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RESEARCH ARTICLE

LIMNOLOGICAL PROFILE OF TALPAD POND IN THE SUB-TROPICAL AREA OF UDHAMPUR DISTRICT OF J&K.

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Abstract

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Water quality is the basic criteria for its use and disuse for human consumption in numerous fields. Not only this, water quality also determines the type of flora and fauna that a water body supports. Thus the water quality determines the fate of any water body which can be estimated by studying the various physico-chemical parameters. These physico-chemical parameters are based on the chemical reactions that take place in the nature under natural conditions. 14 abiotic parameters in this water bodies viz-a-viz depth, air temperature, water temperature, pH, Dissolved Oxygen (DO), free Carbon-dioxide (FCO_2), Carbonates, Bicarbonates, Calcium, Magnesium, Chlorides, Phosphates, Sulphates and Nitrates on monthly basis. The water samples were collected, studied and analyzed from the study sites during January 2015 to December 2015. Pearson correlation was calculated for these parameters which showed their various relations among themselves.

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Introduction:-

Limnology is the complete study of the fresh water bodies including its quality and quantity as well as physical and chemical status. Fresh water is the life line of the majority of organisms including human beings. Lakes and ponds are the natural sources that provide water for various domestic as well as industrial purposes. Pond ecosystem is a complete and suitable ecosystem to study the various phenomenons occurring in an aquatic ecosystem, according to its life time and location. They provide a suitable habitat for innumerable organisms as well. Inspite of their great importance they are being deteriorated by various anthropogenic activities that is leading to their extinction. Thus a loss of habitat for various organisms and eliminating number of organisms from the food chain disturbs the ecological balance. Increased anthropogenic activities have led to decrease in the water quality, harbouring a great number of pathogenic strains causing diseases like cholera, dysentery, typhoid and many more. This raise the need of enhanced monitoring and taking various remedial steps that ultimately replenishes the water quality. These remedial steps to control the pollution directly depends on the type of pollution which can be sort out only after studying the basic physico-chemical parameters. Abiotic characteristics of the water body reflect its status and the nutrients present in it which have direct influence on the aquatic organisms inhabiting that water body. These parameters are greatly influenced by the topography, source of water, vegetation, type of catchment area and the extent of anthropogenic interference. (Shinde *et al*., 2011)

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Material and methods:-

(Talpad pond) : This pond is located at about 25 km away from the main Udhampur city in the vicinity of a village with some shops and a school nearby and the agricultural fields along the road. It is a small domestic pond used for cattle bathing and drinking purpose. It has the input of agricultural waste including organic or inorganic waste as well as waste from the surrounding which help in profuse growth of organism, both phytoplankton and zooplankton. The bottom is very muddy and the water on little agitation becomes turbid. The geographical position of this station on map is 32^0 51′38″ N (latitude), 75^0 11′40″ E (Longitude) and at an elevation of 675 m from sea level. Water samples were collected on the monthly basis in glass bottles and were carried to the laboratory for further analysis except Dissolved oxygen, Carbon dioxide, Carbonates and Bicarbonates which were analysed on the spot. Water samples were analysed for 14 abiotic parameters in this water bodies viz-a-viz depth, air temperature, water temperature, pH, Dissolved Oxygen (DO), free Carbon-dioxide (FCO_2), Carbonates, Bicarbonates, Calcium, Magnesium, Chlorides, Phosphates, Sulphates and Nitrates on monthly basis. The water samples were collected, studied and analyzed from the study sites during January 2015 to December 2015. The data were analyzed and compared statistically.

Results and Discussion:-

Depth: Depth of any water source is important to get an overview of the limnological conditions existing in it(Sharma, 2015) .Depth of any water body greatly affects the limno-biological parameters of water (Welch, 1952; Garg *et al.*, 2009).

Monthly variations in the depth were well recorded for the station which is shown in Table 1. The minimum depth recorded at the station was 23 cm (June) and the maximum depth recorded was 90 cm (Aug-Sept.) with mean average depth as 60.42 ± 21.51 for this station.The reasons for the minimum depth recorded in the summers are increased rate of evaporation due to high temperature. (Zutshi, 1992; Sharma, 1999; Gupta *et al.*,, 2015) and Less rain fall. The reason for maximum depth in the monsoons and post-monsoons (July-Sept) may be heavy rainfall. (Sharma, 2013) and heavy influx of water from the catchment areas due to floods. (Sawhney, 2004; Chowdhary, 2011; Sharma, 2013; Gupta *et al.*,, 2015).

Atmospheric temperature:-

Atmospheric temperature is an important factor regulating the physiology of any water body. Well marked seasonal variation of atmospheric temperature was recorded. Air temperature recorded at the station (Talpad pond) showed maxima of 34^0 C (June) in summers while minima of 19.5^0 C (Nov) in winters and the mean temperature remained around 27.08 ± 1.08 º C. (Table 1).

Maximum air temperature in summers is a well recorded phenomenon for the sub-tropical areas (Manjare *et al.*, 2010; Sharma *et al.*, 2014) Presently also maximum temperature in summers season may be attributed to the longer day length in this region and clear atmosphere (Ahmed, 2004; Sharma *et al.,* 2009; Shinde *et al.* , 2011; Thirupathiah *et al.,* 2012).

On the contrary the minima in winters may be attributed to shorter day length which give lesser incident rays to warm up the air to high temperature and also the increased condensation of water vapours (Fasihuddin and Kumari, 1990; Anita *et al.*, 2005; Shinde *et al.*, 2011).

Water temperature:-

Water temperature is governing parameter as it basically regulates the various physiological processes in any aquatic system. Fluctuations in water temperature were recorded to be in close co-ordinance with air temperature (Thirupathaiah *et al.,* 2012; Sharma *et al.*, 2013; Gupta *et al*. 2015)

At the station the maxima of water temperature was 26º C (June) and the minima was observed as 17º C (Nov) and the average temperature remained around 20.41 ± 3.03º C. (Table 1) Maxima of water temperature in summers may be attributed to the following reasons are increased photoperiod. (Kour, 2002; Akhtar, 2003; Sharma *et al.*, 2009 ; Sharma *et al.*,, 2014) and clear atmosphere with greater insolation of sun rays. (Ahmed, 2004; Thirupathiah *et al.*, 2012). Also increased heating up of water due to less water depth. (Anita *et al.*, 2005, Jawale *et al.*, 2009). Winter minima can be attributed to short photoperiod and thus low water temperature. (Anita *et al.* , 2005; Shinde *et al.* , 2011) and natural vegetation (Lashari *et al.*, 2009)

pH : pH is the negative log of Hydrogen ion concentration. pH governs the solubility of nutrients and regulates most of biological and physiology reaction in a water system. pH presently recorded showed well marked variability at the station, the average pH remained 7.21 ± 0.37 with maximum 7.90 (Jan) and minimum 6.8 (June –Sept). (Table 1). Over all pH showed declining pattern from winters to summers. The reason for low pH during summer and monsoon season can be high temperature which leads to the increased decomposition of organic matter leading to increase in content of FCO_2. This increased FCO_2 brings the pH towards acidic (Lashari *et al.*, 2009; Mohan *et al.*, 2013; Annalakshmi and Amsath, 2012, Mehta *et al., 2016*). Maxima of pH in winters may be due to less organic matter deposited and decreased rate of decomposition due to low microbial activity (Venkatesharaju *et al.*, 2010; Patel and Parikh, 2013).

Dissolved Oxygen (DO):

DO is one of the most important factors on which the physiology of any water body depends**.** Amount of DO in water has direct relation with the abundance of flora and fauna of the water body. The DO content depends on various aspects as temperature, chlorophyll content of the phytoplankton, density of the organisms present in it etc. In present study Dissolved oxygen (DO) showed well marked seasonal fluctuations, the maximum DO was observed in February (8 mg/litre) while minimum DO was observed in June (1.6 mg/litre) and the average DO remained as 3.83 ± 2.43 mg/litre. (Table 1) A usual pattern of DO i.e. high in winters and low in summers was observed at the station.

Low DO in summers may be attributed to low solubility of DO at high temperature in summers (Dutta and Patra, 2013; Gupta *et al.*,, 2015) and increased load of organic matter and more consumption of DO for decomposition (Butcher *et al.*, 1937; Thirupathaiah *et al.*, 2012) while increased level of DO in winters may be due to inverse relation of DO solubility and temperature (Jhingaran, 1975; Khalaf and MacDonald, 1975).

Free carbon-dioxide (FCO_2):

FCO_2 found in water bodies is freely available for the purpose of photosynthesis of aquatic flora. Presently studied water body showed well marked variability in FCO_2 concentration although showing a negative correlation with the carbonates. The peak of FCO_2 was seen in summers while the least amount was recorded during winters with mean value of 6.33 ± 5.24 mg/litre. Maximum value was calculated as 20 mg/ litre (June) and minimum was 6 mg/litre (Jan). (Table 1) Maximum values of FCO_2 in summers could be due to increased rate of decomposition of organic matter due to high temperature (Harney *et al.*, 2013) and increased rate of respiration of aquatic fauna (Singh, 1999; Saksena, 2008 and Harney *et al.*, 2013). Also FCO_2 is inversely related to DO (Goldman and Horne, 1983).

Abrupt rise in the FCO_2 level in June could be due to increased rate of decomposition due to increment in temperature and lowering of depth (Abdel-Satar and Elewa, 2001; Harney *et al.*, 2013). Further, increase in monsoon could be due to influx from catchment areas. (Harney *et al.*, 2013) and due to high rate of decomposition of organic matter by bacteria (Pandey *et al.*, 1999; Laishram and Dey, 2014). Low level of FCO_2 was seen during winters which may be due to the use of available amount in photosynthetic process (Jacklin and Balasingh, 2011)

Carbonates ($CO_3^{2-)}$):-

Carbonates are the most important polymorphic anions in fresh waters and calcium carbonate is the most common form available and is commonly found when FCO_2 is absent. In the present study, complete absence of Carbonates was observed at the station. Reasons for the complete absence of Carbonates in most of the months are inverse relation of Free Carbon-dioxide and Carbonates (Sehgal, 1980; Ahmed, 2004). Presence of FCO_2 in all the months which lead to dissolution of carbonates into bicarbonates (Sehgal, 1980; Sharma *et al.*, 2009).

Bicarbonates (HCO_3^-):-

Bicarbonates act as buffer system to maintain pH of water (Golterman, 1975). T7he maximum value of bicarbonates was 68.32 mg/litre (Jan) and the minimum value was 36.6 mg/litre (Aug) with mean average as 51.98 ± 9.86 mg/litre. (Table 1) High values of Bicarbonates in winters may be due to direct relation with alkanity (Manjare *et al.*, 2010) and reduction in the photosynthetic rate thus causing less bicarbonates dissociation and utilization of carbon source in winters (Sharma *et al.*, 2009; Sharma, 2015).

Alkanity decrease during monsoons may be due to less activity of microbes and decreased rate of cycling (Lashari *et al.*, 2009). Secondly the dilution of water due to rains and floods contribute to it (Kant and Raina, 1990; Kaul, 2000).

Calcium Ca^{2+}:-

Calcium is an important nutrient of aquatic systems. Present study showed a well marked seasonal variations for Ca^{2+} during the study period. Station showed the maximum value for Ca^{2+} as 42.05 mg/ litre (Nov – Dec) and the minima as 4.21 mg/litre (April). The average concentration remained as 21.44 ± 12.27 mg/litre. (Table 1). The maxima for Ca^{2+} was recorded in winters and this may be due to high Calcium values are direct attribute of Calcium rocks present in the stream (Singh and Sharma, 2016) and Increase in solubility due to decrease in temperature (Welch, 1952).

The minima was observed in monsoons at station due to dilution of water because of frequent rains (Gadhia *et al.*, 2012).Decreased value in summers may be due to increased use of Ca^{2+} by the zooplankton for their growth (Patel and Patel, 2013).

Magnesium (Mg^{2+}):-

Magnesium is often associated with the photosynthetic rate as it forms the central ring of the chlorophyll (Das *et al.*, 2014). Present study of the station revealed that, the maximum value of Mg^{2+} recorded was 233.46 mg/litre (Feb) and the minimum was 65.7 mg/litre (July). The mean average concentration remained as 140.14±53.74 mg/liter. (Table 1) The maxima of Mg^{2+} during winter may be attributed to increased solubility at low temperature for Mg^{2+} (Abdel-Satar, 2005; Choudhary, 2011) and slow rate of photosynthesis, so less use of Mg^{2+} (Das *et al.*, 2014). Minima of Mg^{2+} was seen during monsoons which may be because of dilution of water due to heavy rains (Moustafa *et al.*, 2010)

Chlorides (Cl^-):-

Values of Chloride in water source determines its utility. High values of Chlorides in water make it unfit for human consumption. From the present study, it is observed that Chloride concentration showed seasonal variability showing maximum value of chloride as 25mg/litre for four different months (March, April, June, July) while the minima was recorded as 11 mg/litre (Jan) with an average of 19.58 ± 4.56 mg/litre. (Table 1) The summer maxima was observed in this lentic station and the reason for this might be low water level due to high rate of evaporation, leaving behind the salts (Mehta *et al.*,2016) and increased rate of decomposition of organic matter.

Phosphates (PO_4^{2-}):-

Phosphorous is a limiting factor for the growth of Phytoplankton which regulates their growth in the presence of Nitrogen. It occurs in low to moderate concentrations and is non-toxic to living organisms but can cause eutrophication in higher concentration leading to depletion of oxygen in the water bodies. Presently studied data showed comparably higher values during summer and low values during monsoon. At the station the maximum value recorded was 0.4930 mg/ litre (June) and minimum recorded as 0.0017 mg/litre (Jan). The mean average remained as 0.2224 ± 0.2660 mg/litre. (Table 1) The maximum value of Phosphates in summer could be due to more decomposition rate of organic matter (Ahwange *et al.*, 2012) and increased evaporation so, concentration of Phosphates increased during summers (Garg *et al.*,2009). Similar findings have been put forth by Abdel-Satar, 2005; Jacklin and Balasingh, 2011. Low values in winters could be attributed to negative correlation to water temperature (Shinde *et al.*, 2011) and negative correlation between pH and solubility of Phosphates (Abdel-Satasr, 2005).

Sulphates (SO_4^{2-}):-

This is an important micronutrient required for the growth of phytoplankton and deficiency of this ion can limit the growth. Seasonal variation in the presence of SO_4^{2-} was observed. The maximum value of SO_4^{2-} was observed as 0.0873 mg/litre (Jan) and the minimum was observed as 0.0017 mg/litre (July). The average calculated remained as 0.0260 ± 0.0250 mg/litre. (Table 1).

The maximum value was recorded in January. This could be due to more content of organic and inorganic sulphur compounds from the agricultural run-off. In addition to this use of detergents and soaps by local dwellers, dumping of garbage, sewage discharge i.e. anthropogenic stress at and around the stations at the time of sampling. (Gasby *et al.*, 1997). Monsoon minima was recorded which is due to dilution of water due to heavy rains and low rate of decomposition.

Nitrates (NO_3^-):-

Nitrate and its compounds are the most important nutrients required for the various biological activities of phytoplankton like growth, reproduction etc. Well marked seasonal variation was observed in nitrate concentration.

Station almost showed a static record of Nitrate throughout the study period with only fractional difference in the seasons. The mean average remained as 0.5727 ± 0.0004 mg/litre. Maxima was recorded in the month of Sept (0.5740 mg/ litre) and minima in the month of Jan and Feb (0.5724 mg/litre). (Table 1) Maxima at station at the end of the monsoons may be accumulation of released nitrates due to decomposition of organic matter.

Correlation For Physico-Chemical Parameters:-

Two tailed Pearson–correlation has been calculated for the study station which gave significant values for different parameters. **Statistical analysis using Pearson–Correlation for this station was calculated as the star value shows the significance value (* = significant at 0.05 value and ** = significant at 0.01 value).**

Depth: Statistical analysis for depth using Pearson correlation revealed that depth is negatively correlated with the air and water temperature (r = -.756**, r = -.300 respectively) at significance level of 0.01 as temperature decrease with increase in depth. Similar findings were recorded by Sharma, 2015. (Table- 2)

pH: pH showed negative correlation with the air and water temperature (r = -.307, r = -.748** respectively) as increased temperature, release more carbon- dioxide, lowering the pH (Goldman and Horne, 1983). (Table- 2)

Dissolved oxygen: DO showed a negative correlation with the temperature as DO decrease with increase with temperature due to decreased solubility of gases at high temperature (Abdel-Satar, 2005) while positive correlation with depth and pH. (Table-2)

FCO_2: FCO_2 showed a positive correlation for air and water temperature as increased temperature increase the decomposition rate. (Ishaq and Khan, 2013), (r = .635*, r = .559 respectively) significant at 0.05, and showed a negative correlation with depth, pH and DO. (Table- 2)

Bicarbonates: HCO_3^- showed negative correlation with water temperature, depth and free carbon-dioxide and positive correlation with DO and pH. (Table- 2)

Calcium: Calcium showed a negative correlation with the air and water temperature, pH and free carbon-dioxide, similar to the findings of Shiddamallayya and Pratima, 2008 in their study area. (Table- 2)

Magnesium: Magnesium showed a significant positive correlation with pH (r = .647*) at 0.05 level while showed a negative correlation with air and water temperature, depth and free carbon-dioxide. Magnesium can form salts with Carbonates and Bicarbonates and increase the pH and decrease the FCO_2 content (Naresh and Nama, 1991). (Table- 2)

Chloride: Chlorides showed a negative correlation with depth, pH, DO, Bicarbonates, Calcium, Magnesium and the value is significant for depth at 0.01 (r = -.712**) while positively correlated with air and water temperature and significantly correlated with free carbon- dioxide at 0.01 significant value (r = .791**). (Table- 2)

Phosphates: Phosphates showed a negative correlation with air and water temperature, pH, DO, similar to Sharma, 2015. Phosphates are negatively significant for air temperature at 0.01significant level (r = -.789**) while positively correlated with depth and Calcium. (Table- 2)

Sulphates: Sulphates showed a negative correlation with water temperature, depth, free carbon-dioxide, Bicarbonates, Phosphates and a significant correlation with Calcium at significance level of 0.05 (r = -.656*).(Table- 2)

Nitrates: Nitrates showed a positive correlation with depth, Calcium and Phosphates. Similar results were found by Sharma, 2015, while negative correlation with air and water temperature, pH, DO, $FCO_{2,}$ Bi-carbonates, Magnesium, Chlorides and Phosphates. (Table- 2)

Table 1:- Showing seasonal variation in Physico-chemical parameters of Station-1 (Talpad pond) from Jan – Dec, 2015.

	Air temp.	Water temp.	Depth	pH	DO	FCO_2	CO_3^-	HCO_3^{2-}	Ca^{2+}	Mg2+	Cl^-	PO_4^{2-}	SO_4^{2-}	NO_3^-
Air temp														
Water tem	.651*													
Depth	-.756**	-.300												
pH	-.307	-.748**	.019											
DO	-.311	-.565	.287	.477										
FCO_2	.635*	.559	-.763**	-.454	-.753**									
CO_3^-	-	-	-	-	-	-								
HCO_3^{2-}	.036	-.088	-.364	.379	.197	-.080								
Ca^{2+}	-.413	-.047	.187	-.161	.000	-.145	-	.537						
Mg2+	-.004	-.333	-.095	.647*	.340	-.201	-	-.043	-.503					
Cl^-	.520	.284	-.712**	-.424	-.364	.791**	-	-.029	-.052	-.380				
PO_4^{2-}	-.789**	-.280	.558	-.038	-.204	-.181	-	-.129	.504	-.226	-.271			
SO_4^{2-}	.272	-.297	-.246	.294	.429	-.020	-	-.226	-.656*	.311	.335	-.493		
NO_3^-	-.513	-.032	.528	-.412	-.110	-.162	-	-.259	.332	-.395	-.107	.393	-.427	

S.D = Standard Deviation

Months / Parameters	**Units**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Mean**	**S.D**
Air Temp.	^0C	27	27	30	30	29.5	34	30	29	24	20	19.5	25	27.08	±1.08
Water Temp.	^0C	19	19	18	20	19.5	26	25	25	21	18	17	17.5	20.41	±3.03
Depth	cm	65	60	50	43	34	23	40	90	90	80	80	70	60.4	±21.

													2	51
pH		7.9	7.4	7.2	7.4	7.4	6.8	6.8	6.8	6.8	7.4	7.3	7.4	7.21	±0.37
DO	mg/l	5.2	8	4.8	2.8	2.4	1.6	3.2	2.8	3.6	3.1	4.4	6	3.83	±2.43
FCO_2	mg/l	6	8	12	16	16	20	15	10	10	12	8	8	6.33	±5.24
CO_3^{2-}	mg/l	0	0	0	0	0	0	0	0	0	0	0	0	00	0
HCO_3^-	mg/l	68.32	48.8	48.8	43.92	48.8	61	61	36.6	39.04	48.8	58.56	61	51.98	±9.86
Ca^{2+}	mg/l	15.98	9.25	12.62	4.21	12.62	29.44	29.44	16.82	17.66	25.23	42.05	42.05	21.44	±12.27
Mg^{2+}	mg/l	199.26	233.46	69.83	193.37	215.63	103.2	65.7	117.4	117.2	115.4	125.86	125.37	140.14	±53.74
Cl^-	mg/l	11	18	25	25	20	25	25	15	17	18	18	18	19.58	±4.56
PO_4^{2-}	mg/l	0.0017	0.0028	.4710	.4750	.4750	0.4930	0.00176	0.1758	0.176	0.0022	0.0020	0.0930	0.2224	±0.2660
$SO4^{2-}$	mg/l	0.0873	0.0092	0.0327	0.0345	0.0346	0.0018	0.0017	0.0019	0.002	0.002	0.002	0.002	0.0260	±0.0250
NO_3-	mg/l	0.5724	0.5724	0.5725	0.5736	0.5725	0.5725	0.573	0.5726	0.574	0.573	0.573	0.573	0.5727	±0.0004

Table 2:- Showing Pearson correlation among various physico-chemical parameters at the station (Talpad pond)

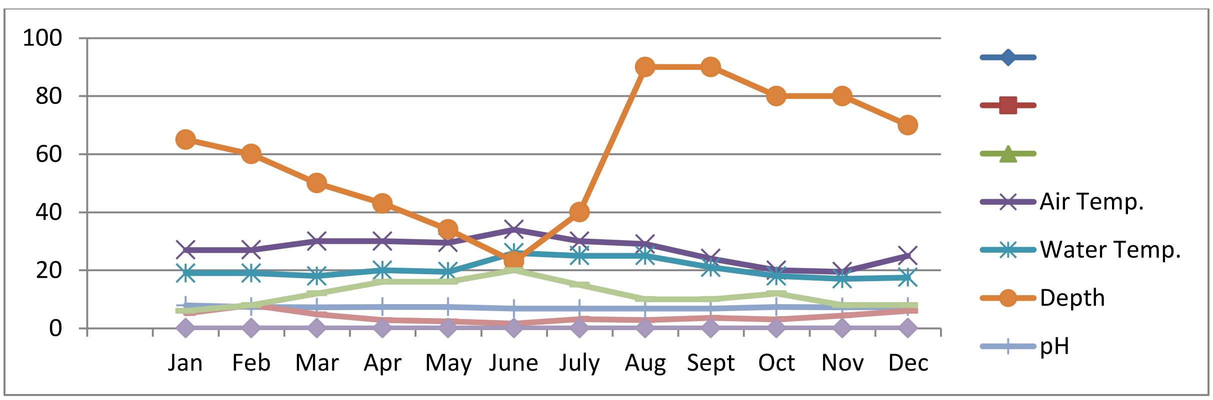

FIG 1:- Graph showing variation in the physico-chemical parameters at the station (Talpad pond).

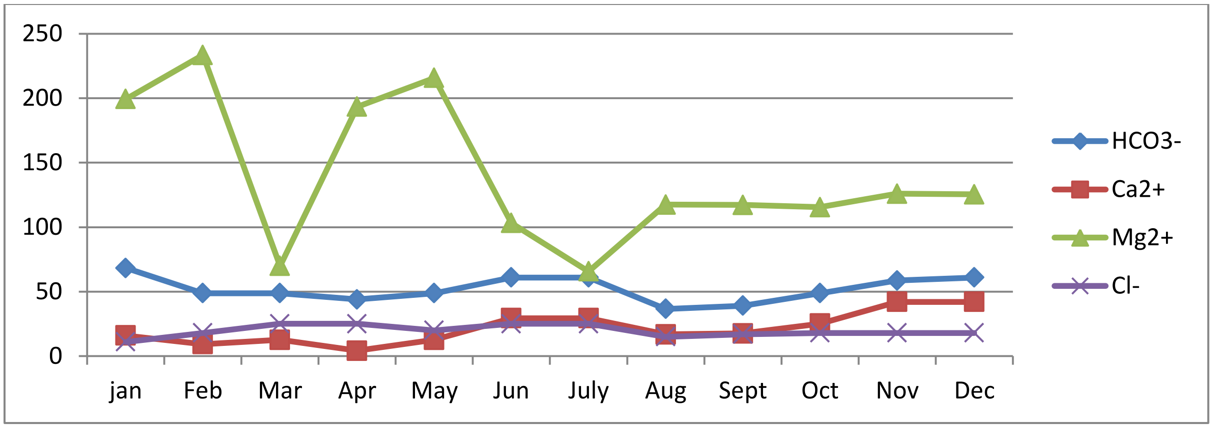

FIG 2:- Graph showing variation in the physico-chemical parameters at the station (Talpad pond).

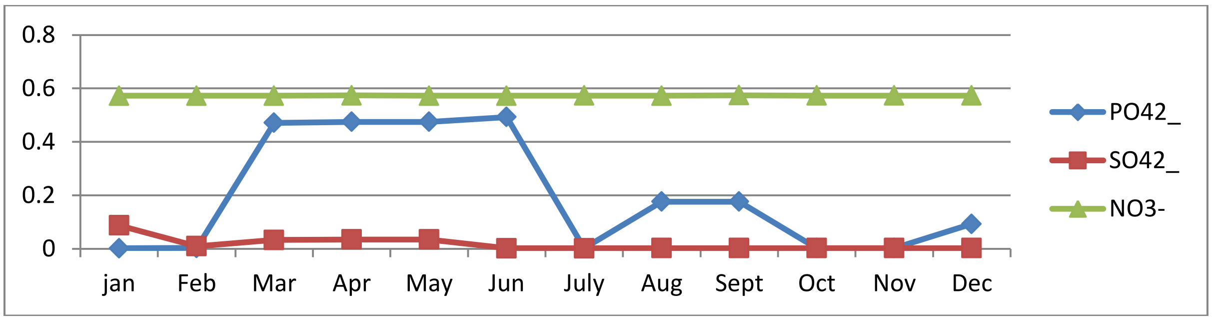

FIG 3:- Graph showing variation in the physico-chemical parameters at the station (Talpad pond).

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