Asian Australas. J. Biosci. Biotechnol. 2022, 7 (1), 13-22; https://doi.org/10.3329/aajbb.v7i1.59385

**Asian-Australasian Journal of Bioscience and Biotechnology**
ISSN 2414-1283 (Print) 2414-6293 (Online)
https://www.ebupress.com/journal/aajbb/

*Article*

# Diversity and distribution of plankton community and physico-chemical parameters in wishpond, wishpond-aquaponics system and traditional fish pond

Md. Rayhan Hossain[1*], Md. Aktaruzzaman[1], Md. Tanvir Rahman[2] and Md. Abdus Salam[2]

[1]Marine Fisheries and Technology Station, Bangladesh Fisheries Research Institute, Cox´s Bazar-4700, Bangladesh
[2]Department of Aquaculture, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

*Corresponding author: Md. Rayhan Hossain, Bangladesh Fisheries Research Institute, Marine Fisheries and Technology Station, Cox's Bazar-4700, Bangladesh. E-mail: rfaa_hossain@yahoo.com

Received: 13 March 2022/Accepted: 16 April 2022/Published: 28 April 2022



**Abstract:** This study was designed to determine the interrelationship between physico-chemical parameters and plankton community in three different aquaculture systems (wishpond, wishpond aquaponics and traditional fish pond). The water quality parameters, dissolve oxygen (DO), temperature, pH, ammonia, alkalinity and transparency were monitored and found within the recommended range. Different phytoplankton of four (4) different groups were observed where Chlorophyceae group was the most dominant (8.03±0.19) × $10^3$ cells/l in wishpond system and Euglenophyceae was the less dominant (45.86±1.15) × $10^3$ cells/l in traditional pond system. In addition, Zooplankton of *Rotifera* was found the most dominant (17.81±0.09) × $10^3$ cells/l with following *Cladocera* and *Copepoda*. A significance difference were observed in case of plankton groups among three different aquaculture systems. The interrelationship among the physico-chemical parameters, temperature showed strongest relationship with all the other physico-chemical parameters where transparency showed no relation with dissolve oxygen. In case of phytoplankton groups, all four groups showed more or less positive relationship in all three different aquaculture system. The findings of this study will assist small-scale producers in choosing and properly operating a simple aquaponics system.

**Keywords:** plankton diversity; water parameters; wishpond; wishpond aquaponics; traditional fish pond; fish culture system

## 1. Introduction

Aquaponics is a food production system that couples aquaculture (culture of aquatic organisms) with hydroponics (cultivating plants in water) whereby the nutrient-rich aquaculture water is fed to hydroponically-grown plants (Rakocy, 2012; Baganz *et al.*, 2021). Aquaponics offers a diverse and stable polyculture system vegetables grow and fish raise at the same time. By having two sources of profit, farmers can continue to earn money (Blidariu and Grozea, 2011). The aquaponics system allows to grow a large variety of crops including vegetables, herbs, flowers and aquatic plants to cater to a broad spectrum of consumers. Herbs, lettuce and speciality greens such as basil or spinach are especially well suited for aquaponics systems due to their low nutritional needs. For the growing number of environmentally conscious consumers, products from aquaponics systems are organic and pesticide free, whilst also leaving a small environmental footprint. Aquaponics system additionally are economically efficient due to least water usage, effective nutrient cycling and needing little land to operate. Perhaps, requirement of soil is minimum and only a little bit of water is required, aquaponics systems can be set up in areas that have traditionally poor soil quality or contaminated water. More importantly, aquaponics systems are usually free of weeds, pests and diseases that would affect soil, which allows them to consistently and quickly produce high quality crops to sell.

Water media that is used as habitat as well as the supplier of food for fish and plants in aquaponics system where biomass production of that water body is directly dependent on the quality and quantity of the food organisms available there. Live organisms of the water consist of several groups and among these, plankton is very important for fish production. Phytoplankton is the basic of primary production of all types of water bodies and is used as food by fish directly or indirectly (Hossain *et al.*, 2013).

The microscopic plankton algae of the ponds are critical food for planktivorous fish species (carps) as well as the larvae of commercially important crustaceans and fin fishes. In most cases, the proliferation of planktonic algae is beneficial for aquaculture, fish production and wild fisheries operations. However, in some situations algal blooms can have a negative effect, causing severe economic losses to aquaculture, fisheries operations and having major environmental and human health impacts. So, the monitoring programmes of plankton are very important because they may provide information on possible new introductions and may serve as early warning systems to detect the onset of potentially hazardous blooms and may suggest predicative factors for blooms. Species diversity indices when correlated with physical and chemical parameters provide one of the best ways to detect and evaluate the impact of pollution on aquatic communities (Hossain *et al.*, 2013). So, study on plankton diversity and physico-chemical parameters of different pond systems in aquaponics would result in better understanding in the quality of end product of the aquaponic and economic viability of the system.

The knowledge of planktonic biomass available in an ecosystem is of fundamental importance for fish culture. The value of phytoplankton in a water body is the basic of food chain of fishes (Islam *et al.*, 2022). The qualitative and quantitative abundance of plankton and its relation to environmental condition has become a prerequisite for fish production. The algae which occur in fish ponds is extremely important since they directly affect the properties of water quality such as colour, smell, taste, dissolved oxygen, turbidity (Boyd, 1982). Therefore, a thorough knowledge of abundance of phytoplankton and its quality in time and space in relation to environmental condition has become a prerequisite for fish production (Hossain *et al.*, 2013).

Changes in the phytoplankton community of large freshwater lakes have been long recognized as a good indicator of the trophic status and environmental quality (Reynolds, 1996). Temporal variability in the structure and function of a phytoplankton community are the fundamental importance to aquatic system. Aquatic environments are subject to high temporal variation, with frequent reorganization of relative abundance and species composition of phytoplankton, as a result of interaction between physical, chemical and biological variables (Reynolds *et al.*, 2000). In freshwater phytoplankton ecology, seasonality is often used to specify those patterns of successional sequences which occur during an annual cycle in response to changing in climatic variables.

Water quality determines the species feasibility for culture under different environments (Dhawan and Karu, 2002). The overall productivity of a water body can easily be deduced from its primary productivity, which is the backbone of the aquatic food chains (Ahmed and Singh, 1989). The phytoplankton population represents the biological wealth of a water body, which is the basement of the food chain. Both the qualitative and quantitative abundance of phytoplankton in a fish pond are of great importance for managing the successful aquaculture operations, as they vary from location to location and pond to pond within the same location even within similar ecological conditions (Boyd, 1982). Phytoplankton not only serves as food for aquatic animals, but also plays an important role in maintaining the biological balance and quality of water (Pandey *et al.*, 2004). The productivity of freshwater community that determines the fish growth is regulated by the dynamics of its physico-chemical and biotic environment (Wetzel, 1983). The physico-chemical and biological characteristics of water also play a big role in plankton productivity as well as the biology of the cultured organisms and final yields. The pH, dissolved oxygen, alkalinity and the dissolved nutrients are important for the phytoplankton production (Bais and Agarwal, 1990). Plankton diversity responds rapidly to changes in the aquatic environment particularly in relation to nutrients. Physico-chemical attributes of a water body are principal determinants of fish growth rates and developments (Jhingran, 1991).

In Bangladesh, most farmers use agrochemicals to enhance food production and storage life, though the country lacks oversight on safe levels of chemicals in foods for human consumption (Islam *et al.*, 2021). A low-cost aquaponics system provides organic production and fish for people living in adverse climatic conditions such as the salinity-prone southern area and the flood-prone haor area in the eastern region. Aquaponics innovates a form of subsistence farming for micro-production goals at the community and personal levels whereas it is aimed exclusively at the commercial level, the latter of the two approaches take advantage of economies of scale.

In the present study an attempt has been made to assess the diversity of plankton and their distribution and fluctuations in the hydrological variables in wishpond, wishpond aquaponics and traditional fish pond. The outcomes of this study will help the small scale producers to select a simple aquaponics system, increase its productivity and run it properly.

## 2. Materials and Methods

### 2.1. Study sites

The study was carried out at Center for Development Innovation and Practices (CDIP), Ashulia Branch, Dhaka, Bangladesh. The study was carried out for four (4) months in 2020 to measure the diversity and distribution of plankton community in wishpond, wishpond aquaponics system and traditional fish pond.

### 2.2. Terms description

Wishpond is a special designed pond with limited spaces. The ponds ($2.1 \times 1.5 \times 0.3$ $m^3$) were designed with tarpaulin lining inside the pond to hold water (Figure 1). A number of sac bag with soil were arranged adjacent to the pond for plants cultivation. In addition, a rack was constructed for leafy items like gourd, beans etc. cultivation. The ponds were filled with underground water.

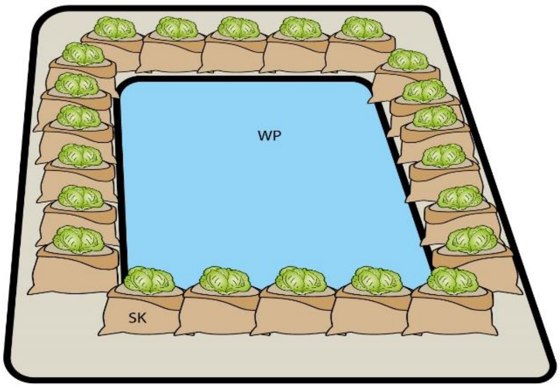


**Figure 1. Diagram of wishpond system (WP-Wishpond, SK –Sac Bag).**

On the other hand, a simplified aquaponics system with the wishpond is termed as wishpond aquaponics system. Six food grade plastics bottles of 20L were incorporated to the system to assist aquaponics vegetables cultivation (Figure 2). The bottles were filled with brick-lets to purify the wishponds water (ammonia-nitrate) when passing. A pump was used to drive the ponds water into the systems. Direct connections were established from the bottom of the bottles to the wishponds to pass the recycled water into the ponds.

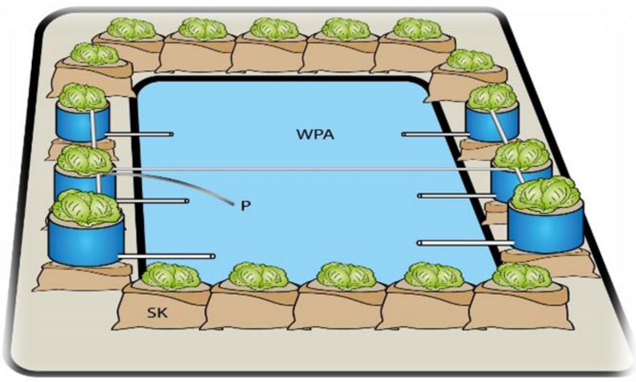


**Figure 2. Diagram of wishpond aquaponics system.**
**(WPA-Wish pond aquaponics, F- Filter, P-Pump, SK –Sac Bag)**

The ponds which we use traditionally as grow-out pond for culturing different types of fish species was defined as traditional fish pond. For this experiment, traditional ponds of 1 × 1.5 × 0.3 $m^3$ volume were selected.
For the experimental setup, three of each types of ponds were selected and prepared for the experiment.

### 2.3. Fish stocking and vegetables planting

Tilapia (*Orechromis niloticus*) fingerlings were stocked in every system with maintaining a uniform stcoking density (200 ind/$m^3$). Commercial floating feed comprising 30% protein was fed at 5% body weight rate. The total feed was divided into two different ration of a day. In additions, various types of vegetables (Chilli, Brinjal, Lettuce, Mint etc.) were planted in sac bags of wishpond system and bottles of aquaponics system. In the aquaponics systems, vegetables were implanted through the bricks and gravels.

### 2.4. Water quality parameters

Water quality was measured in monthly basis. The physico-chemical parameters dissolved oxygen (DO), temperature, ammonia ($NH_3$), and alkalinity were measured by HANNA multiparameter photometer (HI 83099). In addition, transparency was measured by using sechi disk and pH was measured by using HANNA pH meter.

### 2.5. Plankton diversity

#### 2.5.1. Sample collection

The sampling site was visited once in each month for collection of samples. Samples were always collected from a permanent area previously set up in each treatment. A plankton net of 20 µm having a filtering cone attached to a metal ring terminated in a collecting bottle of 20 ml was used to collect the sample. A net with a mesh size of 60 µs was also used to separate the zooplankton and phytoplankton. The 5 liter bucket collected hundreds of liters of water within a 250 m radius. The water was then filtered through the plankton net and concentrated to 20 ml. After finishing sampling all the materials were kept in a cool box and transported to the laboratory for preservation and further analysis.
Adding formalin to the collected plankton in the glass bottles. About 250 µL formalin was added with 50 ml of sample by pipette to preserve the plankton. The final concentration of formalin becomes approximately 5%.

#### 2.5.2. Cell density

Plankton samples were studied under microscope using the Sedge Wick Rafter (S-R) cell a special type of slide having a counting chamber which is 50 mm long, 20 mm wide and 1 mm deep. The volume of the chamber was 1 ml (1cc or 1000 cu mm). The counting chamber was equally divided into 100 fields, each with a volume of 1 µl. The cell was filled and covered with cover slip so as to eliminate the air bubbles, and left to stand for 10 minutes to allow the plankton to settle. Then under microscope plankton were counted randomly.

#### 2.5.3. Quantitative estimate of plankton

Calculation of plankton from concentrated sample was done by using the formula:

$$N = (A\times100\times C) / (V\times F\times L)$$

Where,
N = No of plankton cells/ liter of original
A = Total no. of plankton counted
C = Volume of final concentrated sample in ml
V = Volume of a field (1cumm)
F = No. of fields counted
L = Volume of original water in liter

### 2.6. Statistical analysis

Data were validated by testing statistical significance of the mean value. Tukey test were performed to determine the significance differences among the mean. Pearson's correlation coefficient tests were performed to estimate the correlation coefficient. All the analysis was performed by using Microsoft Excel (2016) and IBMSPSS (V.20.0).

## 3. Results and Discussion

### 3.1. Physico-chemical parameters

Dissolve oxygen (DO) is one of the most crucial parameters for any aquaculture system. It controls the overall physiological systems of the aquatics animals. The mean values of DO of the experimental ponds were in between 3.37 ± 0.55mg/L to 5.37 ± 0.15mg/L during the study period. As DO is a crucial factor, it is recommended to maintain at least more than 5mg/L for good aquaculture production (Riche and Garling. 2003; Singh. 2010). However, DO concentration of 3mg/L has been recorded as the minimum optimum for Tilapia culture by Ross (2002). The values of DO ranged from 3.37 ± 0.55 mg/L to 5.20 ± 0.26 mg/L in wish pond, 3.87 ± 0.23 mg/L to 5.37 ± 0.15 mg/L in wishpond aquaponics, 3.39 ± 0.15 mg/L to 5.20 ± 0.26 mg/L in traditional ponds where the overall mean values were 3.77 ± 0.32mg/L in wish pond, 4.58 ±0.26 mg/L in wishpond aquaponics, and 3.89 ± 0.32mg/L in traditional pond system. Whatever the DO, there is no significance difference (P>0.05) was observed considering the culture system on the basis of time. DO levels differed significantly (<0.05) in relation to the study period (month-month) where wishpond aquaponics systems showed significantly higher DO than the other two systems. As DO is depend on so many others factors it seems to occur different concentration of DO at the same pond during a whole 24hours day (Boyd, 2010).

Temperature is an important parameter to maximize aquatic production. Water temperature has direct impact on aquatic production because of the influence on the physical, chemical, and biological parameters of a water body. The water temperature of the experimental ponds was in between 23.40 ± 0.10°C to 32.70 ± 0.20°C (Figure 3) during the study period. Ngugi *et al.* (2007) reported a temperature range (20-35°C) as ideal for tilapia culture in pond environment. However, the experimental temperature range also fall in the ideal range for plankton growth according to Islam *et al.*, (2021). The values of water temperature ranged from 23.40 ± 0.10°C to 32.23 ± 0.15°C in wish pond, 23.53 ± 0.0.06°C to 32.57 ± 0.32°C in wishpond aquaponics, 23.40 ± 0.10°C to 32.70 ± 0.20°C in traditional ponds where the overall mean values were 29.79 ± 0.03°C in wish pond, 29.89 ± 0.05°C in wishpond aquaponics, and 29.72 ± 0.03°C in traditional pond system. Temperature levels differed significantly (P<0.05) in relation to the study period (month-month) where there is no significance difference (P>0.05) were observed considering the culture system on the basis culture treatment.

pH is known as the index of aquaculture water quality. It varies depending on the volume of water body and its water fluctuations. The water pH values of the experimental ponds were in between 6.73 ± 0.54 to 7.65 ± 0.18 (Figure 3) during the study period. The range 6.5-9.0 was reported as optimum for Tilapia culture and plankton growth (Jhingra. 1991; Islam *et al.*, 2022). The values of pH ranged from 6.83 ± 0.57 to 7.60 ± 0.17 in wish pond, 6.93 ± 0.12 to 7.67 ± 0.76 in wishpond aquaponics, 6.73 ± 0.54 to 7.65 ± 0.18 in traditional ponds where the overall mean values were 7.15 ± 0.28 in wish pond, 7.29 ± 0.20 in wishpond aquaponics, and 7.10 ± 0.26 in traditional pond system. Whatever the pH, there is no significance difference (P>0.05) was observed considering the culture system on the basis of time.

The mean ammonia values of the experimental ponds were in between 0.017 ± 0.01mg/L to 1.33 ± 0.29mg/L (Figure 3) during the study period. For optimum growth of aquatic organisms, it is important to control ammonia. TNAU (2008) reported 0.02-0.05mg/L of ammonia as optimal ranged for Tilapia culture. In addition, BFAR (1992) also reported 0.02-0.05mg/L as the optimum for fish culture. However, the overall mean values of ammonia were 0.75 ± 0.18mg/L in wish pond, 0.46 ± 0.29 mg/L in wishpond aquaponics, and 0.79 ± 0.18mg/L in traditional pond system. Whatever the ammonia, there is no significance difference (P>0.05) was observed considering the culture system on the basis of time and culture system.

Alkalinity indicates the biological productivity of a waterbody. It has slight effect on fish growth. The mean ammonia values of the experimental ponds were in between 129.32 ± 2.42mg/L to 177.67 ± 8.74mg/L (Figure 3) during the study period. Alikunhi (1957) reported that, more than 100mg/L of total alkalinity should be present in a waterbody for better biological production. During the experimental period the overall mean values of alkalinity were 166.04 ± 6.05mg/L in wish pond, 160.56 ± 4.46 mg/L in wishpond aquaponics, and 168.04 ± 0.5.05 mg/L in traditional pond system. Whatever the alkalinity, there is no significance difference (P>0.05) was observed considering the culture system on the basis of time and culture system.

Transparency values of the experimental ponds were in between 10.67 ± 1.15cm to 31 ± 1cm (Figure 3) during the study period. The values of transparency ranged from 10.67 ± 1.15cm to 30.33 ± 1.53cm in wish pond, 16.67 ± 0.0.58cm to 31 ± 1cm in wishpond aquaponics, 12.67 ± 1.15cm to 30.23 ± 1.43cm in traditional ponds where the overall mean values were 16.48 ± 1.33cm in wish pond, 21.04 ± 1.24cm in wishpond aquaponics, and 18.38 ± 1.48 in traditional pond system. Boyd (1982) reported 15-40cm transparency range as ideal for fish growth. In this study, transparency levels differed significantly (P<0.05) in relation to the study period (month-month) and culture treatment types.

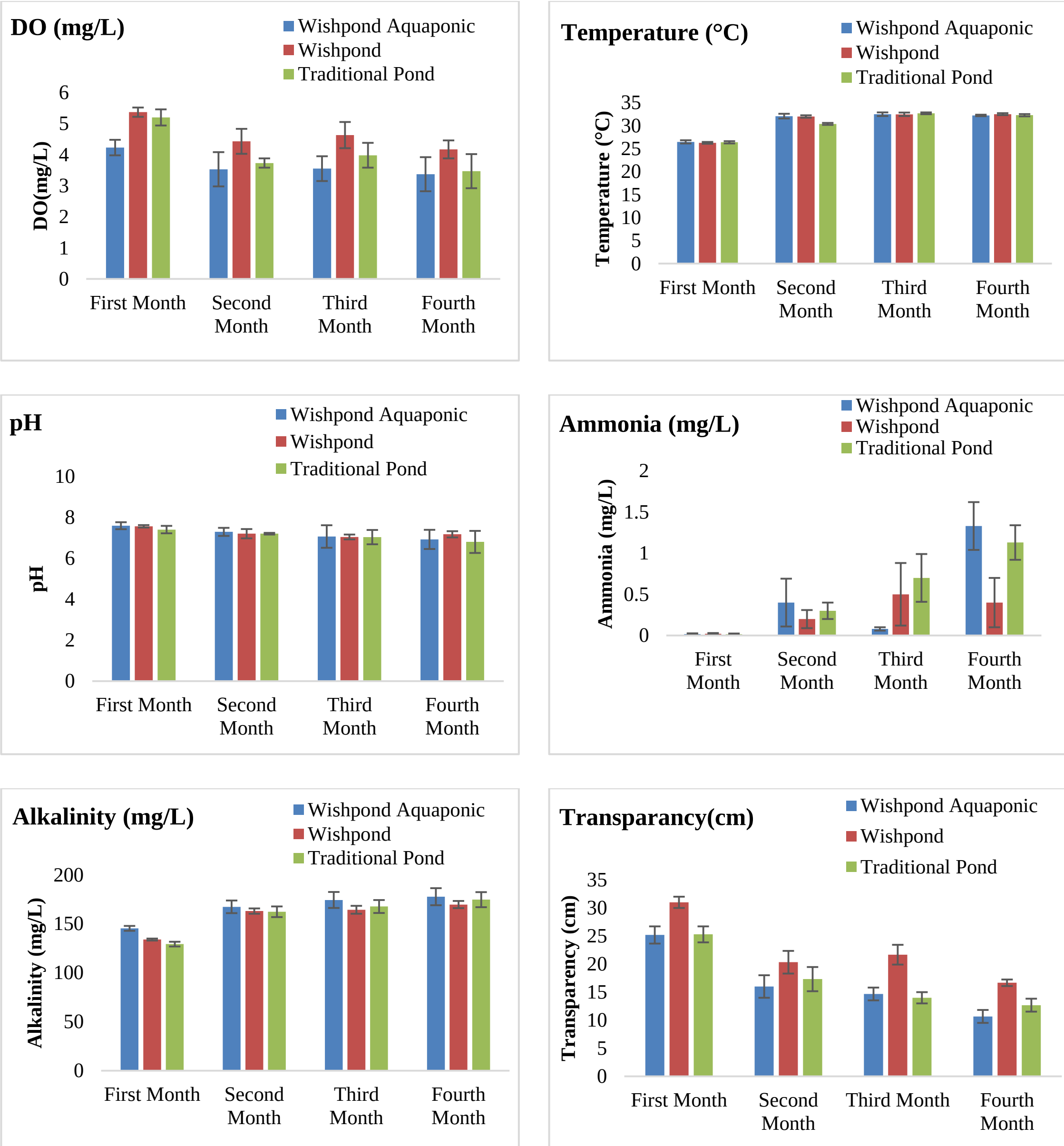


**Figure 3. Physico-chemical parameters of water in wishpond, wishpond aquaponics and traditional ponds culture system.**

## 3.2. Phytoplankton status

During the experimental period different phytoplankton of chlorophyceae, bacillariophyceae, cyanophyceae, euglenophyceae groups were observed. Phytoplanktons of chlorophyceae group were found the most dominant with following cyanophyceae, bacillariophyceae and euglenophyceae. The findings of the experiment was similar with the observations of Hossain *et al.* (1998). The types and diversity of plankton varies depending on the season and physico-chemical parameters of the waterbody (Islam *et al.*, 2022). Chlorophyceae showed an average cell density of $45.86\times10^{3}$cells/l ± 1.15 in wishpond, $38.22\times10^{3}$cells/l ± 0.83 in wishpond aquaponics and $36.37\times10^{3}$cells/l ± 1.56 in traditional ponds during the experimental period. A significance difference of cell density in plankton group were observed among the wishpond, wishpond aquaponics and traditional ponds culture system. Table 1 showed the mean plankton abundance observed in the wishpond, wishpond aquaponics and traditional ponds culture system.

**Table 1. Mean ± SD abundance of Phytoplankton (×10$^3$ cells/l) observed in wishpond, wishpond aquaponics and traditional ponds culture system.**

| Groups | Phytoplankton (×10$^3$ cells/l) | | |
|---|---|---|---|
| | Wishpond | Wishpond aquaponics | Traditional pond |
| Cyanophyceae | 29.63±0.31$^a$ | 23.99±0.58$^b$ | 21.66±0.04$^c$ |
| Euglenophyceae | 8.94±0.27$^a$ | 8.26±0.27$^b$ | 8.03±0.19$^b$ |
| Bacillariophyceae | 13.39±0.13$^a$ | 11.01±0.30$^b$ | 10.46±2.04$^b$ |
| Chlorophyceae | 45.86±1.15$^a$ | 38.22±0.83$^b$ | 36.37±1.56$^b$ |

Bacillariophyceae was dominated by mostly *Navicula* and *Amphora* where maximum density were found in fourth month at wishponds 14.23×10$^3$cells/l ± 0.05 and the minimum density were found in first month at traditional ponds 6.22 ×10$^3$cells/l ± 0.1. The chlorophyceae group were most dominant, where maximum density were found in fourth month at wishponds 51.16×10$^3$cells/l ± 0.67 and the minimum density were found in first month at traditional ponds 27.99 ×10$^3$cells/l ± 0.72. A similar types of results were found by Chowdhury *et al.* (2007). Besides, cyanophyceae was dominated by *Anabaena, Nostoc, Oscillatoria* etc. where maximum density were found in fourth month at wishponds 33.02×10$^3$cells/l ± 0.02 and the minimum density were found in first month at traditional ponds 18.42 ×10$^3$cells/l ± 0.1. Rahman *et al.* (1999) reported the same findings in case of cyanophyceae in four different treatments. The findings of Razu *et al.* (2018) also support the findings of the study. *Euglena* and *Phacus* were most dominant species in case of euglenophyceae group. In this case, maximum density were found in third month at wishponds 10.42×10$^3$cells/l ± 0.33 and the minimum density were found in first month at traditional ponds 6.22 ×10$^3$cells/l ± 0.1. The results were almost similar with the findings of Chowdhury *et al.* (2007). There were significance difference was observed in the cell density of plankton. Figure 4 described the plankton density on the basis of planktons groups.

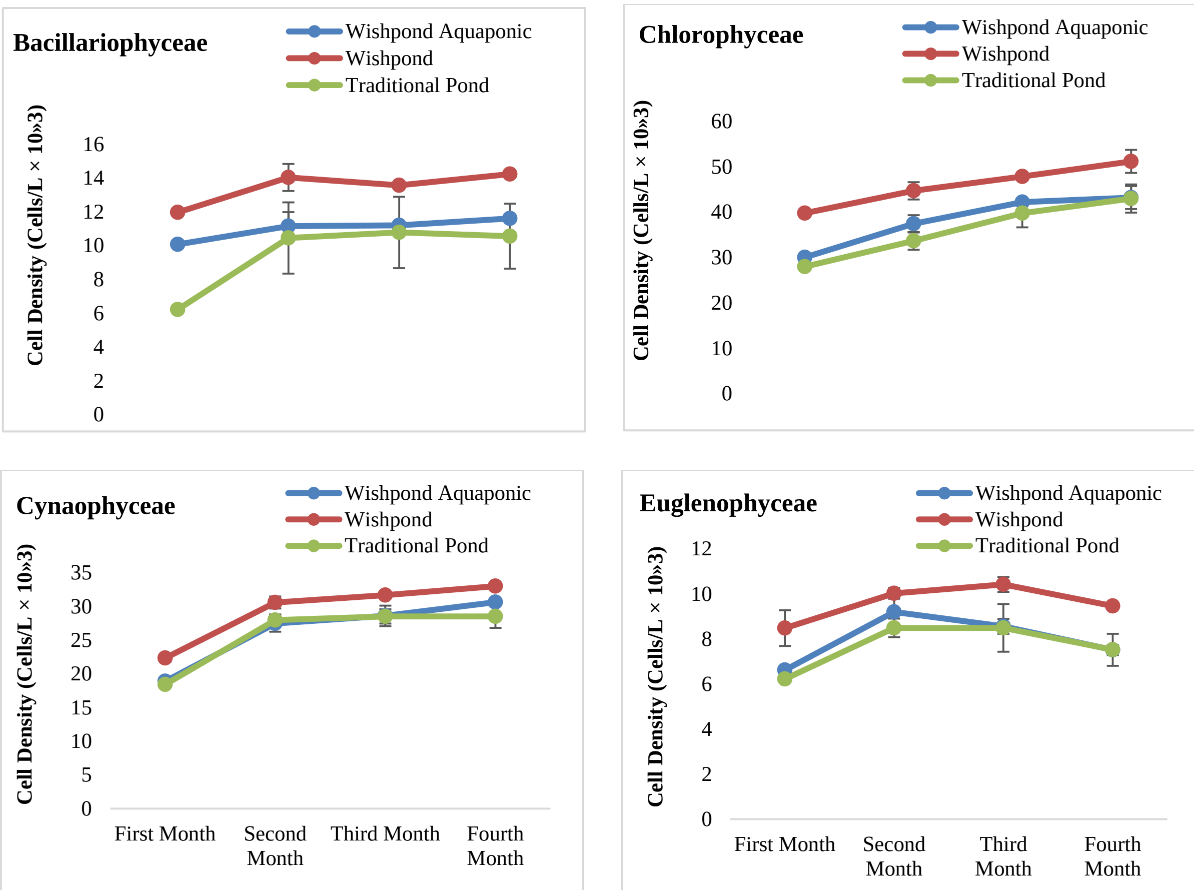


**Figure 4. Cell density of phytoplankton on the basis of group in wishpond, wishpond aquaponics and traditional ponds culture system.**

### 3.3. Zooplankton status

During the experimental period different zooplankton of *Rotifera, Cladocera* and *Copepoda* groups were observed. Zooplankton of *Rotifera* was found the most dominant with following *Cladocera* and *Copepoda*. The findings of the experiment was similar with the observations of Banerjee *et al.* (2014). *Rotifera* showed an average cell density of 17.81×$10^3$cells/l ± 0.09 in wishpond, 16.19×$10^3$cells/l ± 0.31 in wishpond aquaponics and 14.49×$10^3$cells/l ± 0.35 in traditional ponds during the experimental period. A significance difference of cell density in zooplankton types were observed among the wishpond, wishpond aquaponics and traditional ponds culture system. Table 2 showed the mean zooplankton abundance observed in the wishpond, wishpond aquaponics and traditional pond culture system.

**Table 2. Mean ± SD abundance of Zooplankton (×$10^3$ cells/l) observed in wishpond, wishpond aquaponics and traditional ponds culture system.**

| Groups | Zooplankton (×$10^3$ cells/l) | | |
|---|---|---|---|
| | Wishpond | Wishpond aquaponics | Traditional pond |
| **Rotifera** | 17.81±0.09$^a$ | 16.19±0.31$^b$ | 14.49±0.35$^c$ |
| **Cladocera** | 12.54±0.45$^a$ | 10.50±0.12$^b$ | 9.83±0.39$^b$ |
| **Copepoda** | 9.54±0.25$^a$ | 7.88±0.37$^b$ | 8.20±0.05$^b$ |

### 3.4. The physico-chemical parameters relationships

Temperature showed negative relation with pH in all the cases. Similarly dissolve oxygen and transparency showed significant negative correlation with temperature for all the cases. Ammonia and alkalinity showed significant positive relationship in wishpond and traditional system. However, DO-pH, DO-Transparency and Transparency-pH showed significant positive relationship (Table 3). On the other hand, alkalinity-pH, alkalinity-DO and alkalinity transparency showed significant negative relationship. Table 3 described the correlations among the physico-chemical parameters in case of wishpond aquaponics, wishpond and traditional pond system.

**Table 3. Correlations among the physico-chemical parameters in different aquaculture systems.**

| Parameters | Treatment | Temperature | pH | DO | Ammonia | Alkalinity |
|---|---|---|---|---|---|---|
| pH | T1 | -0.867* | | | | |
| | T2 | -0.962* | | | | |
| | T3 | -0.962* | | | | |
| DO | T1 | -0.973* | 0.914* | | | |
| | T2 | -0.932* | 0.803* | | | |
| | T3 | -0.932* | 0.803* | | | |
| Ammonia | T1 | 0.463 | -0.692 | 0.656 | | |
| | T2 | 0.850* | -0.928* | -0.701 | | |
| | T3 | 0.850* | -0.922* | -0.701 | | |
| Alkalinity | T1 | 0.963* | -0.969* | -0.976* | 0.608 | |
| | T2 | 0.990* | -0.926* | -0.968* | 0.837* | |
| | T3 | 0.990* | -0.923* | -0.968* | 0.837* | |
| Transparency | T1 | -0.929* | 0.968* | 0.982* | -0.735 | -0.985* |
| | T2 | -0.944* | 0.820* | 0.997* | -0.707 | -0.979* |
| | T3 | -0.944* | 0.829* | 0.997* | -0.746 | -0.978* |

T1 = Wishpond aquaponic; T2 = Wishpond ; T3 = Traditional pond; * = Significant relationship

### 3.5. The phytoplankton group relationships

All four groups showed more or less positive relationship in all three different cases. However, Euglenophyceae showed significant positive relationship with bacillariophyceae only in the case of traditional pond system. On the other hand, bacillariophyceae-cyanophyceae, bacillariophyce-chlorophyceae and chlorophyceae cyanophyceae showed significant positive relationship in all the cases. It is important to know the algal community and its relationship among the groups as it is known as base the entire aquatic system (Islam *et al.*, 2022). Table 4 described the correlations among the phytoplankton groups in case of wishpond aquaponics, wishpond and traditional pond system.

**Table 4. Correlations among the phytoplankton groups in wishpond, wishpond aquaponics and traditional ponds culture system.**

| Parameters | Treatment | Cyanophyceae | Euglenophyceae | Bacillariophyceae |
|---|---|---|---|---|
| **Euglenophyceae** | T1 | 0.610 | | |
| | T2 | 0.804* | | |
| | T3 | 0.893* | | |
| **Bacillariophyceae** | T1 | 0.995* | 0.568 | |
| | T2 | 0.962* | 0.731 | |
| | T3 | 0.991* | 0.908* | |
| **Chlorophyceae** | T1 | 0.970* | 0.493 | 0.955* |
| | T2 | 0.933* | 0.580 | 0.853* |
| | T3 | 0.841* | 0.547 | 0.830* |

T1 = Wishpond aquaponics; T2 = Wishpond; T3 = Traditional pond; * = Significant relationship

## 4. Conclusions

Optimum water quality and environmental conditions refers a good aquaculture conditions. Moreover, plankton is the base of entire aquatic food chain which diversity and density is also important for better aquaculture practices. In this study, all the physico-chemical parameters were within the range for all the three different systems. In addition, plankton community were found diversified and optimum for good aquaculture practice and better integrated production in wishpond and wishpond aquaponics system. So far, further study is recommended to adapt this new technology in integrated aquaculture production with economic benefits.

**Acknowledgements**

Authors are grateful to Professor Dr. Baki Billah for his unconditional support during the experimental tenure. Authors are also grateful to Center for Innovation and Practices (CDIP) for their logistic and financial support. Authors are also grateful to Zahidul Islam, Turabur Rahman for their support, love and inspiration to complete this journey.

**Data availability**

The data presented in this study are contained in this manuscript.

**Conflict of interest**

None to declare.

**Author's contribution**

Md. Rayhan Hossain: methodology, data curation, writing- original draft, data analysis; Md. Aktaruzzaman: writing- data analysis, critical review and editing; Md. Tanvir Rahman: writing- review and editing; Md. Abdus Salam: conceptualization, research administration, writing-review. All authors have read and approved the final manuscript.

**References**

Ahmed SH and AK Singh, 1989. Correlation between antibiotic factors of water and zooplanktonic communities of a tank in Patina, Bihar, Proceedings of the National Sem. on Forty Years of Freshwater Aquaculture in India, Central Institute of Fresh Aquaculture, Bhubneshwar, 119-121.

Alikunhi KH, 1957. Fish culture in India. Fm. Bull. Indian Coun. Agri. Res., 20: 144.

Baganz GFM, R Junge, MC Portella, G Simon, KJ Keesman, D Baganz, G Staaks, C Shaw, F Lohrberg and W Kloas, 2021. The aquaponic principle-It is all about coupling. Reviews in Aquaculture, 14: 252–264.

Bais VS and NC Agarwal, 1990. Seasonal variations of nitrogen contents in the sediment and water of the Sagar lake. Bulletin Environmental Science, 8: 21-24.

Banerjee N and S Barat, 2014. Study on the Zooplankton Production in Ponds under Different Fish Farming System in West Bengal. Journal of Krishi Vigyan., 3: 79.

Boyd CE, 1982, Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 9: 318.

Boyd CE, 2010. Dissolved oxygen concentration in pond aquaculture. 2010.

Brunson MW, CG Lutz and RM Durborow, 1994. Algae Blooms in commercial fish production ponds. Southern Regional Aquaculture Center, 466.

Chowdhury MMR, MRK Mondol and C Sarker, 2007. Seasonal variation of plankton population of Borobila beel in Rangpur district. Univ. J. Zoo. Rajshahi Univ., 26: 49.

Dhawan A and NS Karu, 2002. The ICLARM Quarterly, 25: 11.

Flavius B and G Adrian, 2011. Increasing the economical efficiency and sustainability of indoor fish farming by means of aquaponics – Review. Scientific Papers Animal Science and Biotechnologies, 44: 1–8.

Hossain MA, AHM Kohinoor and MG Hussain, 1998. Polyculture of gulsha (*Mystus cavasius* Ham.) with raj punti (*Puntius gonionotus* Bleeker) and silver carp (*Hypophthalmichthys molitrix* Val.) in earthen ponds. Bangladesh J. Fish. Res., 2: 9-14.

Hossain MI, MM Alam, M Alam, BMM Kamal and SM Galib, 2013. Investigation of phytoplankton and physico-chemical parameters in nursery, growout and broodstock ponds. Journal of Scientific Research, 5: 555-571.

Islam Z, H Khatoon, TR Minhaz, MR Rahman, S Hasan, Y Mahmud, MS Hossain and J Sarker, 2021. Data on growth, productivity, pigments and proximate composition of indigenous marine microalgae isolated from Cox's Bazar Coast. Data in Brief, 35: 106860.

Islam Z, H Khatoon, MR Rahman, J Hasan and SJ Hasan, 2021. Screening of natural pigments from indigenous marine microalgae isolated from different coastal aquafarms of Bangladesh. Bangladesh Journal of Veterinary and Animal Sciences. 9: 61-72.

Islam Z, H Khatoon, MR Rahman, SK Barman, and S Hossain, SJ Hasan and J Hasan, 2021. Growth, productivity and proximate profiling of indigenous marine microalgae from southern coast of Bangladesh as potential feedstuff for animal feed. Available at SSRN: https://ssrn.com/abstract=3949367 or http://dx.doi.org/10.2139/ssrn.3949367

Islam Z, H Khatoon, MR Rahman, SK Barman, and S Hossain, SJ Usha, SJ Hasan and J Hasan, 2022. Growth, productivity and proximate profiling of indigenous marine microalgae from southern coast of Bangladesh as potential feedstuff for animal feed. Bioresource Technology Reports, 18: 101025.

Islam Z, SM Islam, MUI Kazi, MR Islam and R Karim, 2021. Nutritional properties and hygienic quality of a processed dried organic product from *Moringa oleifera* leaves. Journal of Agricultural and Crop Research, 9: 222-229.

Jhingran VG, 1991. Fish and Fisheries India. 3rd edition (Hindustan Publishing Corporation, India).

Ngugi CC, RB James and OO Bethuel, 2007. A new guide to fish farming in Kenya, Oregon State University, USA.

Pandey J and A Verma, 2004. The influence of catchment on chemical and biological characteristics of two freshwater tropical lakes of southern Rajasthan. Journal of Environmental Biology, 25: 81-87.

Rahman MS, 1999. MS Dissertation, Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh, Bangladesh, pp. 30-31.

Rakocy JE, 2012. Aquaponics-Integrating Fish and Plant Culture. Aquaculture Production Systems, 14:344-386.

Raju RH, M Samad, AA Abdulla, M Billah and M Ali, 2018. Variation in the plankton abundance, biomass and diversity of Municipal pond and Bukvora Baor at Jashore district, Bangladesh. Applied Bioinformatics, 5: 1-14.

Reynolds CS, 1996. The plant life of the pelagic. Verhandlungen des Internationalen Verein Limnologie, 26: 97-113.

Riche M and D Garling Fish, 2003. Feed and Nutrition. Feeding Tilapia in Intensive Recirculating Systems.

Ross LL, 2002. Environmental physiology and energetic. Fish and Fisheries Series, 25: 89-128.

Singh BA, 2010. Culture fisheries in village ponds: a multi-location study in Haryana, India. Agriculture and Biology Journal of North America, 1: 961-968.

Wetzel RG, 1983. Limnology. 2nd Edition, Saunders College Publishing, Philadelphia.