J. Indian Fish Assoc., 35: 9 - 17, 2008

NUTRIENT PROFILE OF POND WATER IN NORTH-EASTERN STATE OF TRIPURA AND IMPACT OF WATER ACIDITY ON AQUACULTURE PRODUCTIVITY

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ABSTRACT

Physico-chemical parameters of 31 fish pond water samples of Tripura were studied to ascertain the nutrient profile of acidic soil zone and the impact of water acidity towards aquaculture productivity. The pH was acidic (mean 6.63±0.44) with high Fe (mean1.04±0.40 mgl^{-1}) and Al (mean 2.67±2.41 mgl^{-1}) contents. These were mostly responsible for pond water acidity and poor productivity with low nitrogen, phosphate and total alkalinity. The study also showed strong negative relationship between water pH and redox potential (R^2=0.5251). However, pH was positively significant with electrical conductivity. The roles of redox potential and electrical conductivity in water acidity were found highly important. Available calcium content was also found low (mean 2.91±2.96 mgl^{-1}). Elevating level of pH of pond water could be the possible management practices in acidic water so that such unproductive water might be productive enough with higher phosphate and nitrogen levels for better biological production.

Keywords: Tripura, red acidic soil, acidic water, pH, redox potential.

INTRODUCTION

Tripura has 21,169.24 ha water area out of which 37.2% is for capture and rest is for culture. It contributes about 7.21 % of fish production of NE region. The per capita availability of fish in Tripura is 5.46 kg where almost total population is fish eater (Anonymous, 2004). Soils are important in pond nutrient availability through water for aquaculture. Importance of pond bottom soil and water in determining pond productivity were extensively studied (Hickling, 1962; Banerjee and Ghosh, 1970; Jhingran, 1993; Boyd, 1990, 1995), but not much work has been conducted on nutrient profile of acidic water and fish farming in India (Mukherjee and Chattopadhyay, 2002; Chattopadhyay, 1995; Neogy, *et al.*, 1994; Neogy *et al.*, 1999). Studies on limnology of acidic water ponds of Tripura are scanty (Banerjee, 1967; Banerjee and Ghosh, 1970). An attempt has been made to study nutrient properties of such acidic water ponds.

MATERIALS AND METHODS

The present study area Lembucherra comes under the west district of Tripura with undulating landscape dominated by red acid soil. The pond water samples used for this experiment were collected from the acid soil zone of Tripura used for aquaculture during 2007. In total, 31 ponds were studied from

Lembucherra village following standard procedures as mentioned below for estimation of different physico-chemical. parameters of water:

The statistical analysis of the parameters of the experiment was carried out using SPSS soft ware package, 15.0 version at College of Fisheries, CAU, Tripura.

Parameter	**Method/ Instrument/ Reference**
Air and water temperature	Digital thermometer (0- 50 °C)
Transparency	Measured by Secchi Disc
Turbidity	Nephelometric method, with digital Nepheloturbidity meter 132 Systronics, (APHA, 2005)
Redox Potential (RP)	By digital pH meter, Model 335, Systronics
Electrical Conductivity (EC)	Electrometric method with a portable digital S-C-T meter, Model 311, Systronics
pH	Portable pH (digital) meter, pH Scan 2
Total alkalinity	Titrimetric method, (APHA, 2005)
Total Hardness	EDTA titrimetric method, (APHA, 2005)
Dissolved Oxygen (DO)	Modified Winklers Method (APHA, 2005)
Carbon dioxide (CO_2)	Titrimetric method, (APHA, 2005)
Nitrate Nitrogen (NO_3-N)	By UV-VIS Spectrophotometry, model Shimadzu- UV-pharmaspcc-1700 at 543 nm, (APHA, 2005)
Ammonia Nitrogen (NH_4- N)	By direct Nesslerization method with Shimadzu- UV-pharmaspcc-1700 at 420 nm, (APHA 2005)
Phosphate (PO_4-P)	Stannous Chloride method, with Shimadzu- UV-pharmaspcc-1700 at 420 nm, at 650 nm, (APHA, 2005)
Calcium (Ca), Iron (Fe), and Aluminium (Al)	With AAS (AAnalist 200, PerkinElmer) (APHA, 2005)

RESULTS AND DISCUSSION

The results of the physico-chemical parameters of the pond water are shown in the Table 1.

Among the physico-chemical parameters influencing aquatic productivity; pH, total alkalinity, dissolved gases like oxygen and carbon dioxide and dissolved inorganic nutrients like nitrogen and phosphorus were considered important and their relationship was well known (Wetzel, 1983; Boyd, 1990).

The pH of studied water was found in between 5.62 - 7.80 (mean 6.63) which is mostly acidic in nature, with higher Fe (0.08 - 1.93; mean 1.04 mgl^{-1}) and Al (0.31 -9.66; mean 2.67 mgl^{-1}) indicating that Fe and Al (Fig. 2) were mostly responsible for pond water acidity with low alkalinity which demonstrated low phosphate and nitrogen contents, the causative factors for lower productivity. The present work confirmed the study of Banerjee (1967) in some acidic ponds in Assam, Manipur and West Bengal which exhibited that acidic pond water with pH < 6.5 were mostly unproductive in nature, having total alkalinity < 50 mg l^{-1}; dissolved nitrogen 0.05- 0.17 mg l^{-1} and dissolved phosphate 0.01 mg l^{-1}, Pani *et al.* (2004).

Same trend was noticed by Egna and Boyd (1997) in their study in pond water of some Asian, African and Latin American countries, where the trend of lower pH values accomplished with higher iron and lower alkalinity levels.

The dissolved oxygen (mgl^{-1}) content was in between 3.20-10.80 (mean 5.21); total alkalinity (mgl^{-1}) between 28.00-186.00 (mean 76.19); total hardness (mgl^{-1}) between 32.00 - 90.00 (mean 52.77); PO_4-P (mgl^{-1}) between 0.01 - 0.70 (mean 0.25); NH^+_4N (mgl^{-1}) between 0.002 - 0.12 (mean 0.04) and NO_3-N: (mgl^{-1}) between 0.01 - 0.14 (mean 0.03). This study also confirmed the low availability of nitrogen, phosphate and total alkalinity (Table1) in these acidic ponds which were also the determining factors for poor aquaculture productivity as studied by Hickling (1962). Mukherjee and Chattopadhyay (2002) in their study in fish ponds of red and lateritic zones also reported same trend with acidic pH; low nitrogen; phosphate; potash; net and gross primary production.

The present study showed that pH of water was highly negatively significant with redox potential where as highly positively significant with electrical conductivity. On the other hand, electrical conductivity was highly positively significant with total alkalinity and total hardness. Negative value was found significant with redox potential in respect of pH and electrical conductivity and total alkalinity (Table 2). Hence, the role of redox potential (Fig.1) and electrical conductivity in water acidity was found important.

Carbon dioxide of the water was found positively correlated with turbidity and transparency and negatively with dissolved oxygen; total alkalinity and phosphorus. Dissolved oxygen was found positively significant with total hardness. Similar correlations were reported in the work of Singh and Sharma (1999) in slightly alkaline water where the pH was also positively correlated with dissolved oxygen.

Table 1. Physico-chemical parameters of pond water of Lembucherra village of Tripura (n-31)

Parameter	Min.	Max.	Mean	SD	CV
Temperature air (°C)	22	26	22.13	0.72	3.57
Temperature water (°C)	20	24	20.13	0.72	3.25
Turbidity (NTU)	7.16	57.00	18.44	10.95	59.35
Transparency (cm)	11.00	29.00	17.11	4.32	25.22
pH	5.62	7.80	6.63	0.44	6.71
Electrical conductivity (S/cm)	10.00	100.00	47.61	21.01	44.12
Redox potential (mV)	-27.00	66.00	3.29	17.69	537.82
CO_2 (mgl^{-1})	1.00	12.00	4.61	3.16	68.48
Dissolved oxygen (mgl^{-1})	3.20	10.80	5.21	1.51	28.99
Total alkalinity (mgl^{-1})	28.00	186.00	76.19	36.92	48.45
Total hardness (mgl^{-1})	32.00	90.00	52.77	13.17	24.96
PO_4-P (mgl^{-1})	0.01	0.70	0.25	0.23	90.54
NH^+_4- N (mgl^{-1})	0.002	0.12	0.04	0.03	77.79
NO_3-N (mgl^{-1})	0.01	0.14	0.03	0.02	67.91
Fe (mgl^{-1})	0.08	1.93	1.04	0.40	38.51
Al (mgl^{-1})	0.31	9.66	2.67	2.41	90.13
Ca (mgl^{-1})	0.38	10.09	2.91	2.96	101.87

Abbreviations: Water temperature (W. temp.); Turbidity (Turb.); Transpency (Trans.); Electrical conductivity (EC); Redox potential (RP); Carbon dioxide (CO_2); Dissolved oxygen (DO); Total alkalinity (TA); Total hardness (TH); Phosphate (PO_4-P); Ammonia nitrogen (NH^+_4- N); Nitrate nitrogen (NO_3-N); Iron (Fe); Aluminium (Al); Calcium (Ca).

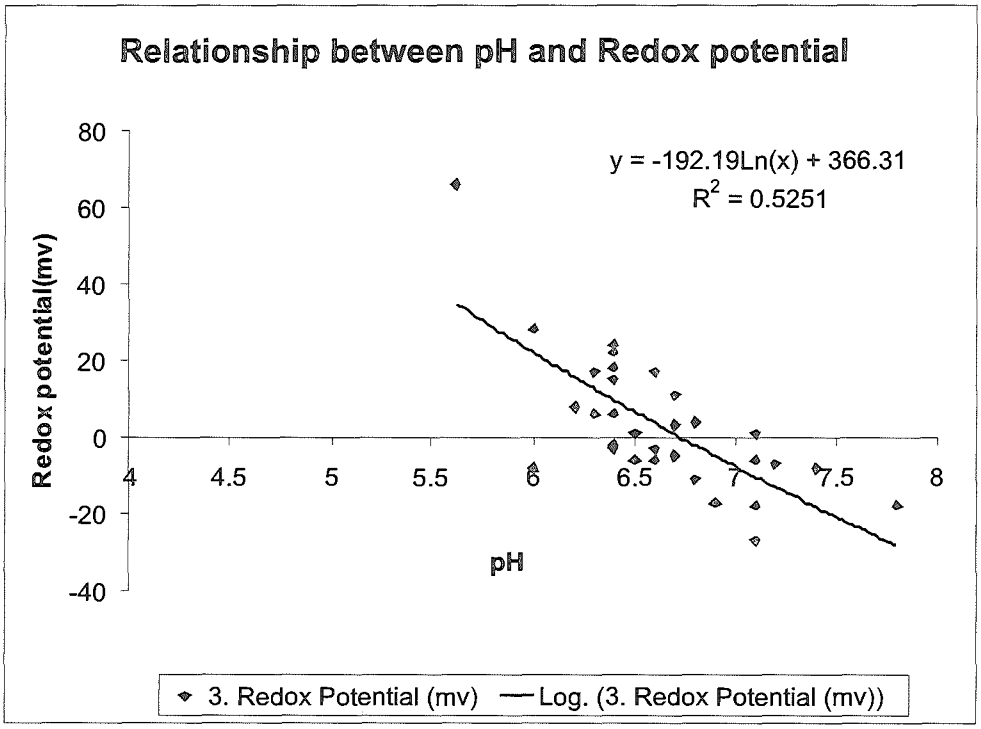

Fig. 1 Showing negatively strong significant relationship between pH and redox potential of acidic pond water.

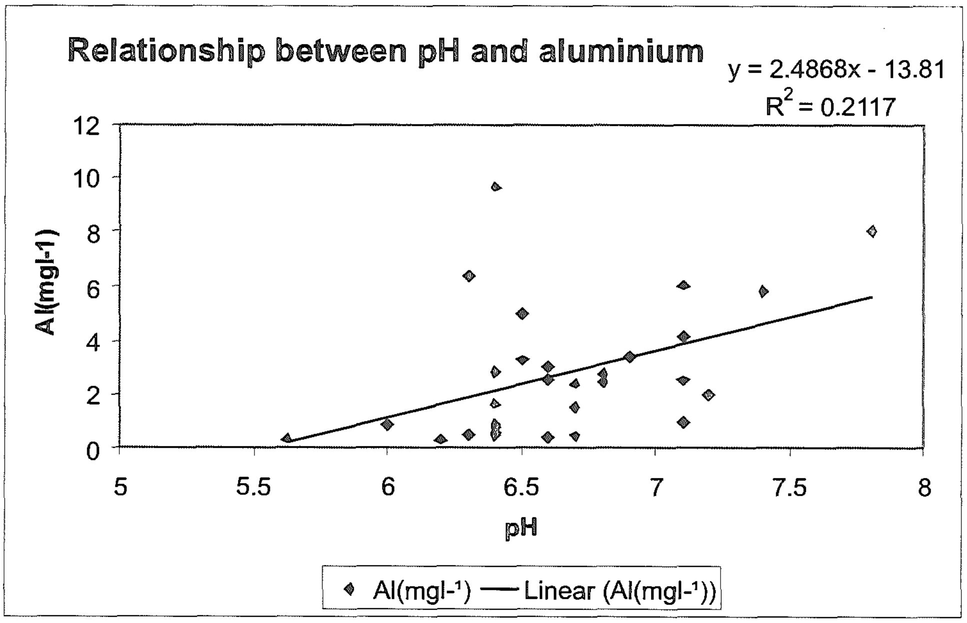

Fig. 2 Showing positively strong significant relationship between pH and aluminium content of acidic pond water

Table 2 Pearson correlation among different physico-chemical parameters of pond water

	Turb.	Trans.	pH	EC	RP	CO_2	DO	TA	TH	PO_4-P	NH_4-N	NO_3-N	Al	Ca	Fe
Turb.	1.00	0.846**	-0.069	-0.369*	0.188	0.534**	-0.155	-0.328	-0.282	-0.439*	-0.107	-0.159	-0.354	-0.397*	0.055
Trans.		1.00	-0.082	-0.306	0.087	0.595**	-0.160	-0.340	-0.301	-0.658*	0.096	-0.226	-0.404	-0.434*	-0.052
pH			1.00	0.527*	-0.710**	-0.279	-0.033	0.350	0.074	0.232	0.056	0.246	-0.184	-0.001	0.043
EC				1.00	-0.553**	-0.081	0.201	0.465	0.469	0.249	-0.270	0.104	-0.039	0.462*	-0.078
RP					1.00	0.239	-0.139	-0.367	-0.295	-0.219	0.029	-0.137	-0.059	-0.186	-0.112
CO_2						1.00	-0.468	-0.453	-0.239	-0.668*	-0.018	-0.294	-0.241	-0.155	-0.082
DO							1.00	0.378	0.566	0.206	-0.046	0.013	0.070	0.332	0.194
TA								1.00	0.596	0.297	-0.239	-0.005	-0.052	0.604*	0.187
TH									1.00	0.189	0.612*	0.056	0.241	0.623*	0.245
PO_4-P										1.00	-0.039	0.364*	0.330	0.370	0.055
NH_4-N											1.00	-0.061	-0.318	-0.251	-0.248
NO_3-N												1.00	-0.058	-0.089	0.193
Al													1.00	-0.016	-0.043
Ca														1.00	0.147

** Correlation is significant at the 0.01 level and * Correlation is significant at the 0.05 level

The total alkalinity was positively significant with electrical conductivity; dissolved oxygen and total hardness but negatively with redox potential and Co_2. Total alkalinity, total hardness and electrical conductivity were significantly depended positively upon calcium and hence calcium was also found important nutrient in productivity enhancement. This study also reflected the study of Bhowmik and Tripathi (1985) in acidic soil based ponds in West Bengal where the water was acidic with low total alkalinity, calcium; nitrate and phosphate.

CO_2 content in acid water required to be kept under control in order to increase the dissolved oxygen as well as total alkalinity content so that water may be productive enough with higher phosphate level. Carbon dioxide may be controlled with higher calcium availability in water. The present study also attributed the studies of Egna and Boyd (1997) and Boyd (1990) where it was exhibited that alkalinity potentially did limit primary production and fish yield. Since inorganic carbon was necessary for photosynthesis the alkalinity below 30 mg l^{-1} as $CaCO_3$ limited primary production in well fertilized ponds.

The role of total hardness in such water was highly relevant as it is positively significant with electrical conductivity; dissolved oxygen; total alkalinity and Ca. Higher level of total hardness might be attributed to higher total alkalinity content in water which leads to better productivity of the water for biomagnifications like plankton. Moreover, role of Al and redox potential in controlling the water pH was also demonstrated in the same study and increase in pH level in water would control the availability of Al and Fe contents in water profile. Same trend was noticed by Mukherjee and Chattopadhyay (2002); Chattopadhyay (1995); Neogy, *et al.* (1994) and Neogy *et al.* (1999) in red and lateritic zones.

Turbidity of water was found negatively correlated with electrical conductivity, phosphate and calcium. In acidic soil base water, turbidity is not considered as index of productivity (due to phytoplankton), rather due to suspended matter which restricts the light penetration resulting in reduced primary production. It makes the water body low in nitrogen, dissolved oxygen and phosphate content. Low electrolytes in such water body due to lower calcium triggers the turbidity due to suspended matter. Hence such situation is indicator of poor fertility of the water.

Electrical conductivity and redox potential of water were found inversely related and negatively correlated. Higher the concentration of electrolytes in water, the more is its electrical conductivity. Generally richer a body of water in electrolytes, the greater is its biological productivity. Acid may be good conductor of electricity, but high sand and low clay of red base soil maintain the water electrical conductivity low in such water body. Electrical conductivity was noticed medium in these ponds. Hence the inverse relation indicates the poor to medium productiveness of the ponds.

On the other hand, low value of redox potential indicates high reduction while high value indicates high oxidation. The observed value was low, inversely significant with pH and total alkalinity, thus found as an indicator of anaerobic environment in the soil-water profile. Poor growth and survival was noticed during fish farming in these ponds.

Elevating pH level of water was considered to be possible management practices in acidic water (Roy *et al.*, 1999). Water pH level in acidic water may be elevated with application of lime in appropriate doses as the experimental pond showed low calcium content.

Higher organic load in pond water is likely to make better availability of nutrients like nitrogen and phosphate which may lead to higher electrical conductivity with a rise in pH level and total alkalinity and in turn neutralizing the acidic phenomenon pond water (Lin, 1986).

Appropriate regular measures for both problematic soil and water of the ponds might be needed for enhancing the pond productivity by raising the pH level vis-a-vis reducing the Fe and Al load through application of calcium as well as organic manures.

ACKNOWLEDGMENTS

The authors are thankful to Dr Dilip Kumar, Director, Central Institute of Fisheries Education, Mumbai and to Dr. S. N. Puri, Vice-chancellor, Central Agricultural University, Imphal, Manipur for providing required facilities for completion of the work.

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