E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2018; 6(2): 269-263

www.fisheriesjournal.com
Received: 04-01-2018
Accepted: 07-02-2018

Md. Abdul Halim
Scientific Officer, Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh

S Sharmin
Scientific Officer, Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh

HM Hafizur Rahman
Assistant Commissioner, Government of the People's Republic of Bangladesh

Md. Mozzamel Haque
Scientific Officer, Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh

Md. Sydur Rahman
Upazilla Fisheries Officer, Department of Fisheries, Government of the People's Republic of Bangladesh

Md. Shahidul Islam
Senior Scientific Officer, Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh

Correspondence
Md. Abdul Halim
Scientific Officer, Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh

Assessment of water quality parameters in *baor* environment, Bangladesh: A review

Md. Abdul Halim, S Sharmin, HM Hafizur Rahman, Md. Mozzamel Haque, Md. Sydur Rahman and Md. Shahidul Islam

Abstract
Water's nickname is life. It has a great contribution in shaping the land and regulating the climate. It is one of the most important elements that directly influence in our life. The water quality parameters generally measured according to its physical, chemical and biological properties. People indiscriminately use of chemicals, fertilizers and pesticides in agriculture. Due to rainfall all those mixes in *baor* environment. It is caused by deterioration of water quality and depletion of aquatic biodiversity. Due to use of contaminated water in *baor* environment, fish production has decreased and loss various aquatic fauna. It is therefore necessary to check the water quality at regular interval of time. Parameters that may be tested include temperature, pH, turbidity, salinity, nitrates, phosphates etc. An assessment of the aquatic macro macroinvertebrates can also provide an indication of water quality.

Keywords: pH, dissolved oxygen (DO), alkalinity, ammonia, transparency

1. Introduction

The fisheries resources of Bangladesh are among the richest in the world and the inland fisheries production still ranks fourth in the world only after China, Indonesia and India [5]. In 2011, global aquaculture production was increased to 62.7 from 59 million tons in 2010 of which 89% came from Asia where Bangladesh achieved 5th position [11] which was replaced by 4th position through advancement in 2013 [12]. The fisheries sector is contributing imperatively towards the economic development of Bangladesh and in the alleviation of rural poverty. About 6 million peoples are directly or indirectly engage in this sector [10]. Bangladesh is blessed with a vast extensive water resources in the form of ponds, natural depressions (*haors* and *beels*), lakes, canals, rivers and estuaries covering an area of 4.56 million ha and 2,640 sq nautical miles area in Bay of Bengal [9].

Oxbow lakes are semi-closed water bodies, which is occupied by the dead channels of the rivers in the moribund delta of the Ganges. Locally it is called resembled as horse-shoe and thus it is named as an oxbow lake. There are approximately 600 oxbow lakes in the southwest region of Bangladesh with an estimated combined water area of 5,488 ha [14]. Baors were the properties of Jomidars (Landlords) during the British colonial days (1757-1947) and became government property after the abolition of the Jomidary system through a land settlement act in 1951. They were leased to private individuals or cooperatives through open auctions. About six hundred natural lakes covering 5,500 hectares (created out of dying or changing the course of rivers/creeks) exist in south-western districts of Bangladesh (greater Jessore district with the highest concentration, Kushtia and Faridpur district) with a significant potential of raising cultural fish in those lakes. The most successful example of culture-based fisheries that has been accomplished in Bangladesh is in oxbow lakes located in south-west Bangladesh [15]. Most of freshwater reservoirs all over the world are getting polluted, thus decreasing the portability of water. The main causes of baors water pollution are to increased human population, industrialization, use of fertilizers and man-made activity.

It is an essential and important to test the baors water before fish culture. Water must be tested with different physic-chemical parameters. Water does content different types of floating, dissolved, suspended and microbiological as well as bacteriological impurities. Some physical test should be performed for testing of its physical appearance such as temperature, color, odour, pH, turbidity, TDS etc.

while chemical tests should be performed for its BOD, COD, dissolved oxygen, alkalinity, hardness and other characters. For obtaining more and more quality and purity water, it should be tested for its trace metal, heavy metal contents and organic i.e. pesticide residue. Following different water quality parameters are tested regularly for monitoring quality of water.

2. Materials & Methods

The study was carried out based on the information through review of the related thesis, journals, reports and books. Some practical knowledge was gained through working experience in *baors* environment, attending different seminars on water quality management and observing research presentation related with the *baors*. The necessary data were collected from internet, different annual statistical yearbooks of Bangladesh, national fish week compendiums, newspapers, visiting *baors* with different on-going researches and consulting associated consultants and researchers.

3. Result and Discussion

3.1 General

Various technical papers on assessment of water quality parameters in *baor* environment have been presented at research level from which referred many papers for study. These papers are presented below.

3.2 Review of Literature

Shofiquzzoha *et al.* (2017) [22] Study the feasibility of gulsha fish (*Mystus cavasius*) in cages under *boar* environment (Abstract). The experiment was carried out to determine the growth and survival rate of gulsha fish (*Mystus cavasius*) in baor (Oxbow lake) environment during February to June 2017. The experiment was done in the Jhapa *baor* at Monirampur *Upazilla* under Jessore district with the help of women fisher group. The water quality parameters were analyzed and observed that, water temp was 27.26±4.33 ^{0}C, air temp was 28.46±5.69 ^{0}C, pH was 8.79±0.90, DO was 3.53±0.80 mg/l, ammonia was 0.05±0.15 mg/l and total alkalinity was 217.20±43.48 mg/l. The transparency was recorded 148.33±21.67 cm during the experimental periods.

Chowdhury *et al.* (2016) [8] Water quality parameters of six selected oxbow lakes (*Baors*) in Bangladesh (Short communication). The investigation was carried out during June 2009-March, 2010 in 6 oxbow lakes, named as the Bergobindopur, Kathgora Fatehpur, Joydia, Baluhar and Marjad *baor* from south- western part of Bangladesh. Water quality indicating physicochemical parameters such as temperature, pH, dissolved oxygen (DO), calcium (Ca) hardness, chlorophyll- *a* (chl *a*), total nitrogen (TN) and conductivity water were studied using the standard methods. Variation of temperature (ºC) of *baors* ranged from 18-34 ^{0}C with the mean value 27.52±0.29. The value of pH ranged from 6.89-10.9 with the highest mean value 9.30 ± 0.13 recorded from Fatehpur *baor* and lowest mean value 7.62±0.07 recorded from Marjad *baor.* The mean value of pH 8.29 ± 0.04 recorded in the present study showed that the water of the six *baors* was alkaline in nature. In this study, Ca hardness (mg/l) ranged from 47-322 mg/l in two seasons. The minimum mean value 78.25±3.32 was recorded from Marjad *baor* while maximum mean value 228.98±9.69 was recorded from Fatehpur *baor.* Dissolved oxygen content was found to fluctuate from 6-18 mg/l with a minimum mean value 4.60±0.32 recorded from Marjad *baor* and maximum mean value 8.82±0.63 from Fatehpur *baor.* In this study, chlorophyll- *a* ranged from 2.02-18.45 μg/l with the minimum mean value 4.46±0.29 recorded from Marjad *baor* and maximum mean value 15.56 ± 0.51 Fatehpur *baor*. The TN content recorded in this study ranged from 2-10 mg/l with the minimum mean value of 1.94±0.13 observed in Marjad *baor* and maximum value 6.8±0.21 observed in Fatehpur *baor.* From this study the TP (mg/l) ranged from 0.1-0.28 mg/l with the minimum mean value of 0.07±0.01 recorded from Marjad *baor* and maximum mean value 0.27±0.00 recorded from Fatehpur *baor.* The maximum mean value of conductivity (μS/cm) was recorded as 626.67±40.77 from Fatehpur *baor* and the minimum mean value was recorded as 129.52±15.64 from Kathgara *baor.* Therefore, the observed conductivity of the six *baors* was within expected range.

Biswas BC and Panigrahi AK (2015) [6] Ecology and zooplankton diversity of a wetland at Jhenidah District, Bangladesh. Three sampling sites were selected for the analysis of water quality and zooplankton. These were Bhabanipur, Balaramnagar and Joydea. Water samples were collected at regular intervals on monthly basis at 8.00 to 9.30 am from the different stations of the study area pH and temperature were measured on the spot by Hanna device (pH meter) and mercury thermometer. DO was measured according to Wrinklers method. Rest of the parameters were measured in the laboratory as described by [1]. Life of an aquatic body depends on physical, chemical and biological characteristics of water. The parameters like pH, DO, alkalinity and nutrients are important for the production of plankton [23]. Temperature is the critical parameters which influence all abiotic parameters of an ecosystem. The growth, distribution and abundance of biota largely depend on the range of temperature. The lowest temperature is estimated 15^{0}C in winter and highest 34.5^{0}C in summer. The pH of the water body showed slightly alkaline in nature. The range of pH 6 to 8.5 is considered as safe limit the permissible limit for free CO_2 is 10 mg/l. Increase in the amount of CO_2 is related to the increase of pollution. DO is essential for every animal for respiration and metabolic activities. The alkalinity of the water body is the capacity to neutralize acid. Nitrates and phosphate are the nutrients of an aquatic body. Excessive amounts of nutrients give rise to the huge production of algal bloom lowers the levels of DO. According [18] the negative relationship observed between zooplankton and water quality parameters like temperature, pH and free CO_2. The presence of lower levels DO reflect the pollution of an aquatic ecosystem. The range of DO indicates less pollution load. The observed results showed that it has a moderate range of dissolved oxygen, a low level of CO_2, lower concentration of nutrients and other biotic factors.

Alam MF and Jahan N (2014) [2] Physico-chemical characteristics and phytoplankton diversity of Marjad *baor* of Kaliganj upazilla, Jhenaidah, Bangladesh. Marjad *baor* is the largest baor (oxbow lake) of Bangladesh with a total area of 253 hectares which is located 25 km apart from the Kaliganj upazilla. Physico-chemical characteristics and phytoplankton diversity of Marjad *baor* were studied from January 2010-March 2010 at four different spots to determine the water quality of the Marjad *baor* including its physico-chemical conditions, phytoplankton diversity and their interrelationships. Water and phytoplankton samples were collected three times from each spot. Water temperature was always less than the surrounding air temperature and varied within 3 to 5 °C. Seasonal variations of transparency was significant and varied within 54 cm to 69 cm. Mean EC value was 230 µs/cm. Mean TDS value was around 215 mg/l. The concentration of DO was within the limit of standard for fish cultivation and mean was 8.0 mg/l. Mean value of BOD was 1.56 mg/l. Mean values of free CO_2, HCO^{3-} alkalinity were respectively 0.05 mg/l and 6.15mg/l. The nature of water is slightly alkaline having a mean value 7.3. Mean values of calcium hardness, magnesium hardness and total hardness were respectively 4.0 mg/l, 3.50 mg/l and 93 mg/l which indicate that the water is moderately hard. Mean values of chloride and phosphate were likewise 0.82 ppm and 0.002 ppm but the concentration of nitrate was relatively high which shows the way to algal bloom.

Kabir AKMN and Naser MN (2011) [17] Physico- chemical aspects of Chandbill oxbow lake of Meherpur, Bangladesh. Some physico- chemical parameters of Chandbill *baor*, a natural oxbow lake of Meherpur district were studied from September 2006-August 2007. Air temperature of the study area varied from 27.73±1.22°C. The water temperature 28.24±1.32°C, Secchi disc depth 26.1±4.29 cm, water depth 183.93±13.88 cm, total alkalinity 68.4±3.64 mg/l, total hardness 125.81±9.38 mg/l, dissolved oxygen 8.42±0.62 mg/l, free CO_2 14.58±2.64 mg/l, pH 8.5 ±0.19, and ammonia- nitrogen 0.46±0.04 mg/l in the *baor* water were found to be suitable for survival of aquatic fauna. Nitrite- nitrogen was absent in the *baor* throughout the year.

3.3 Assessment of Water Quality

3.3.1 General

Due to increase in population, industrialization and urbanization large quantities of sewage and industrial wastewater are discharged into *baors*. It has significantly contributed to the pollution of the *baor* environment. Water quality assessment studies data on the boars were conducted from time to time for the last decade. The objective of the present study was to assess water quality parameters of various *baor* environment in Bangladesh.

3.3.2 Water Quality Parameters Included in *Baors* Assessments

The water quality parameters are sampled regularly to monitor *baors* environment. The parameters analyzed in this assessment include:

a) pH

pH or the concentrations of hydrogen ions (H^+) is the measure of the acidity or alkalinity of a solution of water. pH was positively correlated with electrical conductance and total alkalinity [13]. The pH scale extends from 0 to 14 with 0 being the most acidic and 14 the most alkaline. Water with a pH below 7.0 is considered acidic while water with pH greater than 7.0 is considered basic or alkaline. pH 7 is a condition of neutrality and routine aquaculture occurs in the range 7.0 to 9.0 (optimum is 7.5 to 8.5). The desired concentration of pH was 7-9 [7]. Exceedingly alkaline water (>9) is dangerous as ammonia toxicity increases rapidly. It is an important chemical parameter to consider because it affects the metabolism and other physiological processes of culture organisms. A certain range of pH (6.8–8.7) should be maintained for acceptable growth and production. The higher pH values observed suggests that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to change in physico-chemical condition [16].

b) Temperature (°C)

Water temperature is one of the most important water quality parameters. It is directly influenced the growth, food intake, reproduction and other biological activities of aquatic organisms. Fish are cold-blooded animals. The metabolic rate of aquatic organisms is closely related to the water temperature. The higher the water temperature the greater the metabolic rate. Generally, the metabolic demand for oxygen in aquatic animals double or triples with every 10°C increase within the range of temperature that the animal can tolerate. The water temperature ranged from 28 to 35°C is suitable for fish culture [3].

c) Ammonia (mg/l)

Ammonia is the second gas of importance in fish culture. It is significant to good fish production. High ammonia levels can arise from overfeeding, protein-rich, excess feed decays to liberate toxic ammonia gas. The excreted ammonia may accumulate to dangerously high levels under certain conditions. Fortunately, ammonia concentrations are partially curbed or buffered by conversion to nontoxic nitrate (NO^{3-}) ion by nitrifying bacteria. Additionally, ammonia is converted from toxic ammonia (NH_3) to nontoxic ammonium ion ($NH4^+$) at pH below 8.0. The desirable range of ammonia for fish farming was <0.1 mg/l [7].

d) Hardness (mg/l)

Numerous inorganic (mineral) substances are dissolved in water. Among these, the metals calcium and magnesium along with their counter ion carbonate (CO^{3-2}) comprise the basis for the measurement of hardness. Optimum hardness for aquaculture is in the range of 40 to 400 ppm of hardness. Hard waters have the capability of buffering the effects of heavy metals such as copper or zinc which are in general toxic to fish. The hardness is a vital factor in maintaining good pond equilibrium. Water containing more than 300 mg/L of total hardness is not considered desirable for drinking purpose [21].

e) Turbidity

Water turbidity refers to the quantity of suspended material, which interferes with light penetration in the water column. In *baors*, water turbidity can result from planktonic organisms or from suspended clay particles. Turbidity limits light penetration, thereby limiting photosynthesis in the bottom layer. Higher turbidity can cause temperature and DO stratification in *baor*. Planktonic organisms are desirable when not excessive, but suspended clay particles are undesirable. It can cause clogging of gills or direct injury to tissues of fishes and other organisms. Erosion or the water itself can be the source of small (1-100 nm) colloidal particles responsible for the unwanted turbidity. The particles repel each other due to negative-charges: this can be neutralized by electrolytes resulting in coagulation. It is reported that alum and ferric sulfate are more effective than hydrated lime and gypsum in removing clay turbidity. Both alum and gypsum have acid reactions and can depress pH and total alkalinity, so the simultaneous application of lime is recommended to maintain the suitable range of pH.

f) Conductivity (µS/cm)

Conductivity is a numerical expression of an aqueous solution's capacity to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, valence and relative concentrations, and on the temperature of the liquid. Solutions of most inorganic acids, bases, and salts are relatively good conductors. In contrast, the conductivity of distilled water is less than 1 μmhos/cm. Because conductivity is the inverse of resistance, the unit of conductance is the mho (ohm spelled backward), or in low-conductivity of natural water. The electrical conductivity (EC) was recorded with a minimum value of 970 μS/cm and maximum of 1825 μS/cm [18].

g) Alkalinity (mg/l)

Alkalinity is the sum total of components in the water that tend to elevate the pH to the alkaline side of neutrality. It is measured by titration with standardized acid to a pH value of 4.5 and is expressed commonly as milligrams per liter as calcium carbonate (mg/l as $CaCO_3$). Alkalinity is a measure of the buffering capacity (ability to resist changes in pH) of the water. The pH has a direct effect on organisms as well as an indirect effect on the toxicity of certain other pollutants in the water. The buffering capacity is important to maintain water quality parameters. Commonly occurring materials in water that increase alkalinity are carbonates, bicarbonates, phosphates and hydroxides. Limestone bedrock and thick deposits of glacial till are good sources of carbonate buffering. The alkalinity of most prairie waters is in the range of 100 to 500 mg/l, which is considered acceptable. Water containing more than 200 mg/l of TA is not considered desirable for drinking purpose [4].

h) Phosphorus (mg/l)

Phosphorus is an essential plant nutrient and most often controls aquatic plant (algae and macrophyte) growth in freshwater. It is found in fertilizers, human and animal wastes and yard waste. There is no atmospheric (vapor) form of phosphorus. Because there are few natural sources of phosphorus and the lack of an atmospheric cycle, phosphorus is often a limiting nutrient in aquatic systems. This means that the relative scarcity of phosphorus may limit the ultimate growth and production of algae and rooted aquatic plants. Therefore, management efforts often focus on reducing phosphorus input to a receiving waterway because: (a) it can be managed, and (b) reducing phosphorus can reduce algae production. Two common forms of phosphorus are: Soluble reactive phosphorus (SRP) – SRP is dissolved phosphorus readily usable by algae. SRP is often found in very low concentrations in phosphorus-limited systems where the phosphorus is tied up in the algae and cycled very rapidly. Sources of SRP include fertilizers, animal wastes and septic systems. Total phosphorus (TP) – TP includes dissolved and particulate forms of phosphorus. TP concentrations greater than 0.03 mg/l (or 30 mg/l) can cause algal blooms in *baors* and reservoirs.

i) Nitrite (mg/l)

Nitrite is another form of the nitrogenous compound and an intermediate product of the transformation of ammonia into nitrate by bacterial activity. Nitrite is the ionized form of nitrous acid (HNO_2), and it is lethal as ammonia (NH_3). More recent evidence indicates that nitrite may be a significant limiting factor in fish production ponds. The absorbed nitrites from the gut bind to hemoglobin and reduce its ability to carry oxygen. Nitrite can be associated with ammonia concentration in the water body. In normal aerobic condition, ammonia is oxidized to nitrite by two separate bacterial actions. In the bloodstream of fish nitrite become bound to hemoglobin and reduces the oxygen transporting capacity in the blood. If the nitrite concentration increased in the blood rapidly then it causes the lethal effect to fish and shrimp. An increase of CO_2 may decrease the pH to a value below 6.5, which can lead to toxicity of nitrite through the formation of nitrous acid (HNO_2). At 2 ppm (mg/l) and above, nitrites are toxic (injurious or lethal) to many fish and shrimp. The recommended level of nitrite for fish farming was <0.3 mg/l [7].

j) Light Transmission (cm)

This measurement uses a light meter (photocell) to determine the rate at which light transmission is diminished in the upper portion of the *baors* water column. Another important light transmission measurement is a determination of the 1% light level. The 1% light level is the water depth to which one percent of the surface light penetrates. The 1% light level is considered the lower limit of algal growth in *baors* environment and this area and above is referred to as the euphotic zone.

k) Dissolved Oxygen (DO) (mg/l)

DO is the dissolved gaseous form of oxygen. It is essential for respiration of fish and other aquatic organisms. DO enters the water by diffusion from the atmosphere and as a byproduct of photosynthesis by algae and plants. The concentration of DO in epilimnetic waters continually equilibrates with the concentration of atmospheric oxygen to maintain 100% DO saturation. The desired concentration of DO is 5-15 mg/l [6]. Excessive algae growth can over-saturate (greater than 100% saturation) the water with DO when the rate of photosynthesis is greater than the rate of oxygen diffusion to the atmosphere. Hypolimnetic DO concentration is typically low as there is no mechanism to replace the oxygen that is consumed by respiration and decomposition. Fish need at least 3-5 mg/L of DO to survive. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc. [20].

l) Transparency (cm)

Transparency refers to the depth to which the black and white Secchi disk can be seen in the *baors* water. Water clarity, as determined by a Secchi disk, is affected by two primary factors: algae and suspended particulate matter. Particulates (soil or dead leaves) may be introduced into the water by either runoff or sediments already on the bottom of the *baors*. Erosion from construction sites, agricultural lands, and riverbanks all lead to increased sediment runoff. Bottom sediments may be suspended by bottom-feeding fish such as carp, or by motorboats or strong winds in shallow baors.

The transparency of water was affected by many factors such as silt, microscopic organisms, suspended organic matter, the season of the year, latitude and intensity of light, application of manure, grazing pressure of fishes and rainfall [7]. The transparency of productive water should be 40 cm or less [24].

4. Conclusion

During the summer season, water quality parameters in *baors* are more affected than during winter. The microbial activity gets reduced due to low temperature, thereby keeping DO level at a very satisfactory range during the entire summer season. The suggested measures to improve the *baors* water quality. We should try to ban on the activities that cause pollution. The result of water quality assessment clearly showed that most of the water quality parameters slightly higher in the wet season than in the dry season. Water quality is dependent on the type of the pollutant added and the nature of self-purification of water.

5. Acknowledgement
The authors are thankful and grateful to the DoF of Jessore and Jhenaidath, *Baor* managers, Upazill Fisheries Officers (UFO), staffs etc. for their kind help to supply data and information related to the *baors*.

6. Conflict of Interest
The authors declare that no conflict of interest exists. No writing assistance was utilized in the production of this review article.

7. References

1. APHA. Standard methods for the examination of water and waste water, 17th Edn American Public Health Association, Washington DC, 1989, 540.
2. Alam MF, Jahan N. Physico-chemical characteristics and phytoplankton diversity of Marjad *baor* of Kaliganj Upazilla, Jhenaidah, Bangladesh. ARPN Journal of Science and Technology. 2014; 4(2):91-98.
3. Aminul IM. Qualities of water and soil in aquaculture, Fish Week Compilation, 1996.
4. BIS. Bureau of Indian Standards (BIS): Indian standard drinking water specification. Manak Bhawan, New Delhi, India, Second revision of IS, 2012, 10500.
5. Biswas MMR, Islam MF, Rahman MM, Kawsar MA, Barman SK. Fisheries management scenarios of two *baors* in the district of Chuadanga, Bangladesh. Journal of Innovation and Development Strategy. 2009; 3(5):11-15.
6. Biswas BC, Panigrahi AK. Ecology and zooplankton diversity of a wetland at Jhenidah district Bangladesh. IJIRST –International Journal for Innovative Research in Science & Technology. 2015; 1(9):246-269.
7. Boyd CE. Water quality in ponds for aquaculture, Alabama agricultural experiment station, Auburn University, Alabama, USA, 1990, 482.
8. Chowdhury GW, Bulbul MS, Sarker BS. Water quality parameters of six selected oxbow lakes (*baors*) in Bangladesh (Short communication). Dhaka University Journal of Biological Science. 2016; 25(1):91- 95.
9. DoF (Department of Fisheries). Sangkalan (In Bangla). Ministry of Fisheries and Livestock. National Fish Week. Published by Director General, Department of Fisheries, Dhaka, 2011.
10. DoF, (Department of Fisheries). Saranica, Matsya Pakhya Sankalan, Annual Report, Ministry of Fisheries and Livestock. The Government of Peoples republic of Bangladesh, Dhaka, 2015, 129. (In Bengali).
11. FAO. The state of world fisheries and aquaculture. Food and Agriculture Organization of the United Nations, Rome, Italy, 2012.
12. FAO. The state of world fisheries and aquaculture. Food and Agriculture Organization of the United Nations, Rome, Italy, 2014.
13. Gupta DP, Sunita, Saharan JP. Physio-chemical analysis of ground water of selected area of Kaithal City (Haryana) India, Researcher. 2009; 1(2):1-5.
14. Hasan MR. Aquaculture in Bangladesh. In: M. Mohan Joseph (editor), Aquaculture in Asian Fisheries Society. Indian Branch, Bangalore, 1990, 105-139.
15. Hasan MR, Bala N, De Silva SS. Stocking strategy for culture-based fisheries: A case study from oxbow lakes fisheries project. Proceedings of ICLARM/Danida national workshop on policy for sustainable inland fisheries management. Dhaka, Bangladesh, 1997.
16. Karanth KR. Groundwater assessment development and management Tata McGraw Hill Publishing Company Ltd., New Delhi, 1987, 725-726.
17. Kabir AKMN, MN Naser. Physico- chemical aspects of chandbill oxbow lake of Meherpur, Bangladesh. Dhaka University Journal of Biological Science. 2011; 20(1):31- 39.
18. Mallika S, Umamaheswari R, Krishnamoorthy S. Physico-chemical parameters and bacteriological study of vaigai river water Madurai district, Tamil Nadu, India. International Journal of Fisheries and Aquatic Studies. 2017; 5(1):42-45.
19. Patra PWR, Azadi MA. Ecological studies of planktonic organisms of the Halda river. Bangladesh Journal of Zoology. 1987; 15(2):109-123.
20. Premlata, Vikal. Multivariant analysis of drinking water quality parameters of lake Pichhola in Udaipur, India. Biological Forum, Biological Forum- an International Journal. 2009; 1(2):97-102.
21. Sawyer CN, Parkin GK. Chemistry for environmental engineering, McGraw Hill Publication, New York, 1994.
22. Shofiquzzoha AFM, Islam MS, Halim MA. Study the feasibility of gulsha fish (*Mystus cavasius*) in cages under *boar* environment (Abstract). Fisheries Faculty 50th Years Golden Jubilee, BAU, Mymensingh, 2202, 2017.
23. Sivakumar K, Kareppasmy R. Factor affecting productivity in a reservoir of Tamilnadu, India. IDOSI Publication Am. Eurasian Journal of Botany. 2008; 1(3):99-103.
24. Wahab MA, Ahmed ZF, Islam A, Rahmatullah SM. Effect of introduction of common carp, *Cyprinus carpio* (L) on the pond ecology and growth of fish in polyculture. Aquaculture Research. 1995; 26: 619-628.