) for air temperature and physico- chemical parameters of water of Titrigachhi daha from July, 2002 - June, 2004. (N=24, d.f. = 22); * Significant at 1% level (P<0.01), ** significant at 5% level (P<0.05), *** significant at 10% level (P<0.10); Values not marked denote non-significant correlation.

Correlation	**Water temp. (°C)**	**Transpar-ency (cm)**	**pH**	**Dissolve O_2 (mg/l)**	**Free CO_2 (mg/l)**	**Total alkali-nity (mg/l)**	**Total hard-ness (mg/l)**	**Chloride (mg/l)**	**BOD (mg/l)**
Air temp. (°C)	0.9739*	-0.5496*	-0.6927*	-0.8657*	0.8488*	-0.7234*	-0.6808*	-0.3283	0.6706*
Water temp. (°C)		-0.4687**	-0.7587*	-0.8977*	0.9020*	-0.6182*	-0.6227*	-0.1996	0.7416*
Transpa-rency (cm).			0.3869***	0.5565*	-0.2529	0.5869*	0.8645*	0.6616*	-0.2581
pH				0.7551*	-0.7260*	0.2097	0.4263**	-0.0474	-0.8574*
Dissolve O_2 (mg/l)					-0.871*	0.4866**	0.5481*	0.1262	-0.8076*

Free CO_2 (mg/l)	-0.4551**	-0.3472***	0.0285	0.7852*
Total alkalinity (mg/l)		0.6862*	0.7877*	-0.1180
Total hardness (mg/l)			0.6871*	-0.20307
Chloride (mg/l)				0.2074

Table 4. Seasonal variation of air temperature and physico-chemical parameters of water of Titrigachhi daha during first year (July, 2002 - June, 2003) and second year (July, 2002 - June, 2004) study period.

Parameters	**Year I**			**Year II**		
	Summer	**Rainy**	**Winter**	**summer**	**Rainy**	**Winter**
Air temperature (°C)	30.03	30.38	23.48	30.38	31	24
Water temperature (°C)	27.03	26.45	20.8	27.45	26.75	20.43
Transparency (cm).	26.88	22.03	28.2	28.18	22.88	29.28
pH	7.58	7.95	8.03	7.65	7.98	8.2
Dissolved O_2 (mg/l)	6.58	6.86	7.92	6.73	6.98	7.79
Free CO_2 (mg/l)	6.41	6.17	5.57	6.45	6.11	5.49
Total alkalinity (mg/l)	89.94	71.89	97.93	92.31	73.41	100.88
Total hardness (mg/l)	69.43	59.38	72.25	70.74	60.09	75.22
Chloride (mg/l)	15.26	12.66	14.26	16.40	12.2	15.44
BOD (mg/l)	1.88	1.20	0.94	1.98	1.26	0.94

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