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Research Article

PHYSICOCHEMICAL STATUS OF FOUR FRESHWATER CHAROPHYTE HARBOURING STATIONS OF KANYAKUMARI DISTRICT, TAMIL NADU, INDIA

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ABSTRACT
Four fresh water stations were selected to analyze the physicochemical status of water. Therur kulam (S_1), Kannamangalam kulam (S_2), Kootumangalam kulam (S_3) and Paeyadi kulam (S_4) were studied. Various water quality parameters were measured. The factors such as temperature, pH, dissolved oxygen, total alkalinity, bicarbonate and calcium reflected the effect of seasonal change. Temperature and dissolved oxygen, dissolved oxygen and pH, pH and total alkalinity, total alkalinity and bicarbonate, bicarbonate and calcium maintained significant correlation. All these factors were found to favour the four stations to be charophyte habitats.

Keywords: *Freshwater, Seasonal Influence, Water Quality, Charophytes.*

INTRODUCTION
All waters contain diverse minerals, some species occur more frequently than others. These have varying rates of solubility in water and determine water chemistry. Freshwater resource with nearly balanced concentration of the dissolved salts is suitable for human consumption and for the survival of aquatic biologic species. The parameters of an aquatic ecosystem are very important in assessing the composition of aquatics and also their sensitivity towards pollution (Arimoro *et al.,* 2008). Maintenance and conservation of water quality is essential for the survival of aquatic communities (Abulude *et al.,* 2007). Four freshwater stations of Kanyakumari District were the studied to analyse physicochemical factors and charophyte species. Station 1 (Therur kulam – S_1) is a perennial pond of 3 – 6m depth, referred by the village Therur and included under Thovalai taluk. Station 2 (Kannamangalam kulam – S_2) is a perennial village pond located at Vellichanthai of Kalkulam taluk. This is a large pond of 0.6km breadth and 0.75km length. Station 3 (Kootumangalam kulam – S_3) is located at the Kootumangalam coastal line of Kalkulam taluk. Station 4 (Paeyadi kulam - S_4) is the mother pond with pond systems interconnected through canals and is located at Thickanamcode of Kalkulam taluk.

MATERIALS AND METHODS
Water samples were collected from the four selected sites at monthly intervals for a period of one year from June 2009 to May 2010 by using clean water samplers for the study of various physicochemical parameters. From the water samples the following parameters were analyzed:

Temperature	: $^{\circ}$C Thermometer.
pH	: pH meter (Elico-model-21)
Dissolved Oxygen	: Winkler's Iodometric method
Total alkalinity	: Titrimetric method (APHA, 1985)
Bicarbonate	: Chemical analysis (APHA, 1985)
Calcium	: Flame photometer
Magnesium	: Flame photometer
Phosphate	: Colorimetric estimation
Chloride	: Argentometric method (APHA, 1985)

RESULTS AND DISCUSSION

Systematic study of the selected four stations (S_1-S_4) revealed monthly and seasonal variation in the physicochemical status (Table 1). Correlation studies showed negative and positive correlation (Table 2) among the physicochemical parameters which favoured the charophyte habitat.

Temperature

Seasonal fluctuation in temperature showed the highest value (28.1°C) in non monsoon season in S_2 against the low value (24.15°C) in southwest monsoon in S_3. The high temperature of the site was mainly by the bright sun shine, quick evaporation and low level of water in the second station (Joshi and Sing, 2001). The low temperature in S_3 during southwest monsoon was due to low level of evaporation and cool shade provided by the coconut plantation. Temperature helps in controlling the solubility of gases. In correlation analysis temperature factor shows significant relation with dissolved oxygen.

pH

The observed results on seasonal mean pH values were variable. It was high during non monsoon season 8.45 in S_3 and 8.03 in S_4. Higher concentration of nutrients in the water and increased rate of photosynthesis would have raised the level of pH as pointed out by Misra *et al.* (2005). In correlation analysis pH factor shows significant correlation with dissolved oxygen and total alkalinity.

Dissolved oxygen

The resulted seasonal mean value of dissolved oxygen was high (6.93mg/l) during southwest monsoon season in S_4 and low (3.98 mg/l) in non monsoon season in S_3. Low temperature, dilution effect by rain water and high degradation of organic substance increase the level of dissolved oxygen in the aquatic ecosystem. In a pond or a lake or river system water with more than 5mg/l of DO represents unpolluted nature of the water body (Pawar and Kanvate, 2010). In the present study it showed significant correlation with temperature and pH.

Total alkalinity

The observed total alkalinity seasonal mean values were high during non monsoon season with 77.50 mg/l in S_1, 77.75 mg/l in S_2, 177.75 mg/l in S_3, 40.50 mg/l in S_4. Higher values made the aquatic environment to have high productivity (Munawar, 1970). The higher alkalinity in summer months may be attributed to the high rate of decomposition where Co_2 was released and reacted with water to form HCO_3 and thereby increasing the total alkalinity. Higher level of alkalinity was mainly due to the flow of agricultural runoff. Such observations coincide with the results of Ajagekar *et al.*, (2011). Correlation analysis showed significant correlation with bicarbonate. Several bases like carbonates, bicarbonates, nitrates, phosphates etc. are added to alkalinity which helps in evaluating the buffering capacity of waters (Singbarh *et al.*, 1986).

Bicarbonate

In the present observation bicarbonate concentration was low and it ranged between 0.56 and 4.78mg/l. Concentration of bicarbonate seasonal values showed the maximum 4.78mg/l (S_3) during non monsoon season. Correlation analysis showed significant correlation with temperature, pH, dissolved oxygen, total alkalinity and calcium.

Calcium

Seasonal mean data of calcium showed the highest values (46.50 mg/l in S_1, 36.00 mg/l in S_4) during northeast monsoon season; low value (11.18 mg/l in S_2) was obtained for non monsoon season. Correlation analysis showed significant correlation with bicarbonate.

Magnesium

It is an important cation of water which is associated with calcium in all kinds of water but its concentration remains generally lower than calcium and a major element for hardness (Rajkumar, 2006). The principal elements which impart hardness are Ca^{++} and Mg^{++} (Kumar *et al.*, 2005). Calcium and magnesium are directly proportional to the total hardness of water; the main sources of these ions are sedimentary rocks, seepage and runoff from soil (Paul and Misra, 2004).

Phosphate

Low concentration of phosphate (0.03- 1.80mg/l) was reported in the study stations. Low concentration of phosphate during non monsoon season is probably due to the high utilization of phosphates by phytoplankton and aquatic weeds and it coincides with the observations of George and Mathew (2008).

Chloride

The salts of calcium, sodium and potassium contribute chlorides in water (Khamabrade and Mule, 2005). Chloride concentration in the form of chloride ions is one of the major inorganic anions in water (Harsha *et al.*, 2006). In general, it occurs in the discharges of effluent from industries, sewages, irrigation wastes etc. (Manivasakam, 2003). In coastal areas seepage of sea water increases the chloride ion concentration. Fresh water contains 8.3 mg of chloride per litre (Swarnalatha and Rao, 1998). In S_3 which is a coastal station, chloride concentration was high and found to be 123.50mg/l in non monsoon season.

Charophytes

Charophytes prefer hard waters. In hard waters, calcium ions are usually accompanied by bicarbonate ions which are often the main source of inorganic carbon for macrophytes. Charophytes are reported to have a higher affinity to HCO_3^- than vascular macrophytes. Bicarbonate is often depleted in dense *Chara* beds and the commonly found calcite encrustation on *Chara* upto 60% of $CaCO_3$ in dry weight of charophytes (Hutchinson, 1975) is a visualization of bicarbonate uptake during intensive growth. Concentration of phosphate was found to be low (0.03mg/l- 2.4mg/l) in water from stations with *Chara* as reported by Janna Krolikowska, (1997).

For the success of sustainable aquatic life the required optimum pH is 6.5 to 8.5 (Mur doch *et al.*, 2001). Dissolved oxygen is one of the essential parameters required by all the living organisms for respiration and metabolism which depends on temperature, organic loading and biotic community (Solanki *et al.*, 2007). The level of water pollution is assessed by low level of dissolved oxygen and it is a primary factor in pollution studies (Verma *et al.*, 2011). Charophytes require clean oxygenated water and when water gets contaminated and polluted, disappear. The negatively and positively balanced proportions of the observed physicochemical factors assign the habitats (S_1-S_4) for charophyte survival. In the present study two charophyte genera *Chara* (Fig.1) and *Nitella* (Fig.2) were observed.

One taxon of the genus *Chara* and three taxa of the genus *Nitella* (*C. hydropitys*, *N. hyalina*, *N. flagelliformis, N. batrachosperma*) were observed in S_1. *Nitella flagelliformis* occurred throughout the year and reproduced in the non monsoon season. *N. hyalina* appeared in May and reproduced during northeast monsoon season. *N. batrachosperma* and *C. hydropitys* appeared late in the monsoon and reproduced during non monsoon season. High calcium and low phosphorus concentration in the water are indispensable conditions for the optimum growth of charophytes. This observation corroborates with that of Houge and Putt (1988).

One taxon of the genus *Chara* and two taxa of the genus *Nitella* (*C.erythrogyna, N. furcata, N. burmanica*) were observed in S_2. *Nitella furcata* occurred throughout the year and reproduced during northeast monsoon and late non monsoon season. *Nitella burmanica* and *C.erythrogyna* appeared in late monsoon and reproduced during non monsoon season. The low concentration of bicarbonate ions (SWM 0.65±0.08; NEM 0.91± 0.13; NMS 1.25± 0.19) in this station is indicative of its depletion by the dominating charophytes.

In S_3 which is a coastal station, chloride concentration (123.50mg/l in NMS and 17.50 mg/l in SWM) was high but within the permissible limit (<500mg/l) and was contributed by the higher concentrations of sodium and calcium salts and seepage of sea water. *Chara zeylanica* was reported from this station. Such observation coincides with previous reports. *Chara zeylanica* willd var *zeylanica f.filicaules* (Rob) Wood was reported from a saline ditch near coast (Khepupara, Barisal) and a brackish water pond (Sandwip Island, Chittagong) by Islam and Sarma (1968). Two forms of *Chara zeylanica* from St. Martin's Island, Cox's Bazar were reported from habitats of both lentic and lotic type.

Thickanamcode area is watered by Pamboori Vaikal flowing from Karungal malai and irrigation channel flowing from Pechiparai dam. The mixed water in the mother pond Paeyadi kulam (S_4) harbours four

Nitella species and six *Chara* species. The maximum species diversity in S_4 is supported by the alkaline pH range (SWM-7.48, NEM – 6.55, NMS-8.03) and high dissolved oxygen (SWM-6.93, NEM-6.90, NMS-5.75).

Conclusion

The physicochemical factors such as temperature, pH, dissolved oxygen, total alkalinity, bicarbonate and calcium reflected the effect of seasonal change. Temperature and dissolved oxygen, dissolved oxygen and pH, pH and total alkalinity, total alkalinity and bicarbonate, bicarbonate and calcium maintained significant correlation. All these factors were found to favour the four stations to be charophyte habitats.

Table 1: Seasonal variation (mean ± SD) of physicochemical parameters of water recorded in the stations S_1 to S_4 (June 2009 – May 2010)

Parameters	Season	Experimental stations			
		S_1	S_2	S_3	S_4
Temperature (°C)	SWM	24.20±0.08	24.53± 0.10	24.15± 0.06	25.35± 0.24
	NEM	24.45± .10	25.78± 0.33	25.13± 0.13	25.88± 0.22
	NMS	26.48± .86	28.10± 0.75	25.50± 0.12	27.00± 0.83
pH	SWM	7.00± 0.16	7.10± 0.22	8.16± 0.30	7.48± 0.25
	NEM	6.88± 0.15	6.70± 0.24	7.90± 0.36	6.55± 0.19
	NMS	7.18± 0.13	7.34± 0.12	8.45± 0.10	8.03± 0.22
Dissolved oxygen (mg/l)	SWM	6.26± 0.09	6.10± 0.26	5.20± 0.14	6.93± 0.28
	NEM	6.28± 0.19	5.43± 0.17	5.33± 0.13	6.90± 0.12
	NMS	5.85± 0.10	5.13± 0.10	3.98± 0.15	5.75± 0.19
Total Alkalinity (mg/l)	SWM	67.75±2.06	84.63± 2.87	164.50± 16.52	25.00± 1.15
	NEM	67.00±1.15	56.25± 5.32	163.00± 10.89	32.50± 4.12
	NMS	77.50± 2.52	77.75± 11.62	177.75± 3.69	40.50± 4.43
Calcium (mg/l)	SWM	34.88± 2.78	16.68± 1.66	53.50± 1.91	26.50± 1.91
	NEM	46.50± 4.12	13.58± 0.43	52.50± 1.91	36.00± 5.16
	NMS	24.63± 5.19	11.18± 0.62	56.00± 2.83	23.50± 6.40
Magnesium (mg/l)	SWM	10.30± 0.42	9.68± 0.70	73.00± 2.94	16.50± 1.00
	NEM	6.15± 0.19	6.15± 0.25	68.25± 2.36	12.75± 0.96
	NMS	17.93± 0.30	13.75± 0.65	60.75± 3.40	11.38± 1.11
Phosphate (mg/l)	SWM	0.06±0.01	0.15± 0.02	1.15± 0.10	0.28± 0.01
	NEM	0.04± 0.00	0.09± 0.01	1.00± 0.12	0.35± 0.11
	NMS	0.03± 0.01	0.05± 0.02	0.74± 0.10	1.80± 0.16
Chloride (mg/l)	SWM	34.50± 1.91	32. 00± 1.83	111.25± 0 1.50	36.00± 2.83
	NEM	21.50± 1.91	17.93± 1.04	95.25± 3.57	27.50± 1.91
	NMS	40.50± 3.79	23.30± 0.95	123.50± 4.12	22.50± 1.91
Bicarbonate (mg/l)	SWM	2.43± 0.43	0.65± 0.08	2.88± 0.25	0.56± 0.03
	NEM	3.18± 0.10	0.91± 0.13	3.70± 0.47	0.72± 0.13
	NMS	3.68± 0.25	1.25± 0.19	4.78± 0.37	1.40± 0.28

Table 2: Correlation among the physicochemical parameters of water samples

STATION 1

	Tempe	pH	TDS	DO	BOD	TA	Cal	Mag	Sod	Pota	Nitrate	Phosphate	Chloride	Bicar
Tempe	1													
pH	0.5399	1												
TDS	0.6765	0.6792	1											
DO	-0.7716	-0.6470	-0.6563	1										
BOD	0.7065	0.1773	0.1694	-0.5682	1									
TA	0.9278	0.6522	0.7539	-0.7755	0.6152	1								
Cal	0.8620	0.4314	0.3736	-0.6913	0.8013	0.7453	1							
Mag	0.8294	0.6096	0.8783	-0.8240	0.5254	0.8925	0.6106	1						
Sod	0.7064	0.5952	0.9426	-0.5636	0.1255	0.7882	0.3426	0.8434	1					
Pota	0.4732	0.6558	0.8995	-0.6236	-0.0351	0.5913	0.1328	0.7665	0.8664	1				
Nitrate	-0.7954	-0.2640	-0.2275	0.5863	-0.8283	-0.6875	-0.9164	-0.5553	-0.2392	-0.0115	1			
Phosphate	-0.7910	-0.2560	-0.1648	0.5973	-0.7883	-0.6853	-0.9377	-0.4573	-0.1928	0.0676	0.9186	1		
Chloride	0.5089	0.6697	0.9134	-0.6746	0.1298	0.6553	0.2327	0.8595	0.8138	0.9328	-0.1530	-0.02	1	
Bicar	0.7951	0.3375	0.2245	-0.6025	0.7572	0.6792	0.9604	0.4657	0.2119	-0.0088	-0.8968	-0.97	0.0916	1

STATION 2

	Tempe	pH	TDS	DO	BOD	TA	Cal	Mag	Sod	Pota	Nitrate	Phosphate	Chloride	Bicar
Tempe	1													
pH	0.4133	1												
TDS	-0.6197	0.3126	1											
DO	-0.8873	-0.2720	0.7338	1										
BOD	0.9277	0.6444	-0.4077	-0.7939	1									
TA	-0.0969	0.6146	0.7519	0.3513	0.1453	1								
Cal	-0.8570	-0.2820	0.6718	0.9400	-0.7958	0.2129	1							
Mag	0.4841	0.8016	0.2091	-0.3283	0.7093	0.5740	-0.4732	1						
Sod	0.5176	0.8348	0.2611	-0.2911	0.7190	0.7242	-0.4292	0.9481	1					
Pota	0.6468	0.4539	-0.3247	-0.6045	0.7894	0.1890	-0.7654	0.7798	0.7043	1				
Nitrate	-0.9572	-0.2350	0.7257	0.9254	-0.8667	0.2531	0.9119	-0.4130	-0.4016	-0.6820	1			
Phosphate	-0.9432	-0.3590	0.6993	0.9056	-0.8922	0.1572	0.8979	-0.4049	-0.4251	-0.6637	0.9354	1		
Chloride	-0.5101	0.4214	0.9339	0.6747	-0.2789	0.7858	0.5959	0.3310	0.3907	-0.1557	0.6372	0.6370	1	
Bicar	0.9693	0.4639	-0.5385	-0.8461	0.9267	-0.0279	-0.7703	0.4804	0.5291	0.5870	-0.9124	-0.9100	-0.4558	1

STATION 3

	Tempe	pH	TDS	DO	BOD	TA	Cal	Mag	Sod	Pota	Nitrate	Phosphate	Chloride	Bicar
Tempe	1													
pH	0.2145	1												
TDS	0.6140	0.5255	1											
DO	-0.6446	-0.5960	-0.7638	1										
BOD	0.8113	0.1004	0.7481	-0.6079	1									
TA	0.3799	0.8558	0.6556	-0.5130	0.2723	1								
Cal	0.3552	0.7505	0.5739	-0.6026	0.4600	0.7396	1							
Mag	-0.8269	-0.4390	-0.5203	0.8120	-0.6884	-0.4085	-0.5542	1						
Sod	-0.1111	0.2570	0.3172	0.0331	0.0532	0.4120	0.3569	0.1881	1					
Pota	-0.5116	0.4607	0.2983	-0.1217	-0.1598	0.3028	0.3672	0.3213	0.3942	1				
Nitrate	-0.8701	-0.3370	-0.5739	0.8190	-0.6285	-0.3506	-0.3282	0.8364	0.1726	0.3935	1			
Phosphate	-0.8055	-0.4750	-0.4552	0.7810	-0.6332	-0.4118	-0.6194	0.9572	0.1627	0.3341	0.8425	1		
Chloride	0.2596	-0.5670	-0.3046	0.5510	0.1241	-0.2936	-0.4107	0.0991	-0.2029	-0.7195	0.1163	0.12	1	
Bicar	0.8736	0.5931	0.6828	-0.7906	0.6989	0.6827	0.6542	-0.9097	-0.0536	-0.2406	-0.8291	-0.90	-0.0499	1

STATION 4

	Tempe	pH	TDS	DO	BOD	TA	Cal	Mag	Sod	Pota	Nitrate	Phosphate	Chloride	Bicar
Tempe	1													
pH	0.5257	1												
TDS	0.8126	0.8346	1											
DO	-0.8165	-0.7040	-0.8882	1										
BOD	0.8391	0.6767	0.8072	-0.8658	1									
TA	0.8654	0.4228	0.6753	-0.7931	0.9033	1								
Cal	-0.4839	-0.7570	-0.7747	0.6340	-0.4094	-0.2182	1							
Mag	-0.7717	-0.1990	-0.4858	0.6729	-0.7545	-0.9424	0.0244	1						
Sod	0.9389	0.5052	0.7800	-0.8838	0.9019	0.9432	-0.3721	-0.8787	1					
Pota	0.6787	0.4128	0.6051	-0.6860	0.5981	0.6303	-0.2175	-0.5975	0.7893	1				
Nitrate	-0.9401	-0.5820	-0.8556	0.8979	-0.8760	-0.8985	0.4398	0.8106	-0.9781	-0.8234	1			
Phosphate	0.7396	0.7104	0.8588	-0.9184	0.8757	0.7847	-0.4394	-0.6641	0.8587	0.7669	-0.9033	1		
Chloride	-0.8286	-0.2830	-0.5897	0.6710	-0.7633	-0.9165	0.0470	0.9383	-0.9097	-0.7513	0.8935	-0.750	1	
Bicar	0.9356	0.6649	0.8785	-0.8872	0.9327	0.9239	-0.4666	-0.8046	0.9417	0.6872	-0.9584	0.878	-0.8513	1

Figure 1: ***Chara vulgaris*** **Linn**

Figure 2: ***Nitella batrachosperma*** **(Reich) Braun**

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