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Ashok Kumar Singh
Research Scholar,
Department of Zoology,
L.N.M.U. Darbhanga, Bihar,
India

Dr. Ajay Nath Jha
Professor, Department of
Zoology, C.M. Sc. College,
Darbhanga, Bihar, India

Study of seasonal fluctuation of water quality and fish pond conservation in Darbhanga, Bihar

Ashok Kumar Singh and Dr. Ajay Nath Jha

Abstract

Water is one of the most important and most precious natural resources. Water quality analysis is one of the most important aspects in water studies. Determination of physico-chemical characteristics of water is essential for assessing the suitability of water for various purposes like drinking, domestic, industrial, irrigation and pisciculture. Fish is an inexpensive source of protein and an important cash crop in many regions of world and water is the physical support in which they carry out their life functions such as feeding, swimming, breeding, digestion and excretion. Water quality is determined by various physico-chemical and biological factors, as they may directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals. A sharp drop or increases within these limits have adverse effects on their body functions. So, good water quality is essential for survival and growth of fish. Water quality is not constant; varies with the time of the day, season, weather conditions, water source, soil type, temperature, stocking density, and feeding rate and culture systems. For a successful aquaculture venture, the dynamics and management of water quality in culture media must be taken into consideration.

Keywords: Water, physico-chemical, pisciculture, quality and culture

Introduction

Water is one of the most important and most precious natural resources. Water quality analysis is one of the most important aspects in water studies. Determination of physico-chemical characteristics of water is essential for assessing the suitability of water for various purposes like drinking, domestic, industrial, irrigation and pisciculture. Fish is an inexpensive source of protein and an important cash crop in many regions of world and water is the physical support in which they carry out their life functions such as feeding, swimming, breeding, digestion and excretion. Water quality is determined by various physico-chemical and biological factors, as they may directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals. A sharp drop or increases within these limits have adverse effects on their body functions. So, good water quality is essential for survival and growth of fish. Water quality is not constant; varies with the time of the day, season, weather conditions, water source, soil type, temperature, stocking density, and feeding rate and culture systems. For a successful aquaculture venture, the dynamics and management of water quality in culture media must be taken into consideration. The Earthen pond culture system has been the conventional method of fish culture in India. Due to uncontrolled increase in human population and development of township at large, these freshwater bodies are under tremendous pressure owing to their overuse on one hand and enrichment due to nutrients and organic matter on the other, leading to the cultural eutrophication. If they are properly guided and make aware about water quality management practices, they can get maximum fish yield in their ponds to a greater extent through applying low input cost and getting high output of fish yield. Hence the present attempt has been made to assess the suitability of the physico-chemical characteristics of this pond water for growth of fishes.

Material and Methods

Study Area

This investigation was carried out to evaluate the status of the Maharani pond in Sundarpur, Darbhanga, Bihar.

Corresponding Author:
Ashok Kumar Singh
Research Scholar,
Department of Zoology,
L.N.M.U. Darbhanga, Bihar,
India

It is situated between 26.1542⁰North Latitude and 85.8918⁰East Longitude. The water of this pond is used for agriculture, fisheries and partially domestic activities. The present study was conducted to analyze physico-chemical properties of water in the period of one year from July 2012 to June 2013.

Sample collection

The water samples were collected from Maharani pond of Sundarpur village, Darbhanga, Bihar at monthly intervals from July 2012 to Jun 2013 during 7.00 – 9.00 am in fresh, unsullied plastic bottles. The closed bottle was dipped into the water and then the cap is opened and water is allowed to fill up the bottle absolutely. The cap is then closed and the bottle is brought out of the water. The method adopted for different physico-chemical parameters were followed according to the procedure described in the APHA, AWWA and WPCF 1998.

The Physico-Chemical parameters were analyzed by

- pH: by Digital pH meter
- Temp: by Thermometers
- Turbidity: by Nephello Turbid Meter
- DO: Using standard Winkler method by titration
- Electrical conductance: Conductometer
- CO₂: By titration method
- Alkalinity: By titration method
- Cl: By titration method
- Total hardness: by using EDTA complexometric by titration
- BOD: By titration
- COD: Open condensation and digestion by titration
- Nitrate: Phenoldisulphonic acid method

Result and discussion

Colour

Colour is an important parameter for any aquatic water body and indicates the purity of the water. National Agricultural Extension and Research states pale color, light greenish or greenish waters suitable for fish culture. In the present study, the pond water color is light green so the pond water is good for fish productivity.

pH

The survival and growth of fish are also depending on pH of the water. The pH of freshwater ponds can fluctuate considerably both daily and seasonally. These fluctuations are due to photosynthesis and respiration by plants and animals. Fish are known to have an average blood pH of 7.4; therefore pond water with pH within this average is optimum. It has been reported that the pH between 6 and 9 was appropriate for increased fish production. In the present study pH value recorded ranged from 7.1 to 8.0. This value is tending towards neutrally which is also within the values for optimum fish survival. The highest value of pH was recorded during summer season (8.43±0.02) and the lowest was recorded during pre-monsoon and monsoon season (7.63±0.11). The low value during monsoon season may be due to the dilution of rain water. These values compared very well with results of other workers. They are also within the international standards; ICMR and WHO.

Water Temperature

The temperature of an organism is defined as the level of

hotness or coldness in the body of a living organism either in water or land. It is an important biologically significant factor, which plays an important role in the metabolic activities of the organism. Fish is a cold blooded animal, so its temperature is dependent on the temperature of its environment. It changes with the temperature of the surroundings. The temperature changes affect the metabolism and physiology of fishes and so its productivity. The optimum water temperature for fish survival has been reported to be between 20 – 30 °C. The results obtained from this work showed temperature values ranging from 27.80C to 31.90C. The temperature was recorded maximum during summer (31.56±0.24) and minimum during monsoon season (27.63±0.25). The results were also within the standards (WHO and ICMR). The temperature range showed that the pond water studies were good for fish productions.

Electrical conductivity

Electrical conductivity (EC) is a useful tool to evaluate the purity of water. It is dependent on the ionic concentration and water temperature. A total load of salts in a water body is directly related to its conductivity. Conductivity is also regarded as an indication of its freshness or otherwise of a water body. It has been reported that high values of conductivity are an indication of pollution. The range of electrical conductivity in the present study was between 290.30 to 405.10 µs. The EC was recorded maximum during post monsoon (368.18±28.33) and minimum during monsoon season (298.03±3.41). Similar results were observed by various workers Hulyal, Ramulu [26] and Ancy Mol. These values fall within the WHO and ICMR limits, so the water would be regarded as safe for fish production.

Turbidity

Turbidity and the appearance of water are important considerations in pond aquaculture. This is a measure of the ability of water to transmit the light that restricts light penetration and limit photosynthesis. It is the measure of the light scattered by suspended particles. It consists of suspended particles in water and is usually affected by factors such as clay particles, dispersion of plankton organism, particulate organic matters as well as pigments caused by decomposition of organic matter. The range of turbidity obtained in the present study was 20 to 35 NTU. The turbidity was recorded maximum during monsoon (32.33±0.68) and minimum during summer season (17.66±1.18). There are also within the WHO limit, so the values obtained were within this range which makes these ponds suitable for fish farming.

CO₂

Carbon dioxide in a water body may be derived from the atmospheric sources, biotic respiration, inflowing ground water which seep into the pond, decomposition of organic matter due to bacteria and may also from within the water body itself in a combination of other substances mainly calcium, magnesium etc. The free carbon dioxide in water supporting good fish population should be less than 5mg L⁻¹. In the present investigation dissolved oxygen ranged from 4.2 to 6.0mg/l. The maximum value for CO₂ was recorded in monsoon season (5.13±0.06) and minimum in pre-monsoon period (4.46±0.13). This result is supported by the findings of Tara and Shib Abir.

DO

This is defined as the measure of the amount of gaseous oxygen dissolved in an aqueous solution. Dissolved oxygen is an important parameter in water quality assessment and reflects the physical and biological processes of aquatic life. Oxygen is needed by fish and other aquatic organisms, and levels DO vary daily and seasonally and depends on the species of phytoplankton present, light penetration, nutrient availability, temperature, salinity, water movement, partial pressure of atmospheric oxygen in contact with the water, thickness of the surface film and the bio-depletion rates. The DO obtained from this study had ranged between 6.5 to 7.9 mg/L. The DO was recorded maximum during postmonsoon (7.63 ± 0.06) and minimum during summer season (6.7 ± 0.04). These values are within the WHO limit, so the water would be regarded as safe for fish production.

Salinity

Salinity plays an important role in the growth of culture organisms through osmoregulations of body minerals from that of the surrounding water. It is a major driving factor that affects the density and growth of aquatic organisms population. It acts as a major ecological factor controlling the phytoplankton population of freshwater. According to during the present study the salinity ranged between 11 to 19 ppt. The maximum value for salinity was recorded in summer season (16.66 ± 0.97) and minimum in premonsoon and monsoon period (12.33 ± 0.71). High salinity concentration was associated with fungi and bacterial density of phytoplankton population as observed by Shibu Rani and Shrivastava also found similar results as observed in the present study.

BOD

Bio-chemical Oxygen demand is a parameter to assess the organic load in a water body. It is the measurement of total dissolved oxygen consumed by microorganism for biodegradation of organic matter. It depends on temperature, the extent of biological activity, the concentration of organic matter and microbial population such as bacteria and fungi. The maximum demand of oxygen in the water was recorded during monsoon season was 5.66 ± 0.160 mg/L due to the possible addition of high amount of waste along with rainwater from the surrounding and addition of organic waste in pond by certain human activities which also be responsible for the increase in BOD. The minimum demand of oxygen in the water was recorded during summer season was 4.8 ± 0.12 mg/L due to less vegetation. These findings are also in accordance with Ramadevi and Jeyaraj the BOD level between 3.0 to 6.0 mg/L has been reported as optimal for normal activities for fishes. These BOD values are therefore within the values for optimum fish activities and so the fish ponds studied are being not polluted and therefore safe for fish farming.

COD

COD is an important parameter for establishing the quality of water. It determines the amount of oxygen required for chemical oxidation of organic and inorganic matter. Organic matter and anthropogenic activities are the main factors responsible for higher COD. The high COD values indicate that some degree of non-biodegradable oxygen demanding pollutants were present in the water. During the analysis, it was observed that the COD level was ranged between 4.8 to

7.0 mg/L. The COD was recorded maximum during monsoon (6.86 ± 0.06) and minimum during summer season (5.43 ± 0.19).

Chloride

Chlorine gas is highly toxic, but the chloride ion is a common constituent of all natural water. It is considered as one of the most important inorganic anion in water and it's generally regarded as non-harmful constituent. Though chloride is present in all natural water bodies, high concentration is an indication of pollution from sewage, industrial or intrusion of seawater or saline water into fresh water aquifer. Chloride content obtained from this study ranged between 15.3 to 39.8 mg/L. The chloride was recorded maximum during monsoon (35.86 ± 1.83) and minimum during the postmonsoon season (23.13 ± 3.95). These values are reasonable since higher concentration may be harmful to aquatic life. At even small concentration, it burns the edges of the gills with long term after effects.

Total Hardness

Total hardness of water is the parameters used to describe the effect of dissolved minerals (mainly Ca and Mg), determining suitability for domestic and industrial purposes which is attributed to the presence of bicarbonates, sulfates, chlorides and nitrates. Calcium and Magnesium are essential for bone and scale formation. In the present study, calcium and magnesium contents ranged from 78 to 108 mg/dl and 57 to 73 mg/dl respectively. The calcium was recorded maximum during summer (104.33 ± 1.90) and minimum during pre-monsoon season. The magnesium also maximum during summer (72.00 ± 0.49) and minimum during premonsoon season (58.33 ± 0.76). According to Wurts reported hardness ranged between 25-100 mg/l for good fish culture. Higher values of hardness during summer (April, May and June) can be attributed to low water level and high rate of evaporation of water and addition of calcium and magnesium salts.

Alkalinity

Water alkalinity is a measure of its capacity to neutralize acids. It is a measure of buffering capacity of the water. The obtained alkalinity ranged from 68 to 95 mg/l. The alkalinity values were maximum during summer (92.33 ± 1.43) and minimum during monsoon (69.66 ± 0.71). Higher values of alkalinity registered during summer (April, May and June) might be due to the presence of an excess of the free CO₂ product as a result of decomposition process coupled with the mixing of domestic waste. The low alkalinity during the rainy season (November) may be due to dilution. The values obtained were within this ranged which makes this ponds suitable for fish farming.

Nitrate

It is thought to be produced by autotrophic *Nitrobacter* combining oxygen with nitrite in the converter and on the walls of the pond. It is important that the level of nitrate in a pond is controlled to avoid eutrophication. Nitrates are however not harmful to fish. Nitrate concentrations in this study ranged from 3.17 – 4.50 mg/L with a mean value of 3.81 mg/L. The Nitrate level was recorded maximum during monsoon (3.96 ± 0.06) and minimum during pre-monsoon season and post monsoon (3.6 ± 0.20 and 3.36 ± 0.16). The

obtained values were within this ranged which makes this ponds suitable for fish farming.

Conclusion

Findings from this work revealed that regularly monitoring water parameter such as temperature, pH, DO, BOD, COD, etc provide insight to the health of the aquatic ecosystems. Present study also provides a base line data for the conservation and monitoring of the Maharani pond. In this study, we strongly conclude that there are fluctuations during seasons. The physico-chemical parameters of the water samples from pond and WHO standard indicate that the water samples fall within the stipulated range of acceptability. Hence the water can be classified as a good, stable and healthy aquatic ecosystem and also increased fish productivity.

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