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Impact of Water Quality on Fish Production in Several Ponds of Dinajpur Municipality Area, Bangladesh

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ABSTRACT

The fisheries sector is very important in Bangladesh. This study was conducted to assess the impact of water quality on fish growth and production in several ponds of the Dinajpur Municipality area. This study was conducted for eight months from March 2013 to October 2013. The study was carried out in 60 ponds of three water categories, such as clean water pond, slightly polluted water pond, and polluted water pond. In each water category, 20 ponds were selected. Different types of fish species such as Silver carp, Catla, Rui, Mrigal, Mirror carp, Grass carp, and Thai sharpunti, etc. were cultured, stocked and sometimes combinations of other species were also in the same pond. The mean values ranges of water quality parameters in three water categories in several ponds monitored during the study period were temperature 28-33^{0}C; transparency 18-55 cm; pH 5.5-8.9; dissolved oxygen 7.13-7.81 mg/l; Carbon dioxide 10-23mg/l; alkalinity 20-125 mg/l respectively. The water quality greatly influenced the growth and production of fishes among the three categories significantly in several ponds. However, the average production rate of fish per year was the highest in the clean water ponds (1756.63 kg/acre), medium in the slightly polluted water ponds (1229.86 kg/acre), and the lowest in the amount in polluted water ponds (846.78 kg/acre). The study indicated that water quality significantly impacts the growth and production of fish in several ponds.
Keywords: Water quality, fish, production, pond, Dinajpur Municipality area

Introduction

The people of Bangladesh are commonly referred to as "Macche Bhate Bengali" (i.e., the people mostly feed on fish and rice) is now just a proverb but its reality is different. Bangladesh has extensive water bodies that have a high potential for fisheries production (Mustafa and Brooks, 2009). Fish is an important dietary animal protein source in human nutrition and fish provides 60% of animal protein consumption (Abbas *et al.*, 2010). It is also an important source of micronutrients such as vitamin A, Calcium, and Iron (Roos*et al.*, 2003). In early exists inland fisheries contributed about 90% of the total fish production of the country (DoF, 2011).

In Bangladesh, the fisheries industry is confronted with a range of economic, institutional, and environmental concerns. The fisheries sector plays an important role in the national economy, contributing 4.39% to the Gross Domestic Product-GDP (DoF, 2013). Besides, Bangladesh's agricultural sector contributes 14.2% of GDP employing 47% of the working population, with 17 million people (1.4 million women) depending on the fisheries sector for their livelihoods through fishing, farming, fish handling, and processing (WBD, 2017 and CIA, 2018). According to industry estimates, fish production will reach 5.02 million metric tons within 2020-2021.

Water quality in fish farm ponds should fit in with the physiological requirements for optimal growth of the cultured species; its good quality water is essential for fruitful fish production (Boyd and McNevin, 2015). Water quality is significantly impacted and can be deteriorated by pond management practices such as the daily feed input and the fertilization plan needed for plankton growth (Das*et al.*, 2005, Sipauba-Tavares*et al.*, 2011). The aquatic environment governs fish life; hence water quality should be suitable for fish culture (Rahman, 1992). But the water quality problem is one of the main problems that have been cited by fish culture as a reason for the poor productivity of some carp production in Bangladesh. It is essential to increase pond production by managing the water quality

and adopting modern technology by fish farmers in Bangladesh.

However, in Bangladesh, there are around 0.24 million ponds, and pond covers only 3.5% of the total inland water of the country, which contributes about 31% of the total inland fisheries production is playing a vital role in fish production (UNDP, 1999). A total of 266 species of freshwater fishes and a total of 442 species of marine and migratory fishes are present in Bangladesh (IUCN, 2000). In the past, fish farming was an extensive method and substance in nature, stocked with wild fry and fingerlings caught in rivers and cultured without the use of fish feeds (Mazid*et al.*, 2002). Nowadays, most of the freshwater pond fish farming systems are either extensive or semi-intensive and in very few cases intensive in Bangladesh (Azim, 2012).

In the present study, the impacts on the water quality of several ponds were investigated to determine the overall production of fish species in the selected several fish cultured ponds. The impact of water quality on fish species composition and fish production in three water categories was also recorded in several ponds in the Dinajpur Municipality area, Bangladesh.

Literature Review

Study area: Dinajpur district (25.630N and 88.650E) is a part of the Rangpur Division of northern Bangladesh. Dinajpur Municipality area is situated in the Dinajpur district of Bangladesh (Fig.1). The research area is in Sadar Upazila under Kotwali Thana. It lies between 25044'North latitude and 88046'East longitude (Sadar Upazila). It is bounded in the north by the pour-track terminal of Gopalganj Bazar (Sadar Thana), in the west by Punarbhaba River (Kaharol Thana), in the east by Muktijoddha complex with Medical College, and south by the poolhat-basic area (Sadar Thana). The Dinajpur Municipality area is about 24.20 km2. It consists of 12 wards. It is a densely populated area with about 1, 86,727 people (According to the data of census in 2011).

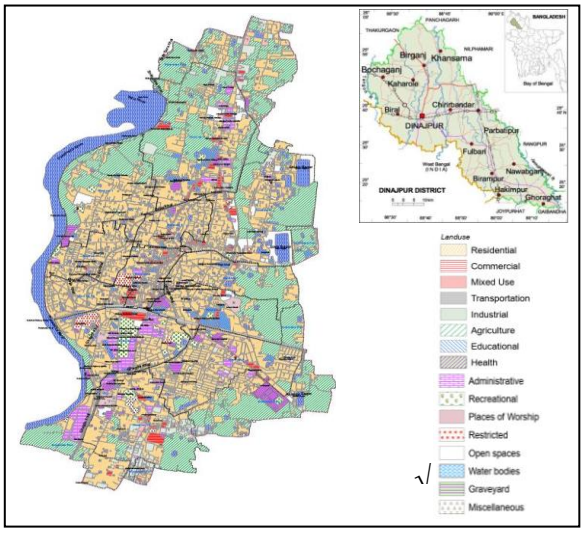

Fig. 1: Map of the Dinajpur Municipality area in Dinajpur District, Bangladesh

Sampling frameworks: The study was carried out from March 2013 to October 2013 in 60 fish cultivating ponds in the Municipality area of Dinajpur. Among these 53 are non-government and seven government ponds which cover 192.72 acres of water area. The data were collected from farmers who are involved in pond fish culture. In this research, the main objective is to find out the impacts of water quality on the average production of fish per year in several ponds. During the study period, the pond preparation; stocking, and sampling experimental fish species; supplementary feeding, and growth monitoring with fish production, and water quality parameters, etc. were done carefully (Mannan et al., 2012).

Pond preparation: In this research, the size of experimental ponds was 30-320 decimal having a depth of 1-3 meter sand daily 10-12 hours available of light. The ponds were randomly selected for preparation step by step such as some ponds were dewatered for removing unwanted fishes, predatory, and other undesirable species; some ponds were properly embankments were repaired; all

aquatics weeds from some ponds were cleared manually before the experiment started. Since the ponds were selected for fish farming, it was found that all the ponds did not have an environmental equilibrium for fish farming. Some of the ponds had clear water, some ponds were filled with residential waste, and some ponds industrial factories wastes have been dumped. Therefore, the selected ponds have been divided into three water categories depending on the water quality. The ponds were limed at the rate of 100 kg/acre was done to maintain good water quality. After 5-7 days of liming to enhance the natural feed production, fertilization was also done by Cow-dung 1000 kg/acre, Urea 24 kg/acre, and Triple Super Phosphate 11.6 kg/acre, etc.

Stocking and sampling of experimental fish species: The study was conducted with the combination of the fish species such as Silver carp, Catla, Rui, Mrigal, Mirror carp, Grass carp, and Thai sharpunti, etc. and the average fingerling weight of these fishes were 2-8 inch respectively (Table 1). All the fish fingerlings were stocked with per decimal one week after pond preparation especially at the end of March respectively for culture in several ponds.

Supplementary feeding and growth monitoring with fish production: The supply of feed is very important for fish production. Supplementary feed that mixture of rice bran, wheat bran, fish meal, and mustard oil cake was applied in all water category selected ponds daily two times 8.00-10.00 am and 3.00-5.00 pm at the rate of 2-3% of fish body weight (5% for the first month, 4% for the second month and 3% for the third month to the end of the fish harvesting were done. The quantity of feed was adjusted every month according to the total biomass of fish obtained from the sampling as part of monitoring fish growth. Sampling was done by seine net from each pond at a monthly interval. The weight of fishes was monitoring by using a spring balance. At the end of the experiment, all the fishes were harvested in October by netting repeatedly with a seine net from each pond. Finally, the production of fishes per year was determined by the average weight (kg/acre) of fish species with the total number of fishes of the same time that survived at the end of the experiment.

Water quality parameters: Water quality is essential for the growth of fishes. Water quality parameters such as temperature, transparency, pH, dissolved oxygen (DO), carbon dioxide, and alkalinity were monitored monthly. Water samples were collected from the ponds and measured for temperature (Handheld mercury thermometer), water transparency is measured with a Secchi disk, pH (Corning pH meter), and other parameters like dissolved oxygen, carbon dioxide, and alkalinity were measured by titri metric method (APHA, 1981).

Statistical analysis: The collected data were arranged with tabular in proper form and subjected to statistical analysis for the normality of data was checked carefully in the study period. The data of stocking experimental fish culture species number with per decimal; water quality parameters and the results of the study were presented in tabular forms in Tables 1, 2 & 3 and the average production of fish are shown in Fig 2.

Results and Discussion

This research studies, water quality is very essential for the growth rate of fishes. Good water quality suggests the exchange and enhances fish production. A few numbers exchanged pond water and a huge number did not exchange the pond water in the fish culture period. In the study area, there was good monitoring of the water quality parameters. Water quality measured from three categories such as clean, slightly polluted, and polluted water ponds and analysis following elements with temperature, transparency, pH, dissolved oxygen, carbon dioxide, and

alkalinity respectively but no measured the ammonia and nitrate, plankton, etc. that impacts the beneficial use of water(Table 2).

In this study the ranges of temperature was 27-350C; pH 6.1-8.8; DO 1.3-3.3 mg/l (morning) and 6.0-13.4 mg/l (evening); CO2 5.0-6.9 mg/l and total alkalinity 47.5-105.0 mg/l in Mymensingh District (Hossain et al., 1997). Where the mean values ranges of water quality parameters in three water categories in several ponds monitored during the present study period were temperature 28-330C; transparency 18-55cm; pH 5.5-8.9; dissolved oxygen 7.13-7.81 mg/l; Carbon dioxide 10-23 mg/l; alkalinity 20-125 mg/l respectively (Table 2). The mean values of water quality parameters in this present study were within the suitable range for fish culture (Alikunhi, 1957; Swingle, 1967 and Boyd, 1998).

The water quality parameters measured at different times throughout the experimental period were done and found to be more or less similar and all of them were within the acceptable ranges for fish culture as of Hossain et al., 1997; Alikunhi, 1957; Swingle, 1967 and Boyd, 1998.In the three water categories, the temperature was ranged from 25-310C, 26-340C, and 28-380C respectively which was within the standard range i.e., 25-350C for fish culture (Das, 1997). The temperature had no significant effect on the water quality for fish culture among them. The mean transparencies were 55, 38, and 18 cm. The transparency of water varied among and within the observation time and especially depends on the number of particles in the water. Generally, a decrease of transparency in the slightly polluted and polluted water of the study was observed.

The pH fluctuated from 8.6-6.2; 9.1-8.7 and 4.9-4.1 respectively which mean values of pH had a great influence on water quality in three categories. Water ranging in pH 6.5-8.5 is generally the most suitable for pond fish production. Among them, clean water means values of pH level is 7.4 which perfect for fish production, slightly polluted water means values of pH level 8.9 nearly suitable, and polluted water means values of pH level 5.5 not suitable because fish production greatly affected with the fish disease, suffocation, and growth rate, etc.

The dissolved oxygen concentration was nearly in all water categories. The mean values of DO in three categories were 7.81, 7.54, and 7.13 mg/l respectively all were suitable for fish culture. Besides, warmer water holds less O2 than cooler water. The DO concentration should be more than 5.0 mg/l is suggested for fisheries, recreation, and irrigation (EQS, 1997). Carbon dioxide mean values in water were recorded 10, 16 mg/l were suitable and 23 mg/l were not suitable for fish culture respectively. The standard level CO2 of pond water is <20 mg/l.

The ranges of alkalinity observed were good except for polluted water categories. The highest content of alkalinity was 125 mg/l respectively in clean water which was suitable for the highest fish production (Alam et al., 2002) and the total alkalinity of medium productive water ranged from 25-100 mg/l for fish culture (Bhuiyan, 1970). This was suitable for the slightly polluted water pond's mean values of alkalinity 100 mg/l. Hence, the ponds are said to be medium fish production. The lowest content was polluted water in mean values of alkalinity 20 mg/l respectively (Uddin, 2002). Which not suitable for fish production and is highly affected by suffocation, fish disease, and growth rate, etc. Besides, the plankton as phytoplankton and zooplankton were expressed numerically per liter of water significance.

The average fish production per year (kg/acre) in several ponds is presented in Table 3 & Fig 2.

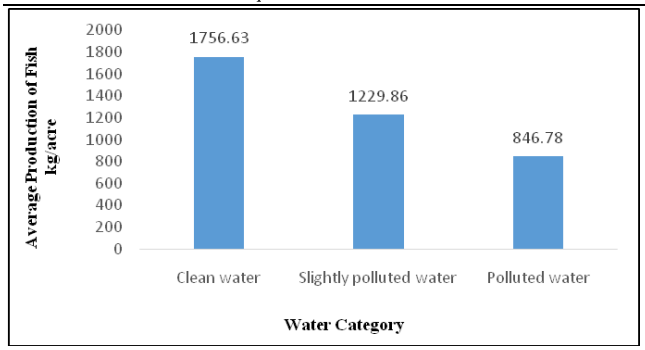

Fig. 2: The average production of fish per year on water category (kg/acre) in several ponds

It was found that the production of fishes among the three categories was significantly different. The first category of clean water ponds has a high production rate, and it was observed as 2,75,930 kg in 157.08 acres area and average production of fish per year in 1756.63 kg/acre. The slightly polluted water ponds have a medium production rate, and it was observed as 30,845 kg in 25.08 acres area and average production of fish per year in 1229.86 kg/acre, and the last category polluted water ponds have a low production rate, and it was observed as 8,942 kg in 10.56 acres area and average production of fish per year in 846.78 kg/acre.

This study was concluded that impacts the water quality highly affected in several ponds for fish production. The soil condition of the Dinajpur Municipality area are various categories such as muddy, clayed-soil, and loam perform a good habitual of various species of fish. The water quality was impacted significantly in several ponds of Dinajpur Municipality area are three categories such as clean, slightly polluted, and polluted water pond. Overall, clean water ponds are important for fish culture. Here, the production rate of fish is very high. The slightly polluted water production rate of fish is medium, and in the polluted water ponds, it is very lower than in others.

Table 1: Stocking experimental fish culture species number (per decimal) in several ponds

Sr. No.	*Common Name*	*Scientific Name*	*Number of fish per decimal*
1	Silver carp	Hypopthalmicthys molitrix	15-18
2	Catla	Catla catla	10-13
3	Rui	Labeo rohita	20-25
4	Mrigal	Cirrhinus mrigala	20-25
5	Mirror carp	Cyprinus carpio	10-12
6	Grass carp	Ctenopharyngodon idella	8-10
7	Thai sharpunti	Puntius gononiotus	15-20

Table 2: Water quality status and value of water category in several ponds

Sr. No.	*Water quality (Unit)*	*Clean water*			*Slightly polluted water*			*Polluted water*		
		Max.	Mini.	Mean	Max.	Mini.	Mean	Max.	Mini.	Mean
1	Temperature (^{0}C)	31	25	28	34	26	30	38	28	33
2	Transparency (cm)	68	42	55	43	33	38	26	10	18
3	pH	8.6	6.2	7.9	9.1	8.7	8.9	4.9	4.1	5.5
4	Dissolved Oxygen-DO (mg/l)	4.11	3.7	7.81	4.14	3.4	7.54	4.03	3.1	7.13
5	Carbon Dioxide-CO_2 (mg/l)	12	8	10	17	15	16	28	18	23
6	Alkalinity (mg/l)	138	112	125	98	92	95	22	18	20

Table 3: Production of fish on water category in several ponds

Sr. No.	*Water category of pond*	*Number of ponds*	*Total area (acres)*	*Total production of fish per year (kg)*
1	Clean water	20	157.08	275930
2	Slightly polluted water	20	25.08	30845
3	Polluted water	20	10.56	8942

Conclusion

Bangladesh is a country where having very few resources to satisfy its demand due to overpopulation. This study concluded that pond management and water quality are highly significant. The study reveals the highest fish production in the clean water ponds but not be suitable during the whole period of growth for polluted water ponds. However, the supplementary feed and proper management system offered more nutritional support to higher fish yield. As a large number of ponds are present in the Dinajpur Municipality area, the proper management of these may provide higher fish production. The water quality of slightly polluted and polluted pond can also be improved by proper management that may yield higher production and can meet the need for protein supply.

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