



Research in

**AGRICULTURE, LIVESTOCK and FISHERIES**

ISSN : P-2409-0603, E-2409-9325

An Open Access Peer-Reviewed International Journal

Article Code: 0239/2019/RALF

Res. Agric. Livest. Fish.

Article Type: Original Research

Vol. 6, No. 2, August 2019 : 301-313.

## QUANTITATIVE ASSESSMENT OF IONIC STATUS OF POND WATER FOR IRRIGATION AND AQUACULTURE USAGE IN THE SELECTED SITES OF MYMENSINGH AREAS, BANGLADESH

Taslina Akter<sup>1</sup>, Shampa Rani Ghosh<sup>2\*</sup>, Sitesh Chandra Sarker<sup>3</sup>, Md. Mokhlesur Rahman<sup>4</sup> and K. M. Eadun Nabi<sup>5</sup>

<sup>1</sup>Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh;

<sup>2</sup>Entomology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh;

<sup>3</sup>Assistantant Commissioner (Land) , Department of Public Administration, Dhaka, Bangladesh;

<sup>4</sup>Professor, Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh;

<sup>5</sup>Plant Pathology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh.

\*Corresponding author: Shampa Rani Ghosh; E-mail: shampa37@gmail.com

### ARTICLE INFO

### ABSTRACT

#### Received

03 August, 2019

#### Revised

25 August, 2019

#### Accepted

27 August, 2019

#### Online

31 August, 2019

#### Key words

Concentrations

Constituents

Water quality

Pollutants

Ponds are considered to be self-contained, land lock ecosystem which is often teeming with rich vegetation and diverse organismal life. The pond water contains different organic and inorganic components. The experiment was carried out in laboratory, Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh through collection of pond water from Gouripur and Muktagacha under Mymensingh division for assessment of major ionic status and suitability parameters for irrigation and aquaculture usage in quantitative way. Around 30 samples were collected from different location. On the basis of  $\text{HCO}_3^-$  ion, all water samples except 3 samples were not suitable for irrigation because this anion exceeded the acceptable limit ( $1.5 \text{ meL}^{-1}$ ). On the other hand,  $\text{HCO}_3^-$  ion was not treated as problematic in all samples except 2 samples for aquaculture usages. The concentrations of Ca, Mg, Na, K,  $\text{PO}_4$  and  $\text{SO}_4$  were far below the recommended limit. Considering aquaculture usage, Cl ion was considered as hazardous in all the pond water samples because this anion was above the legal limit ( $<0.003 \text{ mgL}^{-1}$ ). pH value of pond ranged from 7.02 to 7.87 indicating alkaline in nature and were not problematic for irrigation and aquaculture usage. Among the major ionic constituents, the remarkable significant correlations existed between Ca vs Mg, Ca vs K, Mg vs  $\text{SO}_4$ , K vs Na, Na vs  $\text{SO}_4$ .

**To cite this article:** Akter T, SR Ghosh, SC Sarker, MM Rahman and KME Nabi, 2019. Quantitative assessment of ionic status of pond water for irrigation and aquaculture usage in the selected sites of Mymensingh areas, Bangladesh. Res. Agric. Livest. Fish. 6 (2): 301-313.



Copy right © 2019. The Authors. Published by: AgroAid Foundation

This is an open access article licensed under the terms of the Creative Commons Attribution 4.0 International License



www.agroaid-bd.org/ralf, E-mail: editor.ralf@gmail.com

## INTRODUCTION

Pond water is an inevitable component of natural resource and plays an important role for different beneficial uses as it contains different ions in various amounts. While some can be seen with the naked eye, others are too small and will require the use of a microscope to be able to properly observe them. It is universal solvent and various types of ions are dissolved in it but the concentration of any ion beyond tolerance limit is treated as pollutant. Quality of pond water is deteriorated day by day through several factors. The primary causes of deterioration of surface water quality are municipal and domestic wastewater, industrial and agricultural wastes (Todd, 1980). It is also contaminated by mixing with rain water and flood water which wash down some agrochemicals into rivers, canals and ponds. Intensive agricultural practices toward the goal of food grain self-sufficiency to overcome the food crisis of over population, intensive agriculture is considerably dependent on agricultural chemicals and as a resultant impact of increased use of these chemicals lead to contamination of surface water (Lal and Stewart, 1994). Water quality is essential for irrigation because it contains different ions in different concentrations. Among the ions Ca, Mn, C, HCO<sub>3</sub>, and B are of prime importance in judging the quality of water for irrigation (Michael, 1978). Bohn et al. (1985) reported that the concentrations of toxic ions like Na, Cl and B in irrigation water are potentially important because many crops are susceptible to these ions even in extremely low concentration. In Bangladesh, till now some farmers are also applying Surface water for irrigation. In this fact, farmers always doubt whether irrigation water is improving or deteriorating soil conditions. The toxicity of Surface water is fluctuated from season to season as a result of rainfall, urban and industrial discharge (Mitra and Gupta, 1990; Zaman et al., 2002).

Besides the agricultural use, surface water is equally important for aquaculture usage. The degrees of pollution of different ions are not the same. If these ions exceed the acceptable limit, it becomes harmful to aquaculture. The production of fish can be harmed by chemical presents in water. Chemical in water can be absorbed by gills pan in the bloodstream and circulate through the body. If the concentrations of toxic chemicals are higher, the delicate cells adversely affect the vital function of respiration and salt regulation (Lloyd, 1992). Keeping this view in mind, the present study was conducted to assess the ionic status of pond water used for irrigation and aquaculture and to categorize pond water quality for irrigation and aquaculture usage as per international standard.

## MATERIALS AND METHODS

This experiment was carried out in the month of April, 2011 collecting water samples from different sites of Mymensingh district. A total 15 water samples from each of Gouripur and Muktagacha upazila were collected randomly from ponds following the procedure as outlined by Hunt and Wilson (1986) and APHA (2005).

### Collection and preparation of pond water samples

Water samples were collected in plastic bottles which were previously cleaned and dried. Water samples were taken from the midstream and about 0.30 m below the surface. After collection of water samples, all bottles were sealed immediately to avoid exposure to air. Water samples after proper labeling were carried out to the departmental postgraduate laboratory of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh and all samples were kept in clean, cool and dry Place. All samples were filtered through filter paper to remove unwanted solid and suspended materials before analysis. One sample was analyzed quickly as possible on arrival at the laboratory.

### Water quality parameters

An attempt was made of chemical analyses included the determination of pH, electrical conductivity (EC), total dissolved solids (TDS) and the ionic constituent including Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Carbonate (CO<sub>3</sub>), Bicarbonate (HCO<sub>3</sub>), Sulfate (SO<sub>4</sub>), Chloride (Cl), and Phosphate (PO<sub>4</sub>) ions. The chemical analysis of pond water samples was conducted at the Departmental Laboratory of Agricultural Chemistry, Prof. Mohammad Hossain Central Laboratory, and the Departmental Laboratory of Soil Science, Bangladesh Agricultural University, Mymensingh.

## Analytical methods

### pH

pH value of pond water samples was measured by taking 50 ml. of water in a beaker and then placing the electrode of pH meter (Model: WTW pH 522) into water samples as mentioned by Singh et al. (1999).

### Electrical conductivity

Electrical conductivity of water was measured by taking 100 ml of collected water in a beaker and then immersing the electrode of conductivity meter (Model: WTW LF 521) into water samples according to the technique as described by Ghosh et al. (1963).

### Total dissolved solids

Total dissolved solids (TDS) were measured by evaporating 100 mL water sample to dryness and then were weighed following the method as suggested by Chopra and Kanwar (1980).

## Ionic constituents

### Calcium

Calcium content of water samples was analyzed by EDTA titrimetric method using Na<sub>2</sub> EDTA as a chelating agent (Page et al, 1982; Singh et al, 1999) at pH 12 in presence of calcon indicator. Exactly 25 ml. water sample was taken in a 250 mL conical flask and 50 ml, distilled water was added followed by the additional of 5 mL 10% NaOH solution and then 10 drops each of masking agents such as hydroxylamine hydrochloride (NH<sub>2</sub>OH.HCl), potassium ferrocyanide K<sub>4</sub> [Fe(CN)<sub>6</sub>].3H<sub>2</sub>O and triethanolamine (C<sub>6</sub>H<sub>15</sub>NO<sub>3</sub>) was added. After the addition of 5 drops of calcon indicator, water sample was titrated against Na<sub>2</sub>EDTA (0.01M) solution from burette until pink color completely turned to blue color.

### Magnesium

Magnesium of water samples was determined by EDTA titrimetric method Na<sub>2</sub>EDTA as a completing agent at pH 10 in the presence of Eriochrome Black (EBT) indicator (Page et al., 1982; Singh et al., 1999). Exactly 25 ml. filtered pond water sample was taken in 250 mL conical flask followed by the addition of 50 mL distilled water, 5 ml. NH<sub>3</sub>-NH<sub>4</sub> buffer solution and 10 drops each of masking agents like sodium tungstate (Na<sub>2</sub>WO<sub>4</sub>.2H<sub>2</sub>O), hydroxylamine hydrochloride (NH<sub>2</sub>OH.HCl), potassium ferrocyanide [K<sub>4</sub> Fe (CN)<sub>6</sub>].3H<sub>2</sub>O] and triethanolamine (C<sub>6</sub>H<sub>15</sub>NO<sub>3</sub>). After the addition of EBT indicator solution, sample was titrated against Na<sub>2</sub>EDTA (0.01M) solution from a burette until pink color completely turned to blue color.

### Potassium and sodium

Flame photometer (model: Labtronics) was used to determine potassium and sodium contents from pond water samples separately using potassium and sodium filters. Samples were aspirated into a flame and the intensity of radiation emitted by the ions was measured for K at 766 nm wavelength and at 589 nm wavelength for Na. The intensity of radiation was directly proportional to the concentration of K or Na present in pond water samples, respectively. The per cent of emissions was recorded following the method as outlined by Golterman (1971) and Ghosh et al. (1983).

### Phosphate

Phosphate of pond water samples was analyzed colorimetrically by stannous chloride method according to the procedure outlined by Jackson (1973) and Tandon (1995). In this method, stannous chloride (SnCl<sub>2</sub>.2H<sub>2</sub>O) was used as a reducing agent which formed molybdophosphoric blue complex with the reduction of heteropoly complex formed by co-ordination of molybdate and phosphorus ions. Exactly, 50mL pond water sample was taken in a 100 ml. volumetric flask followed by the addition of 4 mL sulphomolybdic acid and 10 drops of stannous chloride (SnCl<sub>2</sub>.2H<sub>2</sub>O) solution. The color intensity was measured at 660 nm wavelength with the help of a digital photometer (Model: Labtronics LT 31) within 15 minutes after the addition of stannous chloride.

### Sulphate

Sulphate water was determined according to Wolf (1982) and Tandon (1995) using barium chloride ( $\text{BaCl}_2$ , 24,0) as turbidimetric agent. Exactly 25 mL water Sample was taken in a 50 mL volumetric flask followed by addition of 10 mL sodium acetate to acetic acid buffer solution, 1 mL gum acacia and 1g barium chloride crystal. A proper mixing, white turbidity was measured at 425 nm with the help of a digital spectrophotometer (Model: Labtronics LT- 3).

### Carbonate and bicarbonate

Carbonate and bicarbonate contents of the filtered pond water samples were determined by titrating against standard sulphuric acid (0.01 N) using phenolphthalein and methyl orange as indicators. Exactly 10 mL of pond water sample was taken in a clean porcelain dish followed by the addition of 30 ml. distilled water and 3 drops of phenolphthalein. The formation of red color indicated the presence of carbonate and then the titration was continued with standard sulphuric acid till red color disappeared. Then, 3 drops of methyl orange was added in this colorless solution and again, it was titrated till the yellow color changed into rosy red indicating the presence of bicarbonate. This titrimetric method was followed according to the procedure as mentioned by Tandon (1995).

### Chloride

The determination of chloride from water samples was as performed by Argentometric method of titration using potassium chromate ( $\text{K}_2\text{CrO}_4$ ) as indicator. Exactly 10 ml. of water sample was taken in a porcelain dish followed by the addition of 50 ml distilled water and 5 to 6 drops of  $\text{K}_2\text{CrO}_4$  Indicator solution. It was titrated against silver nitrate (0.014N) solution until the brick red tinge appeared. In neutral or slightly alkaline medium (pH-7-10), silver chloride ( $\text{AgCl}$ ) was precipitated quantitatively before red silver chromate ( $\text{Ag}_2\text{CrO}_4$ ) was formed. Finally, chloride was measured titrimetrically (Ghosh et al., 1983; APHA, 2005).

### Statistical analyses

The statistical analyses of the analytical results obtained from pond water samples were performed (Gomez and Gomez, 1984). Correlation studies were done by the (SPSS Program).

## RESULTS AND DISCUSSION

In these study areas, major ionic constituents such as Ca, Mg, Na, K,  $\text{SO}_4$ ,  $\text{PO}_4$ ,  $\text{CO}_3$ ,  $\text{HCO}_3$  and Cl were analyzed and these constituents were detected in ionic form as water being an excellent solvent. The results of chemical analyses and experimental findings have been presented and discussed in the following sequences:

### Assessing pond water quality for irrigation

#### pH

pH value of pond water samples collected from the study areas ranged from 7.02 to 7.87 (Table 1). In both upazilas, all water samples were alkaline in nature. These might be due to the presence of major ions such as Ca, Mg and Na in water (Rao et al.1982). On the basis of water quality standard for irrigation, the recommended pH value is from 6.5 to 8.4 for irrigation (Ayers and Westcot, 1985). According to this limit, all samples in both upazilas were suitable for irrigation.

#### Electrical conductivity

Electrical conductivity (EC) of pond water samples collected from Gouripur and Muktagacha upazilas varied from 225 to 926  $\mu\text{S cm}^{-1}$  with the mean value of 409.57  $\mu\text{S cm}^{-1}$  (Table 1). About 63.33% samples (19 samples) were below the mean value and 36.67% samples (1 sample) were above the mean value. Maximum EC value (926  $\mu\text{S cm}^{-1}$ ) was recorded in pond water (sample no.: 26) due to higher concentration of major ions and minimum EC value (225  $\mu\text{S cm}^{-1}$ ) was obtained from water sample (sample no.: 4) due to the lower concentration of major ions. According to Richards (1968), all water samples except two (sample nos.:4 & 26) under test were rated as medium salinity (C2,  $\text{EC}=250\text{-}750 \mu\text{S cm}^{-1}$ )

**Table 1.** pH, EC, TDS and anionic constituents of pond water samples

Sample No.	pH	EC $\mu\text{S cm}^{-1}$	TDS $\text{mgL}^{-1}$	Cl $\text{meL}^{-1}$	$\text{HCO}_3$ $\text{meL}^{-1}$	$\text{PO}_4$ $\text{mgL}^{-1}$	$\text{SO}_4$ $\text{mgL}^{-1}$
1	7.23	290	194.30	0.56	2.20	1.05	Trace
2	7.44	302	202.34	0.09	1.80	1.08	Trace
3	7.87	265	177.55	0.62	0.80	1.06	Trace
4	7.51	225	150.75	3.90	1.80	0.27	7.58
5	7.57	483	323.61	1.46	1.60	0.32	0.08
6	7.53	320	214.40	1.20	1.20	0.22	Trace
7	7.51	252	168.84	0.14	1.60	0.24	Trace
8	7.49	315	211.05	0.61	3.20	0.22	Trace
9	7.55	305	204.35	1.27	2.60	0.19	Trace
10	7.42	389	260.63	0.66	1.60	0.32	Trace
11	7.45	394	263.98	1.50	1.80	0.32	Trace
12	7.37	328	219.76	1.46	2.00	1.46	1.72
13	7.56	287	192.29	1.02	3.00	0.54	Trace
14	7.51	362	242.54	0.24	2.20	0.16	Trace
15	7.35	358	172.86	0.09	1.60	0.19	Trace
16	7.73	410	274.70	0.92	2.20	0.22	Trace
17	7.39	396	265.32	0.62	2.60	1.40	Trace
18	7.35	495	331.65	0.38	3.40	0.17	0.23
19	7.29	478	320.26	0.82	2.00	0.33	1.17
20	7.50	328	219.76	0.38	2.60	0.16	Trace
21	7.33	424	284.08	0.75	2.80	0.42	Trace
22	7.36	601	402.67	1.25	2.40	1.21	0.16
23	7.28	295	197.65	1.22	2.60	0.17	Trace
24	7.27	415	278.05	1.05	2.80	2.51	0.63
25	7.53	681	456.27	1.32	2.80	0.71	0.78
26	7.38	926	620.42	2.16	2.20	0.68	9.06
27	7.31	383	256.61	0.94	2.00	0.25	0.23
28	7.30	383	256.61	0.92	2.00	0.78	Trace
29	7.06	549	367.83	0.85	2.60	0.54	0.47
30	7.02	748	501.16	0.71	2.60	0.52	Trace
Min.	7.02	225	150.75	0.09	0.80	0.16	Trace
Max.	7.87	926	620.42	3.90	3.40	2.51	9.06
Mean	-	409.57	274.41	0.97	2.24	0.59	2.01
SD	-	158.78	106.38	0.73	0.62	0.54	3.02
CV(%)	-	38.77	38.77	75.20	27.68	90.98	150.24

**Legend:**Trace of  $\text{SO}_4 < 0.01 \text{ mg L}^{-1}$

**Table 2.** Cationic constituent of pond water samples

Sample No	Ca	Mg	Na	K
	meL <sup>-1</sup>			
1	1.80	133	0.37	0.03
2	1.60	1.20	0.37	0.01
3	1.72	1.23	0.53	0.17
4	1.96	1.53	0.73	0.26
5	1.93	165	0.72	0.07
6	1.76	1.03	0.98	0.29
7	2.00	1.33	0.68	0.20
8	1.67	1.93	0.54	0.17
9	1.40	1.53	0.53	0.12
10	1.95	1.87	0.59	0.16
11	1.87	1.53	0.65	0.14
12	1.83	1.45	1.06	0.39
13	1.89	1.05	1.06	0.23
14	1.73	0.80	0.56	0.19
15	1.96	1.14	0.68	0.15
16	2.47	2.03	0.65	0.23
17	2.26	2.05	0.75	0.14
18	2.07	1.30	0.75	0.17
19	2.87	2.20	0.61	0.15
20	2.07	1.33	0.86	0.29
21	2.17	1.33	0.70	0.11
22	2.46	1.16	0.79	0.19
23	2.22	1.30	0.46	0.07
24	2.34	1.37	0.42	0.14
25	2.80	2.53	0.53	0.20
26	2.53	2.33	1.43	0.36
27	2.22	1.62	0.77	0.37
28	1.87	0.93	0.70	0.19
29	2.04	1.59	0.89	0.46
30	1.96	1.83	0.65	0.29
Min.	1.40	0.80	0.37	0.01
Max.	2.87	2.53	1.43	0.43
Mean	2.05	1.51	0.70	0.20
SD	0.34	0.41	0.23	0.11
CV(%)	16.57	27.15	32.24	53.36

**Table 3.** Quality rating and suitability of pond water samples for irrigation

Sample No	SAR	SSP %	RSP meL <sup>-1</sup>	Hardness mgL <sup>-1</sup>	Water class based no				Alkalinity and salinity hazard classes
					SAR <sup>1</sup>	SSP <sup>2</sup>	RSC <sup>3</sup>	H <sub>T</sub> <sup>4</sup>	
1	0.18	11.33	-0.93	156.56	Ex.	Ex.	Suit.	Hard	C2S1
2	0.19	11.94	-0.75	140.09	Ex.	Ex.	Suit.	MH	C2S1
3	0.27	19.17	-2.15	147.57	Ex.	Ex.	Suit.	MH	C2S1
4	0.34	22.09	-1.69	174.55	Ex.	Ex.	Suit.	Hard	C2S1
5	0.33	18.07	-1.98	179.03	Ex.	Ex.	Suit.	Hard	C2S1
6	0.53	31.28	-1.58	139.64	Ex.	Good	Suit.	MH	C2S1
7	0.32	20.90	-1.73	166.61	Ex.	Ex.	Suit.	Hard	C2S1
8	0.24	16.47	-0.40	179.93	Ex.	Ex.	Suit.	Hard	C2S1
9	0.27	18.15	-0.33	146.47	Ex.	Ex.	Suit.	MH	C2S1
10	0.25	16.41	-2.22	191.02	Ex.	Ex.	Suit.	Hard	C2S1
11	0.30	18.85	-1.60	170.02	Ex.	Ex.	Suit.	MH	C2S1
12	0.51	30.65	-1.27	164.10	Ex.	Good	Suit.	Hard	C2S1
13	0.55	30.49	0.06	112.72	Ex.	Good	Suit.	MH	C2S1
14	0.32	22.86	-0.33	124.83	Ex.	Ex.	Suit.	MH	C2S1
15	0.34	21.11	-1.50	155.16	Ex.	Ex.	Suit.	Hard	C2S1
16	0.25	16.35	-2.30	175.26	Ex.	Ex.	Suit.	Hard	C2S1
17	0.29	17.11	-1.70	215.54	Ex.	Ex.	Suit.	Hard	C2S1
18	0.31	21.45	0.33	168.63	Ex.	Ex.	Suit.	Hard	C2S1
19	0.30	13.04	-3.07	253.64	Ex.	Ex.	Suit.	Hard	C2S1
20	0.40	25.27	-0.79	170.11	Ex.	Ex.	Suit.	Hard	C2S1
21	0.32	18.79	1.30	175.14	Ex.	Ex.	Suit.	Hard	C2S1
22	0.34	21.30	-1.21	181.24	Ex.	Ex.	Suit.	Hard	C2S1
23	0.21	13.08	-0.92	175.76	Ex.	Ex.	Suit.	Hard	C2S1
24	0.24	13.11	-0.91	185.67	Ex.	Ex.	Suit.	Hard	C2S1
25	0.18	13.04	-2.53	266.54	Ex.	Ex.	Suit.	Hard	C2S1
26	0.52	26.91	-2.67	241.8	Ex.	Good	Suit.	Hard	C2S1
27	0.33	22.89	-1.85	192.11	Ex.	Ex.	Suit.	Hard	C2S1
28	0.34	24.11	-0.80	146.13	Ex.	Ex.	Suit.	MH	C2S1
29	0.39	27.10	-1.03	181.57	Ex.	Ex.	Suit.	Hard	C2S1
30	0.28	9.11	-1.18	189.51	Ex.	Ex.	Suit.	Hard	C2S1
Min.	0.18	9.11	-3.07	112.72					
Max.	0.55	31.28	0.06	266.54					
Mean	0.32	19.91	-4.76	175.38					
SD	0.09	5.89	3.95	33.82					
CV(%)	30.31	29.88	-83.03	19.28					

Ex. = Excellent, Suit. = Suitable, MH = Moderately hard, C1 = Low salinity C2 = Medium salinity C3 = High salinity and SI = Low alkalinity

#### Total dissolved solid

The amount of total dissolved solids of pond water samples ranged from 150.75 to 620.42 mgL<sup>-1</sup> with the mean value of 274.41 mgL<sup>-1</sup> (Table 1). In the study area, 36.67% samples (11 samples) were higher than the mean value and 63.33% samples (19 samples) were less than the mean value. The calculated standard deviation (SD) and co-efficient of variation (CV) in Gouripur and Muktagacha upazilas were 106.38 and 38.779%, respectively. Maximum TDS value (620.42 mg L) was recorded in pond water (sample no.: 26) and minimum TDS value (150.75 mg L) was recorded in the pond water (Sample no.: 4). According to Freeze and Cherry (1979), water samples having TDS less than 1000 mg L were graded as fresh water in quality. On the basis of water quality standard for irrigation as cited in Appendix 2, all water samples were suitable for irrigation in both upazilas because water samples contained less than 1000 mg L<sup>-1</sup>.

## Ionic constituents

### Calcium

The concentration of Ca in pond water samples varied from 1.40 to 2.87 me L<sup>-1</sup> with an average value of 2.05 meL<sup>-1</sup> (Table 2). In the study area, 40% samples (12 samples) were above the mean value and 60% samples (18 samples) were below the mean value. The calculated standard deviation (SD) and co-efficient of variation (CV) were 0.34 and 16.57%, respectively. The highest value (2.87 meL<sup>-1</sup>) was observed in pond water Sample No. 19) and the lowest value (1.40 me L<sup>-1</sup>) was found in pond water (Sample No.9). The contribution of Ca content in water was largely dependent on the solubility of CaCO<sub>3</sub>, CaSO<sub>4</sub>, and rarely on CaCl<sub>2</sub> (Karanth, 1994). Irrigation water containing less than 20 mg L<sup>-1</sup> Ca was suitable for irrigation crop plants (Ayers and Wesicot, 1985). On the basis of Ca content, all water samples could safely be used for irrigation and would not affect soil system.

### Magnesium

The content of Mg in the study area fluctuated from 0.80 to 2.53 meL<sup>-1</sup> with an average value of 1.51 me L<sup>-1</sup> (Table 2). About 53.35% samples were below the mean value and the rest 46.67% samples were above the mean value. The calculated standard deviation (SD) and co-efficient of variation (CV) were 0.41 and 27.15%, respectively. The highest Mg content (2.53 me L<sup>-1</sup>) in study area was recorded in pond water (Sample no.: 25) and the lowest content (0.80 meL<sup>-1</sup>) was also observed in pond water (Sample no.: 14). According to Ayers and westcot (1963), irrigation water contains less than 5.0 meL<sup>-1</sup>. In the investigated area, not a single sample exceeded this limit (Table 4.2). Therefore, all water samples were suitable for irrigation as per Mg content.

### Chloride

The concentration of Cl in pond water samples in the study area ranged from 0.09 to 5.90 me L<sup>-1</sup> with the mean value of 0.97 meL<sup>-1</sup> (Table 1). In all samples, 40% (12 samples) were higher than the mean value and about 60% (18 samples) were lower than the mean value. The calculated standard deviation (SD) and co-efficient (CV) were 0.75 and 75.20%, respectively. Chloride content of all water samples was not problematic for irrigation because this detected anionic concentration was below the recommended limit (4.0 meL<sup>-1</sup>) as mentioned in Appendix 7. Most of the chloride in water was present as sodium chloride but chloride content may exceed sodium due to base exchange phenomena (Karanth, 1994).

### Phosphate

The content of PO<sub>4</sub> fluctuated from 0.16 to 2.51 mg L<sup>-1</sup> with an average value of 0.59 mg L<sup>-1</sup> (Table 1). About 66.67% samples were below the mean value and the rest 33.33% samples were above the mean value. The calculated standard deviation (SD) and co-efficient of variation (CV) were 0.54 and 90.98%, respectively. The highest PO<sub>4</sub> content (2.51 mg L<sup>-1</sup>) was recorded in pond water sample (Sample no.: 24) and the lowest content (0.16 mgL<sup>-1</sup>) was also observed in pond water (Sample no.: 14). According to Ayers and Westcot (1985), the acceptable limit of PO<sub>4</sub> in irrigation water is less than 2.00 mgL<sup>-1</sup>. On the basis of this limit, all water samples under investigation were not problematic for irrigation having no harmful effect on soils and crops grown in the study area.

### Sulphate

The status of SO<sub>4</sub>, in the collected water samples in both Gouripur and Muktagagha upazilas varied from trace to 9.06 mg L<sup>-1</sup> with the mean value of 2.01 mg L<sup>-1</sup> (Table 1). In both upazilas, only 2 samples were higher the mean value and the rest 28 samples were below the average value. The calculated standard deviation (SD) and co-efficient of variation (CV) were 3.02 and 150.24%, respectively. According to Ayers and Westcot (1985), the acceptable limits of SO<sub>4</sub>, in irrigation water is less than 20 mg L<sup>-1</sup>. On the basis of this limit, all water samples under investigation were not problematic for irrigation having no hazard effect on soils and crops grown in the investigated area.



### Sodium adsorption ratio

The computed sodium adsorption ratio (SAR) of 30 water samples in both Gouripur and Muktagacha upazilas ranged from 0.18 to 0.55 with the mean value of (0.324.3). About 40% (12 samples) were higher than the mean value and about 60% (18 samples) were lower than the mean value. The calculated standard deviation (D) and co-efficient (Cv) were 0.09 and 30.3 1%, respectively. Maximum SAR value (0.55) was recorded in pond water (Sample no.: 13) in pond water but the lowest SAR Value (0.18) was recorded in pond water (Sample nos.: 1 & 25). The present investigation expressed that a balance proportion of Ca and Mg existed in water which was suitable for good structure and tilth condition of soil permeability. Water used for irrigation with SAR less than 10 might not be harmful for agricultural crops (Tood, 1980). Considering this classification, all the water samples were excellent or irrigation and rated as low alkalinity hazard (SI) class as per SAR Value (Table 3).

### Soluble sodium percentage

The status of SSP in the collected water samples in both Gouripur and Muktagacha upazilas varied from 9.11 to 31.28% with the mean value of 19.71% (Table 3). In both upazilas, only 13 samples (43.35%) were higher the mean value and the rest 17 samples (56.67%) were below the average value. The calculated standard deviation (SD) and co-efficient of variation (CV) were 5.89 and 29.88%, respectively. According to water classification proposed by Wilcox (1953), 26 Samples were classified as excellent (SSP<20%) and 4 samples were rated as good classes (SSP=21-40%). In the study area, water samples might safely be applied for irrigating agricultural crops.

### Residual sodium carbonate

The residual sodium carbonate (RSC) of all water samples collected from Gouripur and Muktagacha upazilas ranged from 3.07 to 0.06 me L<sup>-1</sup> with the mean value of 1.25 meL<sup>-1</sup> (Table 3). Most of sample values were negative in both upazilas. The calculated Standard deviation (SD) and co-efficient of variation (CV) in both upazila were 3.95%.

### Hardness

The obtained results revealed that hardness (H) of the collected water samples varied from 12.72 to 266.54 mg L<sup>-1</sup> with the mean value of 175.38 mgL<sup>-1</sup> (Table 3). From the samples, 40 %samples (12 samples) were higher than the mean value rest 60% samples (18 samples) were lower than 273.16 mg L. The calculated standard deviation (SD) and co-efficient of variation (CV) were 33.82 and 19.28, respectively. The highest value (266.1546) was observed in pond water (sample no 25) and the lowest value (112.72%) was found in pond water sample (Sample no. 13). Out of 50 sample, 22 samples were rated as hard (Hy =150-300 mg L<sup>-1</sup>) and rest 8 sample was classified as moderately hard (Hy, 75-150 mg L<sup>-1</sup>) as per the classification proposed by Sawyer and McCarty (1967).

### Assessing pond water quality for aquaculture

#### pH

pH value of pond water samples collected from the study areas ranged from 7.02 to 7.87 indicating alkaline in nature (Table 1). According to water quality standard for aquaculture, the recommended pH value is from 6.5 to 8.0 (Meade, 1989). According to this limit, all samples in both upazilas were suitable for aquaculture

#### Total dissolved solid

The amount of total dissolved solids (TDS) of pond water samples ranged from 150.75 to 620.42 mgL<sup>-1</sup> with the mean value of 274.41mgL<sup>-1</sup> (Table 1). In the study area 36.67% samples (11 samples) were higher than the mean value and 63.33% samples (19 samples) were less than the mean value. On the basis of water quality standard for aquaculture, the recommended TDS value is less than 400 (Meade 1989). According to this limit, all sample except four (Sample No. 22,25,26, and 0) in both upazilas were suitable for aquaculture .

### Hardness

The obtained results revealed that hardness ( $H_T$ ) of the collected water samples varied from 12.72 to 266.54  $\text{mg L}^{-1}$  with the mean value of 273.16  $\text{mg L}^{-1}$  (Table 3). From the samples 40% (12 samples) was higher than the mean value and the rest 60% samples (18 samples) were lower than 175.38  $\text{mg L}^{-1}$ . The calculated standard deviation (SD) and co-efficient of variation (CV) were 33.82 and 19.28%, respectively.

### Ionic constituents

#### Calcium

The concentration of Ca in pond water samples varied from 1.40 to 2.87  $\text{meL}^{-1}$  with an average value of 2.05  $\text{meL}^{-1}$  (Table 2). In the study area 40% Samples (12 Samples) were above the mean value and 60% samples (18 samples) were below the mean value. The calculated standard deviation (SD) and co-efficient of variation (CV) were 0.34 and 16.3%, respectively. On the basis of water quality standard for aquaculture the recommended Ca value is from 4.0 to 160.0  $\text{mg L}^{-1}$  (Meade, 1989). According to this limit, all samples in both upazilas were suitable for aquaculture.

#### Magnesium

The content of Mg in the study area fluctuated from 0.80 to 2.53  $\text{meL}^{-1}$  with an average value of 1.51  $\text{meL}^{-1}$  (Table 2). About 53.33% samples were below the mean value and the rest 46.67% samples were above the mean value. The calculated standard deviation (SD) and co-efficient of variation were 0.41 and 27.15%, respectively. On the basis of water quality standard for aquaculture the recommended Mg value is less than 15  $\text{mg L}^{-1}$  (Meade, 1989). According to this limit, all samples in both upazilas were suitable for aquaculture.

#### Potassium

The concentration of K in the collected water samples in Gouripur and Muktagacha upazilas varied from 0.01 to 0.46  $\text{meL}^{-1}$  with the mean value 0.20  $\text{meL}^{-1}$  (Table 2). About 66.67% Samples were below the mean value and the rest 33.33% above mean value. The calculated standard deviation (SD) and co-efficient of variation (CV) were 0.11 and 53.36%, respectively. The acceptable limit of K for aquaculture is less than 5.00  $\text{mg L}^{-1}$  (Meade 1989). On the basis of K content, all samples in both upazilas were suitable for aquaculture.

#### Phosphate

The content of  $\text{PO}_4$  in pond water samples fluctuated from 0.16 to 2.51  $\text{mg L}^{-1}$  with an average value of 0.59  $\text{mg L}^{-1}$  (Table 1). About 66.67% samples were below the mean value and the rest 33.33% samples were above the mean value. The calculated standard deviation (SD) and co-efficient of variation (CV) were 0.54 and 90.98%, respectively phosphate present in water was minor constituent which did not exhibit the harmful effect on fishes and other aquatic life. The acceptable content of PO, for aquaculture is 2.0  $\text{mg L}^{-1}$  (Meade, 1989). On the basis of  $\text{PO}_4$  content, all the Samples in both upazilas were suitable for aquaculture.

#### Sulphate

The status of  $\text{SO}_4$ , in the collected water samples in both Gouripur and Muktagacha upazilas varied from trace to 9.06  $\text{mg L}^{-1}$  with the mean value of 2.01  $\text{mg L}^{-1}$  (Table 1). In both upazilas, only 2 samples were higher than the mean value and the rest 28 samples were below the average value. The calculated Standard deviation (SD) and co-efficient of variation (CV) were 3.02 and 150.24%, respectively. For aquaculture, the recommended limit of sulphate is less than 50  $\text{mg L}^{-1}$  and according to this recommended limit, all the samples are suitable for fish cultivation.

#### Chloride

The concentration of Cl in pond water samples in the study area ranged from 0.09 to 5.90  $\text{meL}^{-1}$  with the mean value of 0.97  $\text{meL}^{-1}$  (Table 1). In all samples, 40% (12 samples) were higher than the mean value and about 60% (18 samples) were lower than mean value. The calculated standard deviation (SD) and co-efficient (CV) were 0.75 and 75.20%, respectively. The calculated standard deviation (SD) and co-efficient (CV) were 0.75 and 75.20%, respectively. According to Meade (1989), the recommended limit of Cl is less than 0.003  $\text{mg L}^{-1}$ . According, all water samples in both upazilas was hazardous for aquaculture because the estimated amount of Cl exceeded the legal limit.

### Bicarbonate

The experimental results showed that the concentration of HCO<sub>3</sub><sup>-</sup> in the collected water samples fluctuated from 0.80 to 3.40 meL<sup>-1</sup> (Table 1) with the mean value of 2.24 me L<sup>-1</sup>. About 43.33% samples (13 samples) were above the mean value and the rest 56.67% samples (17 samples) were below the mean value. The calculated standard deviation (SD) and co-efficient of variation (CV) were 0.62 and 27.68%, respectively. The recommended concentration of HCO<sub>3</sub><sup>-</sup> in aquaculture is from 50 to 300 mg L<sup>-1</sup> (Boyd, 1998). According to this results, all the water samples except three (sample no.: 6, 12 and 18) were suitable for aquaculture.

**Table 4.** Correlation matrix among pond water quality parameters

Parameters	TDS	SAR	SSP	RSC	Hardness
EC	0.960**	0.179 <sup>NS</sup>	0.094 <sup>NS</sup>	-0.321 <sup>NS</sup>	0.556**
TDS		0.229 <sup>NS</sup>	0.940**	-0.317 <sup>NS</sup>	0.516**
SAR			0.930**	0.115 <sup>NS</sup>	-0.178 <sup>NS</sup>
SSP				0.304 <sup>NS</sup>	-0.349 <sup>NS</sup>
RSC					-0.839**

\*\*Significant at 1% level; <sup>NS</sup>not significant

Tabulated values of r with 28 df are 0.361 and 0.463 at 5% and 1% levels of significance

**Table 5.** Relationship between major ionic constituents of pond water samples

Ions	Mg	K	Na	HCO <sub>3</sub>	Cl	SO <sub>4</sub>	PO <sub>4</sub>
Ca	0.579**	0.402*	0.170 <sup>NS</sup>	0.222 <sup>NS</sup>	0.156 <sup>NS</sup>	0.250 <sup>NS</sup>	0.126 <sup>NS</sup>
Mg		0.237 <sup>NS</sup>	0.075 <sup>NS</sup>	0.087 <sup>NS</sup>	0.059 <sup>NS</sup>	0.910**	0.283 <sup>NS</sup>
K			0.713**	0.190 <sup>NS</sup>	0.268 <sup>NS</sup>	0.361 <sup>NS</sup>	-0.092 <sup>NS</sup>
Na				0.005 <sup>NS</sup>	0.338 <sup>NS</sup>	0.522**	-0.107 <sup>NS</sup>
HCO <sub>3</sub>					-0.085 <sup>NS</sup>	-0.077 <sup>NS</sup>	0.054 <sup>NS</sup>
Cl						0.759**	0.001 <sup>NS</sup>
SO <sub>4</sub>							0.021 <sup>NS</sup>

\*\*Significant at 1% level; \*significant at 5% level; <sup>NS</sup>not significant

Tabulated values of r with 28 df are 0.361 and 0.463 at 5% and 1% levels of significance

### Relationship between water quality criteria and major ionic constituents

The correlation among the computed six parameters of water quality namely SAR, SSP, RSC and Hardness was observed. The purpose of this analysis was to find out the influence of any one, on the quality criteria either as dependent or independent variable. It was observed that significant positive correlation existed between the combinations of EC vs TDS, EC vs Hr, TDS vs SSP, TDS vs H, SAR VS SSP and RSC vs H<sub>T</sub> (Table 4). The relationship between major ionic constituents likes Ca, Mg, K, Na, SO<sub>4</sub>, HCO<sub>3</sub> and Cl differed significantly. The calculated r values for 15 combination of six factors such a EC vs TDS, EC vS SAR, EC vs SSP, EC vs RSC, EC vs H<sub>T</sub>, TDS vs SAR, TDS vs SSP, TDS vs RSC, TDS vs HySAR vs SSP, SAR vs RSC, SAR vs H<sub>T</sub>, SSP vs RSC, SSP vs H<sub>T</sub>, and RSC vs H<sub>T</sub>, were 0.960, 0.179, 0.094, -0.321, 0.556, 0.229, 0.940,0.317,0.516, 0.930, 0.115, -0.178, 0.304,-0.349, 0.839, respectively. Among these combinations, EC vs TDS, EC vs Hy, TDS vs SSP, 1DS vs H<sub>T</sub>,SAR vs SSP, relation showed positive significant correlation . These findings reflected synergistic relationships between the above mentioned quality factor. The combinations RSC vs H<sub>T</sub> relationships showed negative significant correlation. The combination between EC vs SAR, EC VS SSP, EC VS RSC, TDS vs SAR, TDS vs RSC,SAR vS RSC, SAR vs H,SSP VS KSC, and SSP vs Hy Showed insignificant correlation because the respective calculated r values were below the tabulated value of rat 1% and 5% levels of significance . Among the major ionic constituents, the remarkable significant correlations existed between Ca vs Mg, Ca VS K, Mg vs SO<sub>4</sub>, K vs Na, Na vs SO<sub>4</sub>, and Cl vs SO<sub>4</sub> (Table 5).

## CONCLUSION

On the basis of  $\text{HCO}_3$  ion, all water samples except 3 samples were not suitable for irrigation because this anion exceeded the acceptable limit ( $1.5 \text{ meL}^{-1}$ ). On the other hand,  $\text{HCO}_3$  ion was not treated as problematic in all samples except 2 samples for aquaculture usages. The concentrations of Ca, Mg, Na, K,  $\text{PO}_4$  and  $\text{SO}_4$  were far below the recommended limit. Considering aquaculture usage, Cl ion was considered as hazardous in all the pond water samples because this anion was above the legal limit ( $<0.003 \text{ mgL}^{-1}$ ). pH value of pond ranged from 7.02 to 7.87 indicating alkaline in nature and were not problematic for irrigation and aquaculture usage. Among the major ionic constituents, the remarkable significant correlations existed between Ca vs Mg, Ca vs K, Mg vs  $\text{SO}_4$ , K vs Na, Na vs  $\text{SO}_4$ .

## COMPETING INTEREST

To developed new technology for horticultural species in Bangladesh.

## ACKNOWLEDGEMENT

We acknowledge the cooperation of the Department of Agricultural Chemistry, Bangladesh Agricultural University (BAU), Mymensingh, and laboratory peoples of Prof. Md. Mohammad Hossain Central Lab., BAU, Mymensingh for their cooperation to perform the study.

## CONFLICT OF INTEREST

There are no conflicts of interest in this study.

## REFERENCES

1. APHA (American Public Health Association), 2005. Standard Methods for the Examination of Water and Wastewater. 21 edn., AWWA and WEF Washington, USA. pp. 1-30~ 40-175.
2. Ayers RS and Westcot DW, 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29 (Kev.1): T-144
3. Boyd CE, 1998. Water quality for pond aquaculture. Research and Development Series No.43. International Center for Aquaculture and Aquatic Environments, Alabama Agricultural Experimental Station, Auburn University, Auburn, Alabama.
4. Chopra SL and Kanwar JS, 1980. Analytical Chemistry. Kalyani Publishers, Ludhiana, New Delhi, pp.148-289.
5. Freeze AR and Cherry JA, 1979. Groundwater Prentice Hall, Inc. Englewood Cliffs, New Jersey. pp. 84-387,
6. Ghosh AB, Bajaj JC, Hasan R and Singh D, 1983. Soil and Water Testing Methods. A Laboratory Manual, Division of Soil Science and Agricultural Chemistry, IARI, New Delhi, India. pp. 1-48.
7. Golterman HL and Clymo RS, 1971. Methods for Chemical Analysis of Fresh Waters. IBP Handbook No. 8. Blackwell Scientific Publications. Oxford and Edinburgh, England. pp. 41-46
8. Gomez KA and Gomez AA, 1984. Statistical Procedures for Agricultural Research, A Wiley Interscience Publication. New York. pp. 357-387.
9. Hunt DTE and Wilson AL, 1986. The Chemical Analysis of Water: General Principles and Techniques. 2<sup>nd</sup> edn. The Royal Society of Chemistry, Cambridge. pp. 1-2.
10. Jackson ML, 1973. Soil Chemical Analysis. Prentice-Hall of India Private Ltd. New Delhi, India. pp. 10-144
11. Karanth KR, 1994. Ground Water Assessment Development and Management. TATA.

12. McGraw-Hill Publishing Co. Ltd., New Delhi, India. Pp. 217-273.
13. Meade JW, 1989. Aquaculture Management. New York. Van Nostrand Reinhold.
14. Rao BK, Panchaksharjah S, Patil BN, Narayana A and Kailer DLS, 1982. Chemical composition of surface water *Siron irctc* plants of Bjpur district, Karnataka. Mysore Journal of Agricultural Science, 16(4): 426-432.
15. Richards LA (ed), 1968. Diagnosis and Improvement of Saline and Alkaline Soils. Delhi, Agricultural Hand Book 60, USDA and I v H. Publishing Co. Ltd. India, pp. 98-99.
16. Sawyer CN and McCarty PL, 1967. Chemistry for Sanitary Engineers. 2 edn. McGraw Hill, New York. p. 518.
17. Singh D, Chhonker PK and Pandey RN, 1999. Soil Plants Water Analysis: Avenods Manual, Indian Agricultural Research Institute (IARI), New Delhi, India. pp. 72-86.
18. Tandon HLS (ed.), 1995. Methods of Analysis Soils, Plants, Waters and Fertilizers. Fertilizer Development and consultati organization, New Deini, India. pp. 84-90.
19. Todd DK, 1980. Ground water Hydrology. 2<sup>nd</sup> edn., John Wiley and Sons Inc., New York, USA. pp. 267-315.
20. Wilcox LV, 1995. Classification and use of irrigation water, United States Department of Agriculture Circular No.969, Washington D.C.p19.
21. Wolf B, 1982. A comprehensive system of leaf analysis and its use diagnostic crop nutrients status. Communications Soil Science and Plant Analysis, 12(2): 1044-1045.