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Water quality status of Lake Pichhola, Udaipur, Rajasthan

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Abstract
The study has been carried out to investigate the impact of organic loadings on water quality in relation to fish and fisheries of Lake Pichhola. The physico-chemical parameters of water have been studied at two locations for a period of four months from February, 2010 to May, 2010. On the basis of physico-chemical characteristics, Lake Pichhola is nutrient rich, alkaline and hard water body. The water quality indicated the suitability of Lake Pichhola for fishery purpose.
The orthophosphate is recorded in very high amount (0.05-1.25 mg/l) which already crossed the critical level. The lake Pichhola with high EC and TDS could be considered eutrophic. The water quality of Lake Pichhola is highly polluted. Attempt has been made to relate water quality with the observed waste water discharge in this lake.
The overall results from the present investigation indicate that this water body is rapidly under going through process of eutrophication advancement. Therefore, suitable restoration programme should be initiated for the sustained use of this lake, as the lake attracts thousands of tourists from domestic and international level every year.

Keywords: Water quality, eutrophication, physico-chemical parameters

1. Introduction

Rapid development, increase in population of the metro cities and urbanization of their suburbs have resulted in the manifold increase in environmental pollution. The most affected are the water bodies which become highly polluted by addition of foreign materials such as plant and animal matter, and domestic sewage and industrial effluents. Dumping of solid wastes and indiscriminate encroachments also add to the chaos. The diminishing quality of water seriously delimits its use for human consumption and for aquatic life. Therefore, the continuous and periodical monitoring of water quality is necessary so that appropriate preventive and remedial measures can be undertaken. The physico-chemical characteristics of an aquatic body not only reflect the type and diversity of aquatic biota but also the water quality and pollution.

The pollution of water is a serious problem today because all water resources have reached to a point of crises due to unplanned urbanization and industrialization (Singh *et al.*, 2002) [24]. It is recognized that mankind, animals and plants, all face a variety of problems arising from various kinds of environmental pollution (Petak,1980) [15].

Human activities can accelerate the rate at which nutrients enter ecosystem. Runoff from agriculture and development, pollution from septic systems and sewers, and other human-related activities increase the flux of both inorganic nutrients and organic substances into aquatic ecosystems. Elevated atmospheric compounds of nitrogen can increase nitrogen availability. Phosphorus is often regarded as the main culprit in cases of eutrophication in lakes subjected to point source pollution from sewage. The concentration of algae and the trophic state of lakes correspond well to phosphorus levels in water. Humankind has increased the rate of phosphorus cycling on Earth by four times, mainly due to agricultural fertilizer production and application. Between 1950 and 1995; 600,000,000 tones of phosphorus were applied to Earth's surface, primarily on croplands (Carpenter *et al*.1998) [3]. Controls of point sources of phosphorus have resulted in rapid control of eutrophication, mainly due to policy changes.

Materials and Methods

Water quality parameters such as water temperature and air temperature around the lake, pH, dissolved oxygen were determined in the field itself, while the measurement of electrical conductivity (EC)/Total dissolved solid (TDS), orthophosphate, free carbon dioxide, total hardness, carbonate alkalinity, bicarbonate alkalinity and total alkalinity were analyzed in the laboratory of the Department of Aquaculture, College of Fisheries using standard methods of Trivedy and Goel (1986) [28] and APHA (2005) [2].

Sampling Stations

Sampling for estimating physico-chemical as well as bacteriological parameters was conducted at two fixed stations *viz.*A and B of Lake Pichhola. Station "A" was located at Gangour gat where excess organic load enters into the lake and Station "B" was located at just opposite side of doodh talai (Pal site) in the main Pichhola Lake where relatively clear and comparatively deeper water was available. At each station 3 surface water samples were randomly collected at fifteen days interval up to 4 months (February, 20210 to May, 2010).

Sample Collection

During the study period, surface water samples were collected using plastic bottles of 1 liter for the analysis of physico-chemical parameters of water quality.

Review of Literature

In recent years considerable amount of work has been carried out in various lakes and estuaries and a good amount of information is available on the physical, chemical and biological aspects of water and bottom sediment. Studies on water quality of freshwater lakes have been undertaken by a number of scientists (Haniffa and Pandian, 1978 [9], Mohan, 1987 [13], Zutshi and Khan, 1988 [31], Vijay Kumar, 1999 [30], Radhika *et al.* 2004 [17]).

Carpenter *et al*. (1998) [3] and Howarth *et al*. (2000) [10] reported that nutrient loading to aquatic ecosystem typically results in rapid increases in the rate of biological production and significant reduction in water column transparency and can create a wide range of undesirable water quality changes. Moss *et al*. (1989) [14], Smith *et al*. (1997) [25] and Ko'hler and Gelbrecht (1998) [11] clearly demonstrated eutrophication in many rivers worldwide. Donabaum *et al*. (2004) [5] reported that suspended algal biovolume in the Old Danute River (Austria) responded sensitively to changes in total phosphorus concentration, even though this response was hysteretic.

Mathivanan *et al*. (2004) [12] studied the assessment of water quality of river Cauvery at Mettur, Salem district, Tamil Nadu in relation to population. Prabhu *et al.* (2009) [16] studied on the physico-chemical parameters of sugar mill effluents.

Results and Discussions

Notable fluctuations were found in air and water temperature at the two sampling stations during this study. Air temperature ranged from 20.9 to 34.7 ºC while surface water temperature varied from 21.9 to 31.5 ºC (Table 1.1 and Fig. 1.1- 1.2). Shekhawat (1991) [23] reported that the closer association of air and water temperature is found in the small sized water body. Similar relationship was reported by Gupta (1991) [7], Solomon (1994) [26], Rajkumar (2005) [18] and Sarang (2001 [20], 2007 [21]). The temperature is of biological interest too as it affects the distribution of animals through the thermal stratification of the water column. In the present study, the closer association of air and water temperature is understandable in the light of shallowness of this water body.

In general, the water of Lake Pichhola remained alkaline throughout the study period. The minimum and maximum range of pH values were between7.4 to 8.5. However, the mean pH value of lake was found to be 8.13 at station A and 8.24 at station B during the study period which is moderately alkaline and supports fairly good aquatic productivity (Table 1.1 and Fig. 3). Such alkaline pH has also been reported earlier by Gupta (1991) [7]. Ujjania (2003) [29] also found alkaline water in the three water bodies of Southern Rajasthan.

The total ionic load in water is evident from the values of electrical conductance. The EC value fluctuated from 0.41 to 0.67 mS/cm at station A. Whereas at station B from 0.36 to 0.60 mS/cm (Table 1.1 and Fig. 4). Shekhawat (1991) [23] has reported the EC values of 391.87 μ mhos cm^{-1} in Rameshwar anicut. Sarang (2001) [20] has observed the EC values of 765 μScm^{-1} from Jaisamand Lake during April-August. Rajkumar (2005) [18] reported EC values of 630 μScm^{-1} from Daya reservoir.

Dissolved Oxygen in water is of great importance to all aquatic organisms and is considered to be the factor that reflects the biological activity taking place in a water body and determines the biological changes. The minimum and maximum range of dissolved oxygen contents of surface water oscillated between 5.3 to 8.4 mg/l whereas the mean value of dissolved oxygen were 6.98 and 7.50 mg/l respectively (Tables 1.1and 1.2 and Fig. 5). Radhika *et al.* (2004) [17] reported a fluctuated value for dissolved oxygen in Vellayani lake from 4.83 to 7.11 mg/L; 4.11 to 6.81 mg/l; 4.71 to 6.60 mg/l during pre-monsoon, monsoon and post monsoon respectively.

During the study period, the free carbon dioxide in Lake Pichhola was totally absent at both the sampling stations in all the water samples.

Carbonate alkalinity was always present whenever free carbondioxide was lacking. Carbonate alkalinity varied from 34.0 to 58.0 mg/l in surface water at station A. Such variations in carbonate alkalinity at station B were observed from 20.0 to 34.0 mg/l. At station A bicarbonate alkalinity varied from 152.0 to 192.0 mg/l in surface water. Such variations in bicarbonate alkalinity at station B were observed from 144.0 to 164.0 mg/l. As is it evident from Tables 1.1 and 1.2 and Figures 6 to 8. Total alkalinity for station A and station B varied between 192.0 to 248.0 mg/l and 168.0 to 198.0 mg/l with a mean value 216.41 and 180.5mg/l in surface waters respectively. For Indian condition Alikunhi (1957) [1] and David *et al.* (1969) [4] opined that highly productive water have bicarbonate alkalinity above 100 mg/l. Following this criteria obviously Lake Pichhola is more productive (Schaperclaus, 1993) [22].

The value of total hardness oscillated between 160.0 to 224.0 mg/l at station A and from 150.0 to 196.0 mg/l at station B (Tables 1.1 and 1.2and Fig. 9). Hardness of water is mainly due to the presence of calcium and magnesium ions, and is an important indicator of the toxic effect of poisonous elements (Tiwari, 2001) [27].

In the present study, the total dissolved solids (TDS) at station A varied between 262.40 to 428.80 mg/l with a mean value of 339.20 mg/l and at station B it ranged between 230.40 to 384.0 mg/l with a mean value of 314.10 mg/l (Tables 1.1 and 1.2and Fig.10). The Shekhawat (1991) [23] reported total dissolved solids value of 59.8 ppm at Rameshwar anicut, Udaipur. Rajkumar (2005) [18] indicated TDS value 406.21 mg/l in Daya reservior, Udaipur.

Barring a few instances, fairly good amount of orthophosphate was recorded at both the stations of Pichhola. At station A orthophosphate fluctuated from 0.10 to 1.25 mg/l with a mean value of 0.54 (Tables 1.1 and 1.2and Fig.11). At station B this ingredient fluctuated from 0.05 to 0.95 mg/l with a mean value of 0.40 mg/l. Shekhawat (1991) [23] observed a higher value of phosphate in Rameshwar anicut, Udaipur. In other reservoirs around Udaipur the orthophosphate content has been reported to be 585 mg/m^3 in the lake Jaisamand (Rao, 1984) [19] and 685 mg/m^3 in a highly eutrophic lake Rangsagar in Udaipur city (Gopalarao, 1987) [6]. In a reservoir Khandia (Jhalawar, Rajasthan) Gupta (1988) [8] reported the phosphate value of 93 mg/m^3 which is fairly low.

Table 1.1: Minimum-Maximum range, mean values and statistical standard deviation of Physico-chemical parameters of surface water samples of Lake Pichhola, Udaipur

S No.	Parameters	Minimum-Maximum range	Mean Value		S D +		t Value
			Station A	Station B	Station A	Station B	
1	Air Temperature ºC	20.9 - 34.7	27.04	26.59	4.98	4.84	0.32 NS
2	Water Temperature ºC	21.9 - 31.5	26.45	25.99	3.32	3.30	0.48 NS
3	pH	7.4 - 8.5	8.13	8.24	0.30	0.15	1.48 NS
4	EC (mS/cm)	0.38 – 0.67	0.53	0.49	0.08	0.07	1.79 NS
5	Dissolved Oxygen (mg/l)	5.3 – 8.4	6.98	7.50	0.90	0.52	2.44*
6	Carbonate alkalinity (mg/l)	20 – 58	48.58	27.58	7.58	4.25	11.82**
7	Bicarbonate alkalinity (mg/l)	146 - 192	167.91	152.83	12.41	6.09	5.34**
8	Total Alkalinity (mg/l)	168 – 248	216.41	180.50	18.39	9.36	8.52**
9	Total Hardness (mg/l)	150 – 224	186.91	174.08	19.89	13.81	2.60*
10	Orthophosphate (mg/l)	0.05 – 1.25	0.53	0.40	0.40	0.28	1.32 NS
11	Total Dissolved Solids (mg/l)	230.4 – 428.8	339.20	314.13	51.71	45.13	1.80 NS
12	Free CO2 (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil

NS - Non Significant
* - Significant at 5% level of significance
** - Significant at 1% level of significance

Table 1.2: Mean values of Physico-chemical parameters of surface water samples of Lake Pichhola, Udaipur

S. No.	Parameters	Mean value
1	Air Temperature ºC	26.80
2	Water Temperature ºC	26.15
3	pH	8.15
4	Electrical Conductivity (mS/cm)	0.51
5	Dissolved Oxygen (mg/l)	7.2
6	Carbonate alkalinity (mg/l)	38.08
7	Bicarbonate alkalinity (mg/l)	99.22
8	Total Alkalinity (mg/l)	198.50
9	Total Hardness (mg/l)	180.50
10	Orthophosphate (mg/l)	0.47
11	Total Dissolved Solids (mg/l)	326.65
12	Free CO2 (mg/l)	Nil

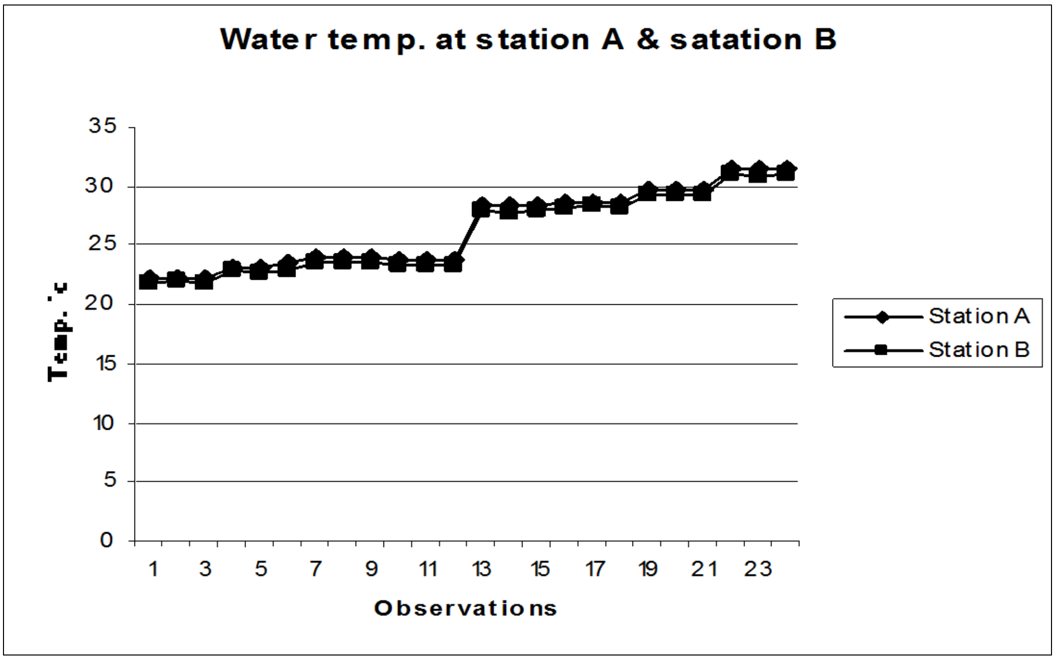
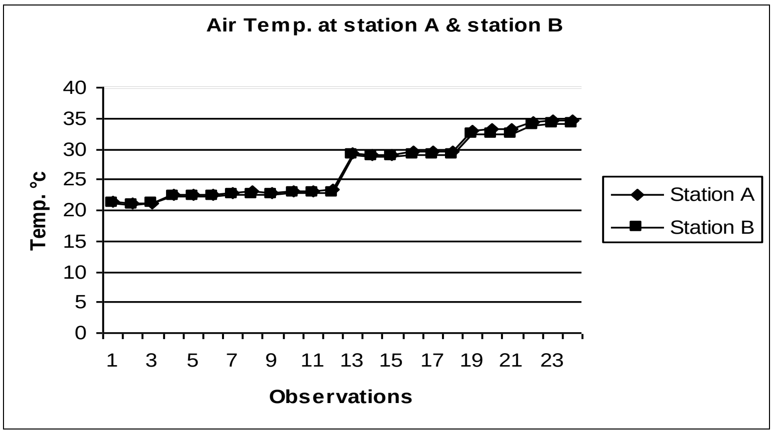


Fig 1:



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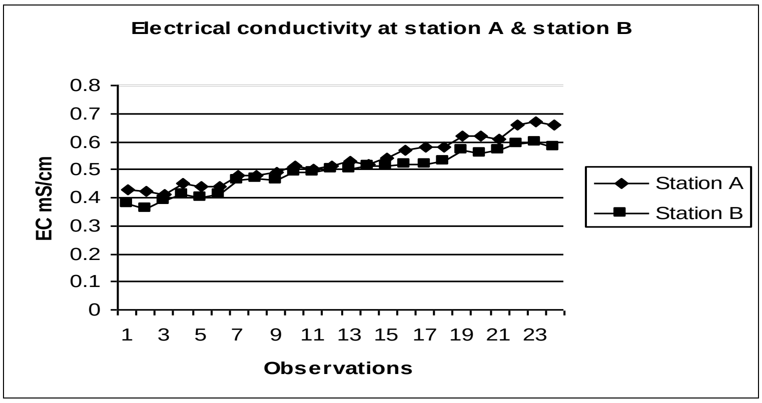

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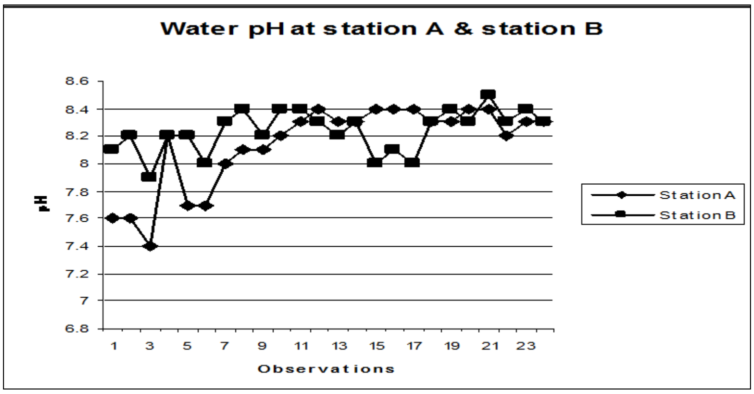

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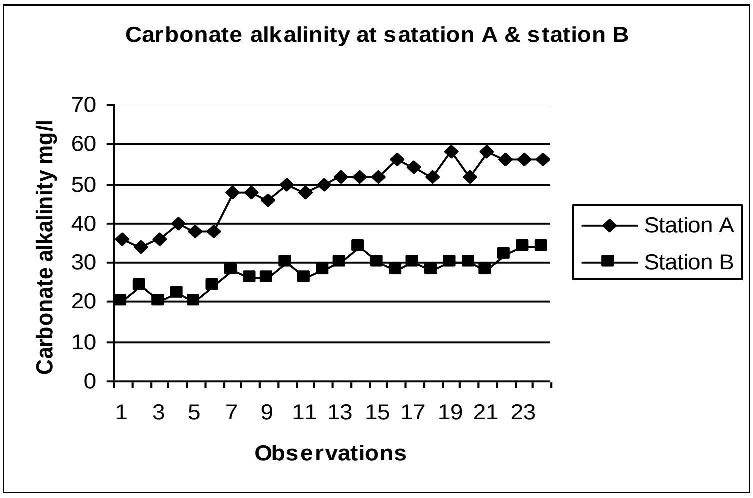

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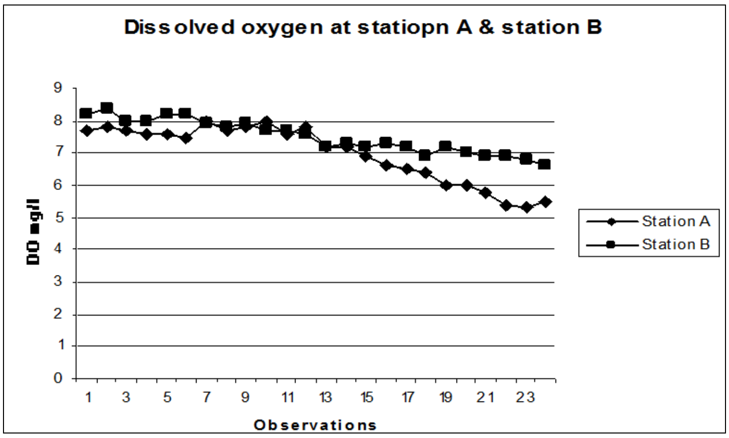

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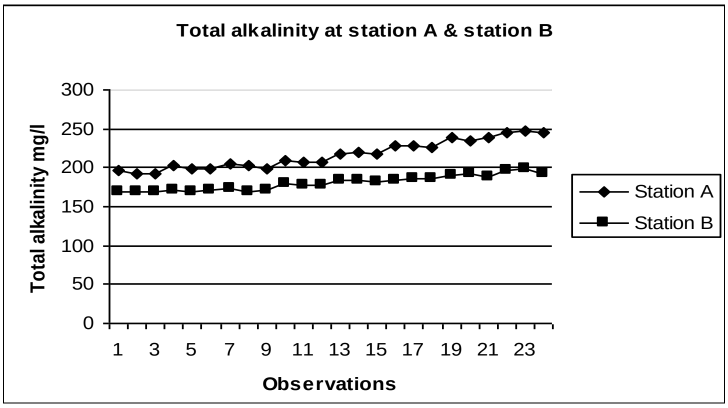

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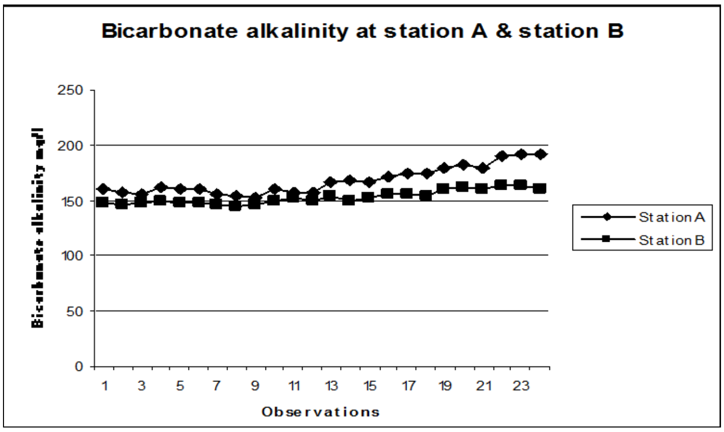

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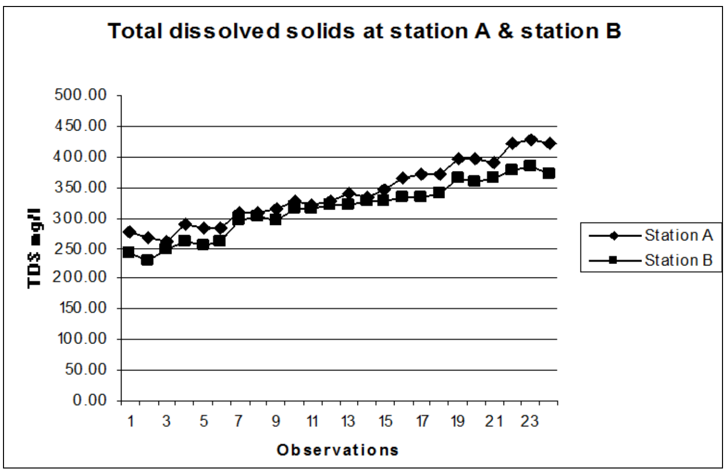

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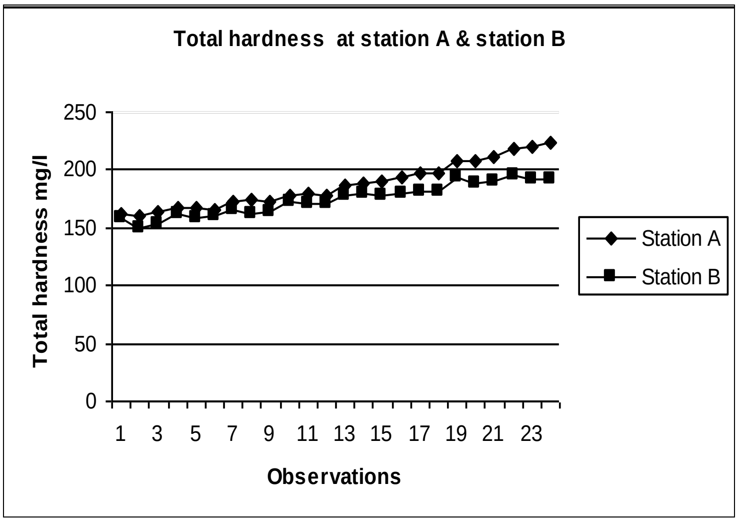

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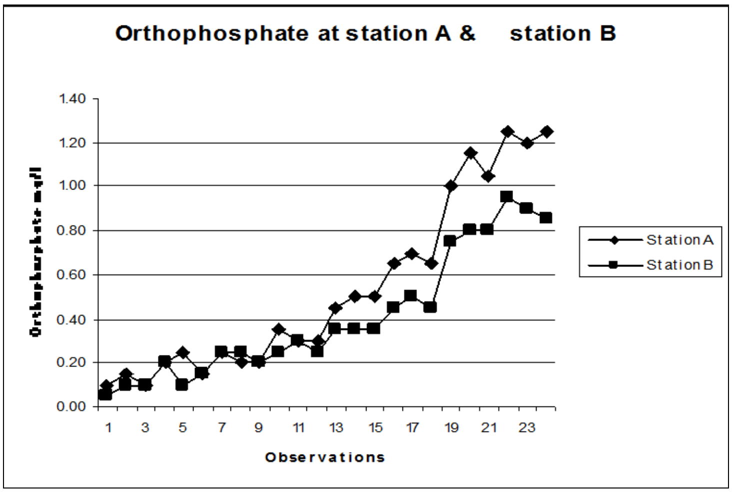

Fig 11:

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