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ORIGINAL ARTICLE

Effects of Pond Age and Depth on Bottom Soil Nutrients, pH and Salinity in Jatahi Pond at Chapra

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ABSTRACT

Aquaculture is immensely increasing in India to meet the growing fish protein demand due to availability of freshwater and marine ecosystems. This study was conducted to know the variation of physicochemical parameters of aquaculture farm with different pond age and depth. The culture ponds were divided into two distinct groups i.e. 1-5 years group pond and 6-10 years pond for analysis. The ponds were also divided based on depth (i.e. shallow pond (0.5-1 m) and deep pond (2-3.5m). The soil pH of different ponds was recorded and salinity sharply increased with pond's depth and age. Amount of organic matter and organic carbon also highly accumulated with the increasing of pond's age and depth. Sulfur and phosphorus decreases with pond's age and depth but nitrogen and potassium were found similar with age and depth of pond. The results will help for our further understanding of the influence of pond processes on pond productivity.

Key words: *Pond age, Soil Nurients, Jatahi Pond*

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INTRODUCTION

The pond soil is a function of buffer to the aquatic ecosystem and provides all the important nutrients with water and serves as a biological filter through the adsorption of the organic residues of feed, fish excretions and algal metabolites (Townsend, 1982). Depth of a pond has also an important factor which affects the physical and chemical qualities of water. The optimum level of pH and salinity of overlying water and concentrations of plant nutrients required for the growth of phytoplankton, which is the base of food chain of the fish [Pravakar, *et al*, 2013; Hossain and Rahman, 2017). Low pH can retard decomposition of organic matter and permits its accumulation and cause a high oxygen demand in the surface layer of soil. Low concentration of soil retards the decomposition of water because soil microorganism can use oxygen from nitrate when molecular oxygen depleted. The accumulation of sediment enriched with nutrients and organic matter are thought to be a major factor causing the intensification of management problems in old ponds.

There have been a few studies linking pond age and bottom soil quality (Ahmed, 2004). Considering the above stated facts, the objectives of the current study were to assess soil nutrient content (i.e. organic carbon, organic matter, nitrogen, phosphorus, potassium, sulfur), pH and salinity in different aged and depth of ponds, to compare soil nutrient content, pH and salinity of ponds among different ages and depth of pond and to have a basic knowledge of soil condition of fish pond. Therefore, this study was carried out to

determine the relationships among pond age and depth with some key soil parameters to further our understanding of the influence of pond processes on pond productivity.

MATERIALS AND METHODS

Twelve fish ponds have been selected from Chapra district near the Jai Prakash University campus. This study area was chosen due to required pond depth and age which were found together and has potential scope for aquaculture expansion. An attempt was taken to select ponds those are similar with respect to stocking densities, fertilization and feeding regimes and other management inputs. Only ponds those were in continuous production were selected. For this experiment, selected culture ponds have been divided into two distinct groups i.e. 1-5 years group pond and 6-10 years pond. We have also divided the ponds in two categories based on depth –shallow (0.5-1m) and deep pond (2-3.5m).

The bottom soils were collected from the selected ponds manually. To make the sample representative, a number of samples were collected from different places and mixed to have the final sample (Followed by "Z"-shaped sapling method). The samples were air dried, mixed thoroughly and sieved through 10 m mesh sieve. The composite soil sample was stored in a clean plastic polythene bag for chemical analyses. The soil samples were sent to the state soil laboratory, Patna for analysis.

The properties studied include pH, salinity, organic matter, organic carbon and nutrients (Total nitrogen and available phosphorus, potassium and sulfur content). The soil samples were analyzed following the standard methods. Soil pH was determined with the help of a Glass Electrode pH meter, the soil- water ratio was maintained as 1: 2.5 as described by Jackson (1962). Soil salinity was determined from electrical conductivity (EC). The determination of electrical conductivity was described by Rayment (1992). Organic carbon (OC) in soil sample was determined volumetrically by wet oxidation method of Walkley and Black (1934). The amount of soil organic matter (OM) was calculated by multiplying the value of organic carbon with the Van Bemmelen factor, 1.724 (Piper, 1950). The total nitrogen (N) in the soil was determined by Kjeldahl method (Page *et al*, 1982). Available phosphorus (P) was extracted from the soil by the following the method of Bray and Kurtz (1945). Exchangeable potassium (K) of soil was determined by extraction with 1N ammonium acetate (Black, 1965) and the ammonium acetate method developed by Schollenberger and Simon (1945). Available sulfur (S) content of soil was determined by extracting the soil with sulfur extracting method was described by Fox, *et al.* (1964).

The collected data were summarized and scrutinized carefully using the following software Microsoft Excel version 13.0 and Statistical Package for Social Science (SPSS) version 20.0.

RESULTS AND OBSERVATIONS

All the physical parameters and soil nutrients of shallow pond and deep pond as well as in the 1-5 years pond and 6-10 years pond were given in Table 1. The average value of pH, electrical conductivity, organic matter, organic carbon, nitrogen, potassium, phosphorus and sulfur were recorded 7.65, 2.03 dS/m, 2.02 %, 1.19 %, 0.09 %, 0.28 (meq/100g), 3.56 µg/g and 441.09 µg/g respectively.

The present investigation was found that soil pH moderately influenced by depth. The soil pH increases with depth of the pond and inverse relation with sulfur (Table 1). The average pH of soil was found almost similar in different categories of pond (Table 1). The average pH 7.65 indicates the basic nature of pond soils. The reason is that farmers continuously use lime to maintain the water quality of these ponds.

The freshwater fish species generally show poor tolerance to large changes in water pH increases with depth of the pond and inverse relation with sulfur (Table 1). The pH of the soil is one of the most important factors for maintaining pond productivity since it

controls most of the chemical reactions in the pond environment. The average pH of soil was found almost similar in different categories of pond (Table 1). The average pH 7.65 indicates the basic nature of pond soils. The reason is that farmers continuously use lime to maintain the water quality of this pond. In the present study; we found that pond soil salinity become low with increasing age of the pond (Table 1).

Table 1: Physical parameters and some nutrient levels in the experimental ponds

Parameters	1-5 years old		6-10 years old	
	Shallow (0.5-1m)	Deep (2-3.5m)	Shallow (0.5-1m)	Deep (2-3.5m)
Ph	7.34±0.2	7.90±0.3	7.72±0.2	7.89±0.6
ECe (dS/m)	1.62±0.4	2.98±1.2	1.22±0.6	2.48±1.4
Organic matter (%)	1.79±0.4	1.87±0.4	2.04±0.3	2.56±0.4
Organic carbon (%)	1.14±0.2	1.10±0.2	1.18±0.2	1.52±0.2
Nitrogen (%)	0.12±0.03	0.12±0.2	0.12±0.2	0.11±0.02
Phosphorus (µg/g)	4.12±1.2	4.48±1.3	3.61±0.25	2.19±0.1
Potassium (meq/100g)	0.31±0.02	0.27±0.02	0.29±0.06	0.38±0.05
Sulphur (µg/g)	616.28±8.9	428.76±28.5	554.85±17.08	178.24±46.4

There was some dissimilarity found for organic carbon contents in pond soil with changing pond age and there was significantly positive and negative correlation of soil pH with pond depth and sulfur respectively (Table 2). Soil salinity had significant positive correlation with pond depth but negative with pond age (Table 2). On the other hand, salinity of deep pond becomes higher than the shallow pond.

Table 2: Pearson Correlation among the physical parameters and nutrients with pond age and depth

Para	Age	Depth	Ph	ECe	OM	OC	N	P	K	S
Ph	0.377	0.678								
ECe	-0.196	0.718	0.292							
OM	0.538	0.437	0.308	0.304						
OC	0.538	0.389	0.176	0.272	0.978					
N	-0.198	-0.232	-0.194	-0.083	0.223	0.114				
P	-0.602	-0.113	-0.016	0.146	-0.448	-0.515	-0.147			
K	0.476	0.403	0.164	0.367	0.603	0.687	0.384	0.147		
S	-0.532	-0.854	-0.667	-0.378	-0.538	-0.536	0.403	0.408	-0.509	

The average electrical conductivity of all selected pond soil was recorded 2.03 dS/m. It is apparent from the present study that salinity of the pond soil rapidly increases with comparatively higher depth but gradually decreases with increasing age of the pond. In the present study, we found that organic matter sharply increases in bottom mud with age and depth of pond. The composition of the soil bottom is related to organic matter. It is observed that the accumulation of organic matter increases with age and depth of pond. The average accumulation of organic matter lies within 1.76 to 2.51 %.

Organic carbon increases with age and depth of the pond but a little dissimilarity found in (1-5) years ponds. The average percentage of organic carbon recorded within 1.06 to 1.46 %. The average nitrogen was recorded 0.09 % in present study. There have no noticeable change according to age and depth of pond. About 99% of the combined nitrogen in the soil is contained in the organic matte (Humus) in the form of amino acids, peptides and easily decomposed proteins. It may also be in the form of inorganic compounds such as NH_4^+ and NO_3 which are utilized by green plants (Phytoplankton). Anaerobic organisms

(Bacteria) helps in the decomposition of organic matter into simple inorganic forms forming products such as CO_2, water and ammonia which influences directly or indirectly in pond productivity.

The present study identified that comparatively the amount of phosphorus was decreasing with age and depth of the pond though mismatched with deep ponds of (1-5) year pond group. Average value of phosphorus recorded 3.56 µg/g and which ranges 2.16 to 4.43 µg/g in different category ponds (Table 1). The average percentage of potassium of all selected pond was recorded 0.28 (meq/100g). Phosphorus had significant negative correlation with pond age but positive correlation with sulfur (Table 2). Sulfur had significant negative correlation with both pond age and pond depth (Table 2).

We recorded that sulfur in the pond soil has strongly inverse relation with age and depth of pond. The average sulfur of the all selected pond soil was recorded 441.09(µg/g) but in deep pond of 6-10 years old pond group have very low compare to other categories pond.

DISCUSSION

In this research, we found that there were some effects of pond age and depth on physicochemical parameters of aquaculture farm. pH was moderately influenced by pond depth. The pH of the soil is one of the most important factors for maintaining pond productivity since it controls most of the chemical reactions in the pond environment. Near neutral to slightly alkaline soil pH (7 and a little above) is considered to be the ideal for fish production. If the pH is too low (Strongly acidic), this can reduce the availability of key nutrients in the water and lower pond fertility (Anonymous, 2006).

Salinity is a major driving factor that affects the density and growth of aquatic organisms' population (Jamabo, 2008). Salinity was increasing with increasing pond depth. Near neutral to slightly alkaline soil pH (7 and a little above) is considered to be the ideal for fish production. If the pH is too low (Strongly acidic), this can reduce the availability of key nutrients in the water and lower pond fertility (Anonymous, 2006). Salinity is a major driving factor that affects the density and growth of aquatic organisms' population (Jamabo, 2008). According to Meck (1996) fresh and saltwater fish species generally show poor tolerance to large changes in water salinity. Often salinity limits vary species to species level.

There had significant positive correlation with pond age, pond depth, organic carbon and potassium and negative correlation with phosphorus of organic matter. Organic carbon acts as the source of energy for bacteria and other microbes that release nutrients through various biochemical processes (Jahiruddin and Satler, 2010). The reason is that farmers restore the pond bed, dry it and supply comparatively less supplementary feed.

The importance of soil phosphorus for increasing the aquatic productivity is well recognized. It is second only to nitrogen in frequency of use as a fertilizer element. The availability of phosphorus is important to aquatic productivity owing to the fact that PO_4 ions in soil form insoluble compounds with iron and aluminum under acidic conditions and with calcium under alkaline conditions, rendering the phosphorus ion unavailable to water body (Haque, 2006).

We have found almost similar value in different categories pond. Generally, relatively small amount of potassium is need in fish ponds. Optimum concentrations of this element are unknown. However, it is readily available absorbed by plant tissues and it is particularly effective in stimulating the growth of aquatic flora. The reason is that hydrogen sulphide gas concentration found more during pond construction but so long could soon be reduced by oxidizing.

CONCLUSION

Sustainable aquaculture development can bring real and lasting benefits for aqua farmers and dependent communities. There is, therefore, an increasing need for good planning and management of aquaculture in our countries. In the above discussion it has shown

that soil pH, alkalinity, organic carbon and organic matter more or less similar with some exception (Sulfur) to the standard level for aquaculture activity in Bangladesh. Public opinion is also more or less similar to the investigation. Considering the results of soil analysis it may be suggested that soil characteristics in the study area seems to be suitable for development of aquaculture. It has been found that very shallow and comparatively deeper ponds are not suitable for commercial aquaculture in this area.

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