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RESEARCH ARTICLE

INVESTIGATION OF WATER QUALITY PARAMETERS FOR AQUACULTURE – A CASE STUDY OF VEERANAM LAKE IN CUDDALORE DISTRICT, TAMILNADU

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ABSTRACT

Water quality plays an important role in the survival and distribution of aquatic organisms. It is dependent on physico-chemical and nutrient parameters. The present investigation deals with the analysis of water quality of Veeranam Lake water samples were collected monthly for a period of one year from June 2009 to May 2010 at 5 sites of the lake. The physico-chemical parameters such as temperature, pH, total dissolved solids (TDS), total hardness (TH), electrical conductivity (EC), biological oxygen demand (BOD), chemical oxygen demand (COD), calcium (Ca), magnesium (Mg), chloride (Cl), sulphate (SO_4), phosphate (PO_4), gross primary productivity (GPP) and net primary productivity (NPP) were analysed. The water quality of the Veeranam lake water was within the safe limits throughout the study period which shows that this water is fit for aquaculture.

INTRODUCTION

Water is essential natural resource for sustaining life and environment without water life is not possible. Fish are totally dependent upon water to breathe, feed, growth, reproduction and maintain a salt balance. Fish perform all their bodily functions in water. The water quality determines the success or failure of an aquaculture operation. The physical and chemical qualities of water not only determines growth of fish, but also their survival. Some water quality factors such as dissolved oxygen, temperature, ammonia and heavy metals are directly involved with fish to kill but other factors such as pH, alkalinity, hardness and clarity are not directly toxic to fish (Joseph et al., 1993). The quality of water should be assessed on the basis of physico-chemical parameters in order to provide information for the purpose of water management (Kadam et al., 2007). Water analysis is carried out to assess the optimum and harmful limits of various parameters for survival and general health of aquatic organisms. Physico-chemical properties of a water body play a major role in its productivity process and growth of aquatic organisms under culture. Several studies have been conducted to understand the physical and chemical properties of lakes, pond and reservoirs.

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MATERIALS AND METHODS

Veeranam lake is located 14 km SSW of Chidambaram in Cuddalore District in the State of Tamil Nadu in South India. [Coordinates 11°120'10" N 79°32' 40E]. The lake located 235km from Chennai, is one of the water reservoirs from where water is planned to be supplied to

Chennai for drinking purpose Ayacut area of 48,000 acres irrigation and capture fisheries practices for people living around the lake. Water samples from Veeranam lake were collected periodically from June 2009 to May 2010 in 2L clean well dried polythene bottles at five sites with necessary precautions and labelled for collecting points. The physico-chemical parameters like pH, conductivity, alkalinity, BOD, COD, TDS, chlorides, hardness, nitrate, phosphate, sulphate and ammonia were estimated employing standard methods (APHA, 1998). Temperature was measured at all the collection sites. The samples for primary productivity were fixed in the BOD bottles at the site and brought to the laboratory for analysis by Winkler's method.

RESULTS AND DISCUSSION

The five sites average values of water quality parameters were given in Table 1. It is an established fact that maintenance of healthy aquatic ecosystem in dependent on the physico-chemical properties of water and biological diversity.

Temperature

Temperature is one of the most important ecological factor, which control the physiological behaviour and distribution of organisms. In the present study the highest temperature was recorded in the month of July (32°C) and lowest in the month of January (22°C). The temperature of lake water varied with seasons. It corresponds to the prevailing climatic condition. During winter season water temperature was found to be low due to frequent clouds, high humidity, high current velocity and high water level (Shakar et al., 1993; Jain et al., 1996).

Higher temperatures were observed during summer due to clear atmosphere, greater solar radiation and low water level (Swaranalatha and Narsing Rai, 1998; Yogesh Shastri and Pendse, 2001). At temperature above or below optimum, fish growth is reduced and if extremes, fish mortalities occur (Joseph et al., 1993).

Turbidity

The value of turbidity in samples varies from 1.2 to 3 NTU. Turbidity is the decreased ability of water to transmit light caused by suspended particulate matter and phytoplankton. The higher concentrations of suspended particles increase the turbidity. If turbidity becomes too high, primary productivity may be reduced. In the present study all the months the values are less.

pH

The pH of the lake water varied between 7.2 (June) to 8.6 (January) indicating the alkaline nature of water. The pH of water was relatively high in the winter months and low in the monsoon and summers. The lower pH during monsoon is due to high turbidity, and in summers, the high temperature enhances microbial activity, causing excessive productivity leads to increase production of CO_2 and reduced pH (Khan and Khan, 1985; Narayani, 1990). The higher value of pH recorded during winter months could be attributed to increased primary productivity. Higher value of pH can be attributed to higher growth rate of algal population which utilized CO_2 through photosynthesis (Chaterjee and Raziuddin, 2006). The pH is one of the most important factors that serves as an index for pollution. The pH of the lake water ranges from 7.2 to 8.6 in all the months. Valladolid et al. (1954) observed that among the physico-chemical factors of pH between 7.3 to 8.4 is suitable for growth of fishes. As per report of Ellis (1937) water pH ranging between 6.5 to 9.0 is most suitable for better fish growth.

Table 1. Physico-chemical parameter analysis of water quality from Veeranam lake during the period from June 2009 to May 2010

	June	July	August	September	October	November	December	January	February	March	April	May
Temperature	31	32	25.1	28	24	23	24	22	25.2	26	26.8	30
Turbidity	3	2.3	2.8	1.3	1.5	1.4	1.7	1.6	1.2	1.7	1.6	2.3
TDS	615	626	576	471	418	442	465	379	377	516	533	571
EC	533	485	256	188	183	166	230	195	193	271	299	469
pH	7.2	8.2	7.9	8	7.9	7.6	7.2	8.6	8.4	8.3	8.3	7.4
TH	259	165	153	136	151	150	160	157	117	141	152	195
Calcium	53.4	65	64	47	39	34	64	53	54	62	56.5	65.3
Magnesium	29	26.8	23.4	23.9	22	22	33	25	24.5	28.9	25.8	30
Ammonia	0.62	0.87	0.81	0.77	0.41	0.40	0.60	0.66	0.66	0.79	0.78	0.83
Chloride	87	78	79	73	62.5	65	70	62	73	71.5	73.2	79
Sulphate	32	27	37	29.5	20	20	33	32	36.4	28.5	28.2	32
Phosphate	0.20	0.21	0.30	0.20	0.27	0.27	0.34	0.25	0.20	0.16	0.28	0.29
BOD	12	7.7	22	15.9	17.5	16	10.8	11.2	9.8	7.1	6.9	8.3
COD	29	25	28.5	23.5	27	27.5	22.5	24.2	25	20.4	21.2	24.5
GPP	1036	1150	1815	2118	1715	1657	2557	3303	1515	1215	1350	1211
NPP	527	850	1261	1363	1185	1057	1565	2272	957.5	854	903	853

Electrical conductivity

Electrical conductivity (EC) values of lake water samples ranged between 166-533 μmoles/cm (Table 1) with maximum in summer and minimum in the monsoon. Conductivity of water depends upon the concentration of ions and its various dissolved solid content (Dilution of water during the rains causes a decrease in electrical conductance. EC is highly depends on the amount of dissolved solids in waters Kumar et al. (2005).

Total dissolved solids

Generally, the disposal of sewage and industrial pollutants contribute suspended matter to rivers and lake. The value of total dissolved solids (TDS) in water samples varied from a minimum of 377 mg/L (February 2009) to a maximum of 626 mg/L (July 2009). A high content of TDS elevates density of water, influences osmoregulation, reduces gas solubility and utility of water for drinking (Manivasakam, 2003). The high concentration of TDS may be due to addition of solids from the runoff water.

Total hardness

The total hardness (TH) of water samples were ranges from 117 mg/L (February) to 259 mg/L (June). Maximum hardness in water can be attributed to low water level and high rate of evaporation due to higher atmospheric temperature thereby increasing the solubility of calcium and magnesium salts (Garg, 2003). The total hardness values of all sampling are inbetween the tolerance range.

Biological oxygen demand

Biological oxygen demand (BOD) test was found to be more sensitive test for organic pollution. The BOD values vary between 6.9 mg/L to 17.5 mg/L (October). Since BOD is a measure of biodegradable material in water, increase in the organic matter causes increase in the BOD level. Greater the BOD values, the more rapidly oxygen is depleted in the water. The low value of BOD clearly indicate that the low level of biodegradable material. The highest BOD was due to the highest biological activity at high temperature, although the water level got reduced, but the level of pollutants from the nearby domestic or industries added was the same throughout the year. This view was in agreement with the work of Paramasivam and Sreenivasan (1981).

Chemical oxygen demand

Chemical oxygen demand (COD) was found to be in the range of 20.4 mg/L (March) to 29 mg/L (June). COD is a measure of oxidizable impurities. High BOD and COD are noticed along with high fish mortality by interfacing with respiratory metabolism (Venkataraman, 1996).

Calcium

Calcium (Ca) is a dominant cation which ranges from 34 mg/L (November) to 65.3 mg/L (May). The level was low in November probably due to its utilization by the biotic community. Increase in summer is due to the decomposition of plants and fall off the shots of submerged macrophytes as observed by Purohit (1989) in other lake.

Magnesium

Magnesium (Mg) is an essential micronutrient for both autotrophs and heterotrophs. The magnesium content in the study area was found from 22 mg/L (October, November) to 30 mg/L (May). The amount of Mg in water samples was low as compared to the amount of Ca in water. Mg was maximum in summer season and minimum in rainy season (Table 1). The amount of Mg was low in rainy season indicating possible increase in water level (Hoyle, 1989; Gyananath et al., 2000). The higher values of Mg may be due to its release from the bottom sediment and due to decomposition of biota.

Chloride

In the study area chloride (Cl) ranges from 62.5 mg/L (October) to 87 mg/L (June). The presence of chloride in the lake water was mainly due to domestic sewage and its concentration is an indicator of organic pollution (NEERI, 1979; Kumara, 2002). High chloride values may be due to organic wastes of animal origin and domestic wastes, the higher concentration of chloride during summer months may be associated with reduced water level.

Phosphate

Phosphate contamination comes from disposal of detergent contaminated sewage and directs washing of clothes in water. Inorganic phosphorus or orthophosphate plays a dynamic role in water bodies as it is readily taken up by phytoplankton (Heron, 1961). According to Galterman (1975), the increased application of fertilizer, use of detergents and domestic sewage play major roles in the loading of phosphorus in water. In the present study it ranged from 0.16 mg/L (March) to 0.30 mg/L (August).

Sulphate

The range of the concentration of sulphate from 20 mg/L (October, November) to 37.1 mg/L (August). A few studies have reported sulphate toxicity to some aquatic organisms. In the present study all the samples are within the tolerable limits.

Primary productivity

Productivity of lakes depends on the presence of plankton biomass. Enrichment of nutrients and dissolved matter in the water affects diversity of plankton and also physico-chemical properties of water. In any aquatic body primary productivity gives an information relating to the amount of energy (Vollenweider, 1969). The primary productivity of the lake during the present investigation revealed wide variation showed in Table 1. Maximum during November to January and minimum in the month of May to July. The high productivity values were considered with the low values of water transparency, temperature and high phytoplankton proliferation. The low primary production may be due to high turbidity. The volume of water leaving from the reservoir determines the rate of primary productivity (Singh and Desai, 1980). The inflowing water is very poor in planktonic population and the outflowing washes out all the productive organisms. Anand (1982) reports that the rapid changes in the density of producer organisms affect the productivity rate.

Ammonia

Ammonia is present in two forms in water as gas (NH_3) or as ammonium ion (NH_4^+). In the present study the values ranged from 0.40 mg/L (November) to 0.87 mg/L (July). Ammonia is toxic to culture animals in the gaseous form and can cause gill irritation and respiratory problems. Ammonia levels will depend on the temperature and pH of the lake water. Because a higher temperature and pH, a greater number of ammonium ions are converted into ammonia gas, thus causing an increase in toxic ammonia levels with the lake water. From this study we concluded that the overall quality of the water from Veeranam lake remained within the safe limits throughout the study period which showed that this water was fit particularly for aquaculture.

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