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Qualitative and quantitative analysis of phytoplankton in culture pond of Noakhali district, Bangladesh

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Abstract
A study was conducted on qualitative and quantitative analysis of phytoplankton in cultured ponds of two fish farms of Noakhali district, Bangladesh from 15 September to 15 November 2012 to identify and estimate the abundance of phytoplankton in various culture ponds of two fish farms. Analyses of phytoplankton samples recorded a total of 4 classes phytoplankton viz.; Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae. Out of 21 phytoplankton genera identified, 5 belong to Cyanophyceae, 7 to Chlorophyceae, 5 to Bacillariophyceae and 4 to Euglenophyceae. Among the identified genera, *Euglena, Microcystis, Eurolena* were found to be dominant genera. Total phytoplankton abundance was varied from 36×10^5 cells/L to 94.92×10^5 cells/L in the experimental ponds. Among all experimental ponds, Chlorophyceae was found dominant (44.4×10^5 cells/L). Second dominant group was Euglenophyceae (39.6×10^5 cells/L) observed in pond-1 of Bismillah Agro Production (BAP). Total phytoplankton densities were recorded 47.82×10^5cells/L and 51×105 cells/L in pond-1 and pond-2 of Subarna Agro Based Initiative (SABI) respectively. In BAP, total phytoplankton densities were recorded 94.92×10^5cells/L and 36×10^5 cells/L in pond-1 and pond-2 respectively. Management technique and water quality parameters were also studied during study period namely water temperature, conductivity, salinity, transparency, dissolve oxygen and pH. The present study reveals that phytoplankton species are variable among the culture ponds and their density is also variable. The information provides for more research to compare water quality and pond phytoplankton characteristics in earthen aquaculture systems with and without fish stocking. Further studies on the seasonal changes of water quality parameters and its effects on phytoplankton production in the fish ponds and all year extended monitoring is recommended in future studies.

Keywords: Bangladesh, phytoplankton, fish culture pond, physico-chemical parameters

1. Introduction

The quality of life is linked with quality of environment. The biological components of a freshwater ecosystem are ruled by the physico-chemical conditions (Saksena *et al*., 2008) [18]. Phytoplanktons are integral components of freshwater wetlands which significantly contribute towards succession and dynamics of zooplankton and fish. Community structure, dominance and seasonality of phytoplankton in tropical wetlands are highly variable and are functions of nutrient status, water level, morphometry of the underlying substrate and other regional factors (Gopal and Zutshi, 1998; Zohary *et al*., 1998; Agostinho *et al*., 2001) [10, 26, 2]. Phytoplankton forms the main producers of an aquatic ecosystem which control the biological productivity. The variability of phytoplankton with the seasonal changes in aquatic environment is very much necessary for the maintenance of water quality and sustainable aquaculture in Bangladesh. The success of phytoplankton estimation and productivity would largely depend upon the use of correct methodology which involves collections of samples, fixation, preservation, analysis and computation of data. The qualitative and quantitative abundance of plankton and its relation to environmental condition has become a prerequisite for fish production. Noakhali is one of the southern coastal districts of Bangladesh. In Noakhali region, there are thousands of small and larger ponds where extensive fish culture is mainly practiced depending on natural food (phytoplankton). In the fish farms, natural food productivity is increased in various ways such as artificial feeds and fertilizers (both organic and inorganic) etc., which lead to nutrient enrichment in fish ponds.

In any aquatic body the primary productivity has given information relating to the amount of energy available to support bioactivity of the system (Vollenweider, 1969) [24]. The quality and quantity of planktons vary in relation to depth, site, time and the season of the collection. They also differ according to biological and climatic factors (Sukumaran and Das, 2002) [22]. Good water quality in fish or shrimp ponds is essential for survival and adequate growth (Burford, 1997) [7]. Little or no studies on water quality and phytoplankton in culture ponds within Noakhali region of Bangladesh have been done, though similar experiments have been in fish ponds from the Indian sub-continent (Bose and Philops, 1994; Wahab *et al*., 1994; Hossain *et al*., 2006) [5, 25, 11]. Therefore, this research reports on qualitative and quantitative analysis of phytoplankton in culture ponds with some recommendations for further studies in the earthen fish ponds within the Noakhali district, Bangladesh. The study was conducted for understanding the nutritive quality of the pond water in order to assess its suitability for inland aquaculture of fishes.

2. Materials and Methods

2.1 The experimental site and periods

The study was conducted in four culture ponds of two fish farms situated in Subarno Agro Based Initiative (SABI) and Bismillah Agro Production (BAP) in Sonapur region of Noakhali district, Bangladesh. Sampling was conducted over a 3-months period from 15 September to 15 November, 2012. Two ponds (pond-1 and pond-2) of SABI were used as a culture pond and nursery pond of mainly monosex tilapia with white fish respectively and two ponds (pond-1and pond-2) of BAP were also used as a nursery pond of monosex tilapia with white fish and only monosex tilapia respectively. The ground water is the main source of water for these ponds. These ponds were well protected from the entrance of surface runoff. These ponds were managed by lime, fertilizer, cow dung, zeolite etc.

2.2 Phytoplankton sampling and analysis

Plankton samples were collected using plankton net (25 µm mesh size) and fixed in 5% formalin on site. Identification of the phytoplankton species was conducted under a phase contrast light microscope at 16×40 and 16×10 magnification (Model No: XSZ21-05DN, Made in China) with bright field and phase contrast illumination. Quantitative analyses of Phytoplankton were done on Sedge wick-Rafter counting chamber (S-R cell). Analyses involved transfer of 1 mL sub-sample from each of the samples to the Sedge wick-Rafter counter and counting of cells within 10 squares of the cells, chosen randomly. The cell counts were used for compute the cell density using the Striling (1985) [21] formula where the plankton density is estimated by-

$$N= (A\times1000\times C)/ (V\times F\times L)$$

Where,
N=no. Of plankton cells or units per liter of original water
A=Total no of plankton counted.
C=Volume of final concentrate of the sample in ml.
V=volume of a field in cubic mm.
F=No. Of fields counted.
L=Volume of original water in liter

The phytoplankton were then identified up to the genus level and enumerated by the following (APHA, 1992; Bellinger, 1992) [3, 4]. The mean number of phytoplankton was recorded and expressed numerically per liter of water of the pond.

2.3 Water quality analysis

Surface water samples were collected once in a month between 10:00 and 11:00 hours for analysis of various physico-chemical parameters using dark bottles. Water temperature was measured on site using a mercury thermometer. Physico-chemical parameters including pH, salinity, and conductivity were determined using a portable meter. Dissolve oxygen (DO) were estimated by dissolve oxygen test kit. Transparency was measured using a Secchi disc at two depths (disappearing, reappearing) using a black and white standard colour coded disc.

2.4 Statistical analysis

Graphs and tables were represented in Microsoft excel. The Microsoft Excel 2007 was used to plots graphs for dissemination of the results.

3. Results

3.1 Qualitative status of phytoplankton community in culture ponds of two fish farms

In the present study, 21 genera were identified in the culture ponds of two Fish farms (Table 1). All most all the genera were found in the culture ponds of both fish farms during the sampling period.

Table 1: Generic status of phytoplankton with their different groups recorded from SABI and BAP Fish farm during the study period.

Group	Genus
Euglenophyceae	*Euglena*
	Phacus
	Tracelomonus
	Strombomonus
Bacillariophyceae	*Amphora*
	Cyclotella
	Cymbella
	Navicula
	Surrirella
	Tabellaria
	Cymatopleura
Chlorophyceae	*Chlorogonium*
	Pediastrum
	Scenedesmus
	Ankistrodesmus
Cyanophyceae	*Anabaena*
	Aphanothece
	Merismopedia
	Gomphosphaeria
	Oscillatoria

3.2 Quantitative analysis of phytoplankton community in culture ponds of two Fish farms

Phytoplankton density was found variable among the culture ponds of both fish farms. During the study period, highest total density of phytoplankton was observed in pond-1 (94.92×10^5 cells/L) of BAP and lowest was also found in pond-2 (36×10^5 cells/L) of BAP (Table 2).

Table 2: Phytoplankton density observed among the cultured ponds of both Fish farms in Noakhali region.

Group	Cultured pond			
	SABI		BAP	
	Pond-1 (Cells/litre)	Pond-2 (Cells/litre)	Pond-1 (Cells/litre)	Pond-2 (Cells/litre)
Euglenophyceae	7.8×10^5	3×10^5	39.6×10^5	7.02×10^5
Bacillariophycee	10.02×10^5	24×10^5	9.6×10^5	4.98×10^5
Chlorophyceae	28.02×10^5	15×10^5	44.4×10^5	15×10^5
Cyanophyceae	1.98×10^5	9×10^5	1.32×10^5	9×10^5
Total phytoplankton density	47.82×10^5	51×10^5	94.92×10^5	36×10^5

3.3 Comparison of Phytoplankton density between the two culture ponds of SABI

Among the two ponds of SABI, while Chlorophyceae group was found dominant in pond-1, Bacillariophyceae group was found dominant in pond-2. In pond-1, Euglenophyceae and Bacillariophyceae were found medium level while Cyanophyceae was recorded in lowest level. On the other hand, in pond-2 of SABI, Chlorophyceae and Cyanophyceae density was found moderate than the group Euglenophyceae (Fig.1).

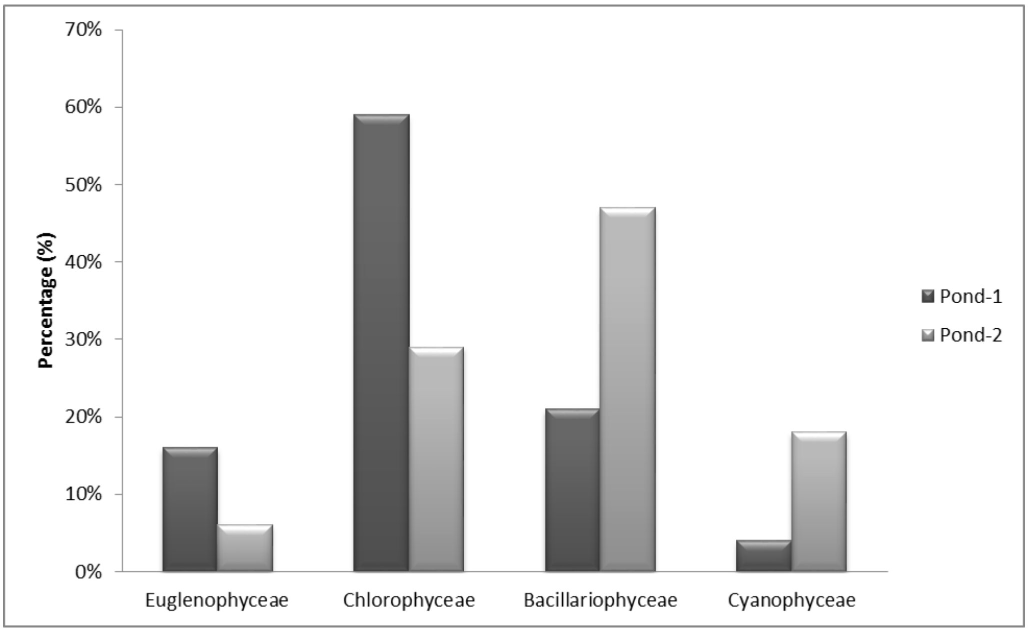

Fig 1: Comparison of phytoplankton density between two exper imental ponds of SABI.

3.4 Comparison of Phytoplankton density between the two culture ponds of BAP

Among the two ponds of BAP, while Chlorophyceae was found dominant in the both ponds, Euglenophyceae was found dominant only in the pond-1. The group Bacillariophyceae was found almost in similar level in both ponds of BAP. The group Cyanophyceae density is lower in pond-1 than the pond-2 of BAP (Fig. 2).

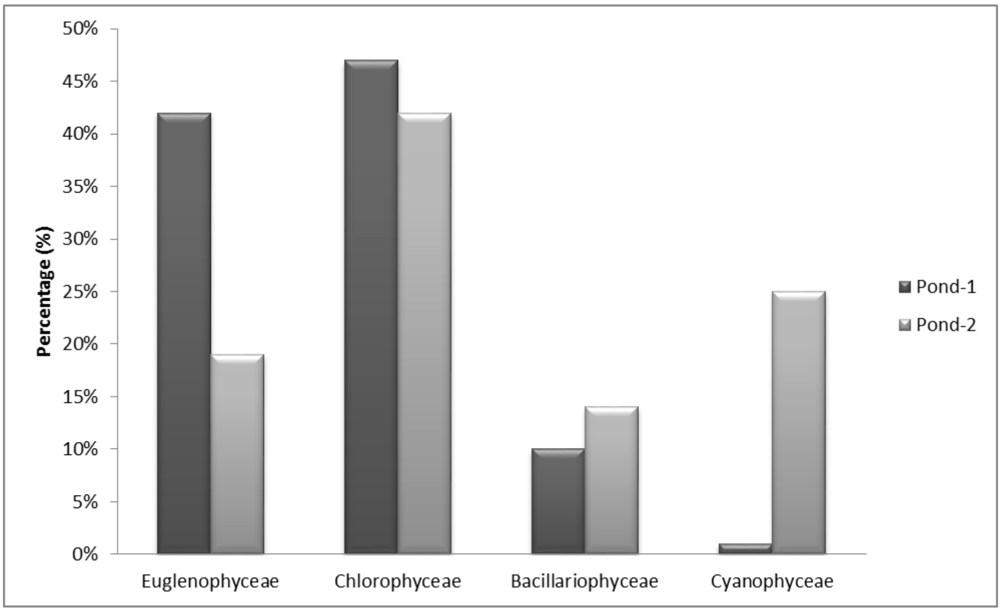

Fig 2: Comparison of phytoplankton density between two culture ponds of BAP.

3.5 Water quality parameters observed in the culture ponds of two fish farms

During study period, water samples were collected for water quality parameter analysis. Table 3 represents observed water quality parameters during the study period.

Table 3: Physico-chemical parameters of culture pond in two Fish farms

Water quality parameters	Cultured pond			
	SABI		BAP	
Physical parameters	Pond-1	Pond-2	Pond-1	Pond-2
Transperancy (cm)	30-34	28-32	25-30	42-45
Temperature (^{0}C)	28-30	28-30	28-30	28-30
Salinity (ppt)	0	0	0	0
Conductivity (ppm)	460-545	500-573	500-565	465-567
Chemical parameters				
pH	6.9-7	8-8.3	7.5-8.9	7.9-8.3
DO mg/L	3.7-5	4-4.5	3.9-4.8	3.8-4.3

4. Discussion

Qualitative status of phytoplankton community are depends on pond, season, management activities, water quality parameters etc. During the study period, 21 genera of phytoplankton population were identified which falls into four major groups named Bacillariphyceae, Euglenophyceae, Chlorophyceae, Cyanophyceae. Margalef (1964) [13] also reported that the phytoplankton population in nutrient rich waters is more diverse than those in nutrient deficient waters. Verma and Shukla (1970) [23] recorded 30 genera of phytoplankton from Kamala Nehru Tank, Muzaffarnagar, India. Islam *et al.* (2017) [12] recorded 7 species of phytoplankton and algae different water bodies at Bangladesh Agricultural University campus in Mymensingh. Similarly, Hossain *et al.* (2006) [11] recorded 38 genera of phytoplankton during a three month study period in earthen fish ponds within the Mymensingh region, Bangladesh. Affan *et al.* (2005) [1] studied on seasonal cycle of phytoplankton in aquaculture ponds in Bangladesh over a period of 16 months and identified 45 species belonging to four major groups; Bacillariphyceae, Euglenophyceae, Chlorophyceae and Cyanophyceae. The total density of phytoplankton abundance 94.92×10^5 cells/L was found higher in pond-1of BAP than others experimental ponds, whereas minimal 36×10^5 cells/L was found in pond-2 of BAP during study period. Flura *et al.* (2015) [9] reported 28,552±7,486 cells/L of phytoplankton biomass was found in the Balla beel in Moulovibazar district, Bngladesh. Affan *et al.*, (2005) [1] recorded the phytoplankton abundance varied from 25.6 to 1590.6×10^6 cells L^{-1} at similar kind of studies in aquaculture ponds in Bangladesh. Among two ponds of SABI, phytoplankton density was higher in pond-2 than pond-1 because of pond-2 was used as a culture pond and many fertilizers were used in this pond. Bacillariophyceae group was found dominant in pond-2 of than pond-1 of SABI because of lower pH in pond-1. Patrick (1973) [15] observed that the acidic waters do not support an abundance of Bacillariophyceae, while in alkaline waters with pH above 8.0, their density is more. Chlorophyceae dominated the phytoplankton groups, followed by Cyanophyceae, Bacillariophyceae, Euglenophyceae and Dinophyceae in the pond-1 of BAP. This is attributed to favorable water quality attributes, particularly high levels of total alkalinity recorded during the study. Similar findings where high phytoplankton density is recorded are also reported by Islam *et al.* (2017) [12] and Seenayya (1971) [19]. The effects of fertilizer application and frequent water change to avoid development of anoxic pockets within the pond are also to account for these high levels of plankton productivity observed in this pond. Total phytoplankton density was lowest in pond-2 of BAP than other experimental pond during the study period. Because of pond-2 of BAP was used as hapa nursery pond for only mono-sex tilapia. In this pond, hormonal feed were used to reverse the sex of tilapia and other artificial feed and fertilizers were not used in study period which generally stimulate the growth of phytoplankton productivity. As a result, phytoplankton density was not found at abundant rate in pond-2. Water temperature is a pre-requisite for increasing the phytoplankton density. In the present study, temperature and pH value was recorded 28.0-30.0 ^{0}C and 6.9 -8.9 respectively. Chowdhury *et al.*, (2007) [8] recorded the temperature yearly ranged from 18.5 ^{0}C in December to 33.72 ^{0}C in August and pH value is 7.12-8.68 for study on seasonal variation of plankton population of Borobila beel in Rangpur district. Boyd (1982) [6] recommends optimal temperatures for fish culture, in the range of 26.06-31.97 °C, if fish growth and consequently yields are to be optimized. Similarly, secchi disk depths recorded (24-30 cm) showed no significant difference, implying that phytoplankton abundance and productivity levels were similar throughout all months during the study period. Neogi *et al.* (2016) [14] revealed that phytoplankton diversity is the key factor of productivity of water body. Reported that the transparency of water depends on several factors such as silting, plankton density, suspended organic matter, latitude, season and the angle and intensity of incident light. However Sreenivasan (1964) [20] further reported that peaks of phytoplankton abundance occur at different periods in different years. It should also be noted that temperature alone may not account for variations in phytoplankton densities as other factors such as high pH, alkalinity, carbon dioxide and nutrients are also responsible for the organic production (Pulle and Khan, 2003) [16]. Thus it may be concluded that the composition of phytoplankton is dependent on different abiotic factors either directly or indirectly.

5. Conclusions

A detailed description of the dynamics of phytoplankton within these ponds hasn't been given in this study since the samples only cover a period of 3 months. Hence there is a need to carry out successive studies to look at the dynamics of the plankton groups within the culture ponds sampled over several years in order to fully characterize the variations both due to water quality and variability in climatic conditions. This information is useful for the future research as a foundation study towards characterization of these dynamics within the culture ponds of the Noakhali, Bangladesh.

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