

RESEARCH PAPER

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Assessment of physicochemical parameters and bacteriological quality of pond water of Sylhet agricultural university, Sylhet

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ABSTRACT

Water quality is indispensable for sustaining aquaculture and safeguarding public health, particularly in Bangladesh, where fisheries play a conclusive role in the national economy. This study aimed to assess the physicochemical and bacteriological quality of pond water from three designated ponds at Sylhet Agricultural University. The primary aim was to evaluate the ponds' suitability for aquaculture and to assess potential microbial contamination risks. Sterile methods were used to collect water samples and then a multi-parameter water quality meter and standard chemical test kits were used to look at important physicochemical parameters like pH, temperature, dissolved oxygen (DO), salinity, total dissolved solids (TDS), conductivity, ammonia, and nitrate levels. Microbiological analysis was conducted using serial dilution and culture techniques on selective media, succeeded by biochemical tests including IMViC, Triple Sugar Iron (TSI), citrate utilization, catalase, and other standard identification methods. The results showed noticeable variation among the three ponds. The pH values were slightly alkaline, ranging from 8.2 to 8.9, which in some cases exceeded the recommended range for aquaculture. Dissolved oxygen levels varied widely, with one pond showing critically low DO (1.32 mg/L), indicating unsuitable conditions for aquatic organisms. Ammonia was detected in one pond, while nitrate was absent in all samples. Microbial analysis revealed high bacterial loads, particularly in the pond with low oxygen and higher turbidity. Biochemical characterization indicated the presence of potentially pathogenic bacteria such as *Escherichia coli*, *Salmonella* spp., and *Edwardsiella* spp., suggesting contamination from fecal matter and organic waste. Overall, the findings highlight that while the studied ponds at Sylhet Agricultural University provide the basic environment for aquaculture, variations in physicochemical parameters and the presence of pathogenic bacteria pose significant risks to fish health and public safety. The critically low dissolved oxygen and detection of fecal-associated microbes underscore the urgent need for improved pond management and regular monitoring.

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INTRODUCTION

Bangladesh has an abundance of water resources, such as lakes, canals, estuaries, small ponds, and ditches, thanks to its 24,000 kilometers of rivers (Ghose, 2014). With 3.61% of GDP coming from fisheries and aquaculture, these industries are vital to the national economy. However, heavy metal builds up, infectious diseases, and chemical contaminants pose major health risks to aquaculture (Shamsuzzaman and Mozumder, 2020).

Aquaculture development is hampered by disease-related fish mortality and water pollution, and water quality is a major source of contamination (Ali *et al.*, 2014). Although water has been utilized for many things since the dawn of civilization, human activity is currently endangering it. Just 2.5 percent of the earth's surface is freshwater, despite the fact that water covers nearly 71% of it (Munni *et al.*, 2015). Two-thirds of the world's population encounter water scarcity at least once and about 1.6 billion people suffer from economic water shortages (Chatterjee and Raziuddin, 2007). Inadequate sanitation, urbanization, industrialization, and population growth are all contributing to Bangladesh's declining water quality. Arsenic-containing groundwater sources are dangerous for human health and can cause water-borne illnesses, especially in young children (Hasan *et al.*, 2019). Water quality is also influenced by elements like dissolved oxygen, bacterial counts, salt, and material composition. Water bodies close to industrial areas contain heavy metals and pesticide residues, as well as newly discovered pollutants like microplastics, antibiotic residue, and fluorescence whitening agents. According to health risk assessment based on hazard quotient and carcinogenic risk assessment, the water quality is already declining and could endanger large populations (Sarkar *et al.*, 2019).

Physical parameters of water quality includes the solubility, palatability, chemical reactions, odors and viscosity of water. Biological oxygen demand, chlorination, and sedimentation that are all impacted by ideal temperatures, which fall between 50 and 60 degrees Fahrenheit (Davis, 2010). Chemical

parameters of water quality determined by pH, acidity, alkalinity, ammonia, nitrate, dissolve oxygen (DO) Total dissolved solids (TDS). A lot of the nitrogen in contaminated water is organic and ammonia, which microbes convert to nitrites and nitrates (Alley, 2007). Biological parameters measured by the presence of bacteria, viruses, protozoa and algae etc. Water quality can be assessed by the presence or absence of living organisms, such as fish and insects, using a species diversity index (SDI). A healthy system has a large number of well-balanced species. Microorganisms, including coliform bacteria, exist in nature and are mostly harmless in wastewater (Abou El-Naga *et al.*, 2005). The present study is aimed to isolate, characterize, and then check for physiochemical and bacteriological parameter of pond water located in Sylhet Agricultural University area.

MATERIALS AND METHODS

Study area

The present experiment was carried out in the central laboratory of faculty of Biotechnology and Genetic Engineering, Aquatic Resource Management department laboratory of faculty of Fisheries and also in the Microbiology and Immunology laboratory of faculty of Veterinary, Animal and Biomedical Sciences of Sylhet Agricultural University.

Collection of sample and physicochemical analysis

Water samples were collected from three ponds at Sylhet Agricultural University with strict attention to cleanliness and proper handling to ensure accurate results. Green plastic bottles (Fig. 1) were used to protect the samples from sunlight, preserving microbial life.



Fig. 1. Sampling bottle

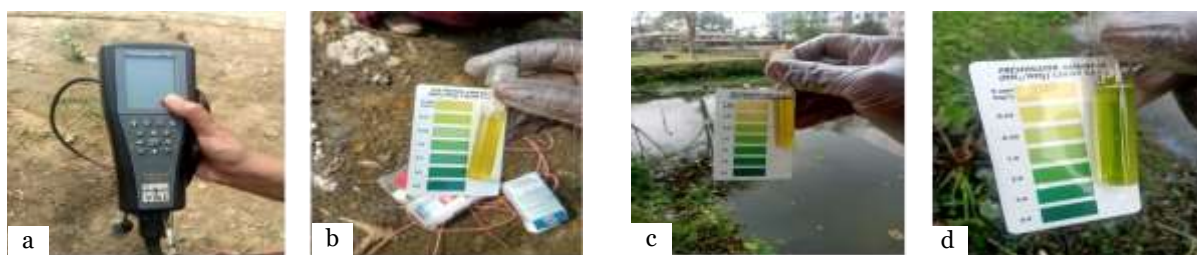


Fig. 2. (a) YSI ProQuatro multiparameter; (b) Ammonia measurement of pond 1; (c) Ammonia measurement on pond 2; (d) Ammonia measurement on pond 3



Fig. 3. (a) Ammonia measurement of pond 2; (b) Nitrate measurement of pond 3; (c) pH measurement on pond 2; (d) Measuring pH on pond 3

For physicochemical analysis, a YSI ProQuatro multiparameter water quality meter was used, where the probe was directly immersed into the pond water and the displayed readings were recorded (Fig. 2a). The pH of the water samples was measured using a pH meter (Fig. 3). Ammonia concentration was determined by adding eight drops of ammonia test solution to 5 ml of water sample, while nitrate concentration was measured by adding five drops of nitrate test solution to another 5 ml of sample (Fig. 2 b,c,d). The resulting color changes were compared with standard color scales to estimate the levels of ammonia and nitrate present in the water. These systematic procedures ensured accurate assessment of the physicochemical characteristics of pond water from the selected study sites. For microbiological testing, sample bottles were thoroughly cleaned with detergent, rinsed, and dried before collection. Water was collected carefully by filling the bottles multiple times to minimize contamination, and each sample was labeled P1S1, P2S1, P2S2, P3S1, and P3S2 according to its pond of origin. The samples were promptly transported to the laboratory for detailed bacteriological analysis, with some preserved in refrigeration to maintain their quality until testing. This careful procedure ensured reliable and

comprehensive assessment of the water quality in the selected ponds.

Media preparation

Nutrient Agar, Eosin methylene blue agar (EMB), MacConkey Agar, Simmons citrate agar media, MR-VP media (Buffered Glucose Phosphate Broth) and Peptone broth is used for the various tests. All the media used in this experiment were prepared by manufacturer's guidelines.

Biochemical tests for identification of bacteria

Various biochemical tests was performed for the identification of bacteria including Gram staining, Indole test ,Citrate utilization test, Catalase test, Methyl red-Voges-Proskauer test (MRVP),MR (Methyl red) test ,VP (Voges-Proskauer) test and Triple sugar iron agar (TSI) test.

RESULTS

Physicochemical quality analysis of water samples

Three ponds at Sylhet Agricultural University were evaluated for physicochemical quality using YSI ProQuatro multiparameter equipment and a pH meter. None of the sites had any odor at all, according

to visual evaluation of every water sample for color and odor. Pond 1 looked somewhat greenish, Pond 2

looked greenish, and Pond 3 displayed turbidity- which would point to suspended particle debris.

Table 1. The values of physiochemical parameters of three ponds

Sl	Parameters	Pond 1	Pond 2	Pond 3
1	Dissolved oxygen	4.89	7.95	1.32
2	pH	8.9	8.4	8.2
3	Conductivity	286.4	96.6	216.8
4	Salinity	0.12	0.04	0.09
5	TDS	130.50	45.00	97.50
6	Ammonia	0 ppm	0 ppm	0.5 ppm
7	Nitrate ion	0 ppm	0 ppm	0 ppm
8	Depth	2.5 feet	10 feet	2 feet
9	Temperature	30.9°C	29°C	31°C

Table 2. Key biochemical test results for bacterial isolates

Sample name	Indole test	Methyl red (MR) test	Voges-Proskauer (VP) test	Citrate test	TSI Slant	TSI Butt	Gas	H ₂ S
P1S1 10 ⁻¹	–	+	–	+	Red	Yellow	–	+
P1S1 10 ⁻³	+	+	–	–	Yellow	Red	–	–
P1S2 10 ⁻⁵	+	+	–	+	Red	Yellow	–	–
P2S2 10 ⁻¹	+	–	–	+	Yellow	Red	–	–
P3S1 10 ⁻¹	+	+	–	+	Red	Red	–	–
P3S2 10 ⁻³	+	+	–	–	Yellow	Red	–	–



Fig. 4. (a) TSI test results; (b) TSI test slant producing H₂S; (c) Bacterial subculture on MacConkey agar; (d) Bacterial subculture on MacConkey

Table 1 compiles the values of the physicochemical criteria. The pH values of the ponds varied from 8.2 to 8.9, somewhat beyond the range permitted for aquaculture (6.5–8.0) and the WHO's advised safe human consumption range (6.5–8.5). This can indicate more alkaline circumstances brought on by changes in CO₂ or another chemical imbalance. The water's temperature ran from 29 to 31 degrees Celsius. Just Pond 3 surpassed the ideal temperature range of 20 to 30°C for aquaculture, therefore affecting fish metabolism and dissolved oxygen (DO) levels. Well within the range allowed for freshwater aquaculture, salinity levels stayed low, ranging from 0.04 to 0.12 parts per thousand.

While keeping within the maximum allowed limit (400 mg/L), fish culture's total dissolved solids (TDS) ranged from 45 to 130.5 mg/L. Ionic compounds were indicated by range of conductivity values between 96.6 and 286.4 µS/cm.

With the highest conductivity, Pond 1 was approaching pollution-indicative values (APHA, 1995). Dissolved oxygen values fell between 1.32 mg/L (Pond 3) and 7.95 mg/L (Pond 2). As Ponds 1 and 3 (DoF, 2010) show, DO levels below 5 mg/L are insufficient for fish health and could compromise the sustainability of aquatic life. Though the lack of nitrates may also indicate inadequate nitrogen cycling, all ponds had nitrate levels of 0 ppm,

within the recommended aquaculture range of 0.1–4.0 mg/L. Only in Pond 3 at a 0.5 ppm concentration - within Bangladesh's allowed range - was ammonium found.

Bacteriological quality analysis of water samples

Microbial analysis found significant bacterial loads in every pond sample, suggesting most likely impact of temperature and organic load as source of biological activity. Pond 3's samples revealed the greatest colony counts among ranges from 12 to 200 CFU per dilution plate. This corresponds with increased turbidity and reduced DO levels in the pond.

Biochemical tests helped to identify certain bacterial species. *E. coli* in sample P1S1 (10^{-1}) was identified by negative citrate and VP tests as well as by positive indole and MR tests validated by IMViC biochemical profiling (Table 2, Fig. 4& 5). Samples P1S1 (10^{-1}) showed *salmonella* species by positive citrate and MR tests as well as negative indole and VP tests. *Edwardsiella* species in P3S2 (10^{-1}), producing H_2S in TSI coupled with showing good citrate and indole results.

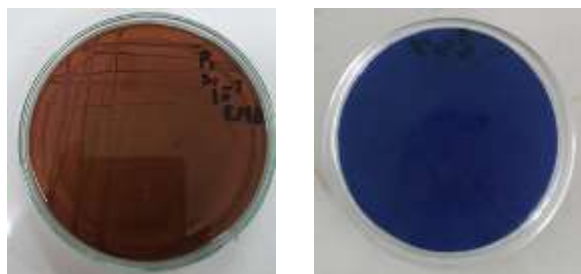


Fig. 5. (a) Bacterial subculture on EMB; (b) Simmons citrate medium after incubation with bacteria, turns to blue and gave positive result

Usually leftovers or dung, these dangerous bacteria show contamination from organic waste, so compromising human health and aquatic life. Their existence underlines the need of regular inspections and improved waste management techniques in aquaculture systems.

DISCUSSION

The objective of this study was to evaluate the physicochemical and bacteriological quality of pond

water from three sites located at Sylhet Agricultural University in order to assess their suitability for both human use and aquaculture. The findings reveal a complex interplay between environmental parameters and microbial presence that can significantly impact aquatic health and potential risks to consumers. Temperature is a fundamental determinant of microbial growth, metabolic activity, and oxygen solubility in aquatic systems. Meade (2009) recommends an optimal aquaculture range of (20–30°C), yet pond 3 exceeded this threshold (29–31°C), potentially stressing aquatic organisms and accelerating bacterial proliferation.

Elevated pH values (8.2 to 8.9) also surpassed recommended aquaculture range pH (6.5–8.0) and the WHO drinking water guideline (6.5–8.5) (WHO, 2017). Such alkalinity may impair fish physiology and nutrition availability, often linked to low CO_2 concentrations or higher photosynthetic activity (Boyd, 1998).

TDS levels (45–130.5 mg/L) remain below the 400 mg/L threshold considered safe for diverse fish species (APHA, 1995), indicating minimal mineral saturation and good water clarity. Salinity values (0.04–0.12 ppt) were appropriate for freshwater species, suggesting limited intrusion of brackish water or industrial discharge. Conductivity ranges from 96.6 and 286.4 $\mu S/cm$, with Pond 1 approaching the upper limit for inlet freshwater habitats. Elevated connectivity often reflects agricultural runoff or organic waste accumulation.

Dissolved oxygen (DO) of ponds varies markedly across pond. Pond 2 exhibited optimal DO (7.95 mg/L) while Pond 1 was borderline (4.89 mg/L) and Pond 3 critically hypoxic (1.32 mg/L), both below the suggested range (5–8 mg/L) (DoF, 2010). The hypoxic conditions in Pond 3 most likely affect fish negatively; they could be brought on by algal blooms or decomposition of organic material (Eze, 2010). One known poison to aquatic life, ammonia, 0.5 ppm was present in only Pond 3. Though it is under Bangladesh's safe aquaculture limits (DoF, 2010), its presence suggests the accumulation of

nitrogenous waste, presumably from fish excrement or uneaten feed. Although non-toxic, all ponds had nitrate levels of 0 ppm, which could point to inadequate nitrification activity or insufficient nutrient cycling, therefore affecting pond production (Boyd, 1998).

Microbiological investigation revealed substantial bacterial load across all ponds, with Pond 3 showing the highest microbial counts (12-200 CFU per dilution plate), consistent with its low DO and high turbidity. The detection of *E. coli* Sample P1S1 (10^{-1}) indicates fecal contamination, posing risk to both fish and human consumers (WHO, 2017). The *Salmonella* species found in the same sample underscore foodborne illness potential and environmental contamination (Meade, 2009). *Edwardsiella* spp. in sample P3S2 (10^{-1}) is particularly concerning, as it is a known fish pathogen capable of causing septicemia and significant aquaculture losses (Plumb, 1999).

Since all identified pathogens belong to Enterobacteriaceae family, their existence suggests suboptimal water quality and inadequate management practices. The coexistence of *E. coli*, *Salmonella* and *Edwardsiella* highlights the dual threat of zoonotic transmission and aquaculture collapse. As Eze (2010) emphasized, organic enrichment and elevated temperatures create ideal conditions for microbial proliferation, reinforcing the need for improved waste management and regular monitoring.

CONCLUSION

These findings highlight that although the pond provide a basic environment for aquaculture, physicochemical imbalances and pathogenic contamination pose serious risks to fish health and food safety. The detection of *Edwardsiella* spp. is particularly concerning, given its role in fish diseases and zoonotic potential. Future work should focus on longitudinal studies across seasons, molecular level identification of microbial communities, and integration of advanced water treatment strategies to ensure sustainable aquaculture practices and safeguard community health.

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