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Water quality analysis and aquaculture development in village pond, Navsari, Gujarat, India

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Abstract

The current study was conducted to determine the physico-chemical parameters for development of aquacultural activities in village pond located at Degam, Navsari (Gujarat). In this research work, important water quality parameters like temperature, turbidity, pH, dissolved oxygen, total dissolved solids, total hardness, total alkalinity, nitrate-N, nitrite-N, phosphate and silicate were analysed and result was compared with prescribed standard values. The "physico-chemical parameters" during the study were observed as temperature (26.20°C), turbidity (4.70 NTU), pH (7.80), dissolved oxygen (10.37mg/L), total hardness (115.20mg/L), total alkalinity (266.00mg/L), nitrate-N (0.16mg/L), nitrite-N (0.13mg/L), phosphate (0.10mg/L) and Silicate (3.00mg/L). These findings were observed within the optimum limits for physicochemical parameters for aquaculture except dissolved oxygen and it can be suggested that the aquatic environment of studied village pond at Degam, Navsari (Gujarat) is conducive and suitable for fish culture. Such kind of practices could be helpful to provide cheap animal protein and employment for rural people.

Keywords: Physico-chemical parameters, Village pond, Aquaculture.

Introduction

It globally considered that water is not only important but also precious natural resource for the life and living organism but due to inadvertent urbanization, speedy industrialization and indiscrimination uses of synthetic chemical in agriculture aquatic environments is polluted that resulted in water quality deterioration and aquatic faunadepletion¹. The domestic wastes, untreated or partially treated industrial effluents, pesticides and many other organic compounds are responsible for the water pollution. These toxic chemicals and metals have changed the quality of water that affects the fish and other aquatic organisms². The healthy aquatic environment supports the amusing and diverse organisms' community and protect the public health³. Village ponds are the excellent water sources for various domestic uses including human and cattle consumption and irrigation for agriculture crops. The tremendous potential and augment fish production of these village ponds can be explored to develop these as fish production unit. For such kind of development physico chemical property of pond water play important role⁴. Water quality generally means the water containing components must be present in balance or in optimum quantity for growth of aquatic organisms⁵. The interactions of these water quality parameters are significantly important for the composition, distribution, abundance, diversity, reproduction and migration of aquatic organisms⁶. The fish production of aquatic resources is totally depend on optimum level of physical, chemical and biological parameters of the aquatic environment. The variation in these parameters of the pond water has potential effects on the health and production of fish⁷. The complete information about the water quality is essential to comprehend the water body's status for aquacultural practices and ultimately implement the suitable management practices to enhance the fish production. Therefore, the present study was deliberate to determine the water quality and viability of village pond for fish culture and rural development.

Materials and methods

Studied village pond is existed in Degam village near to the Navsari city and situated on 20°79'58 - 20°79'86N Longitude and 73°08'32 - 73°08'53 E Latitude geographical location. This water spread area of pond is about 1.2 ha and it was constructed for the domestic purpose. This village pond is perennial water body because it remains full of water round the year.

The water samples were collected (1.5-2.0 L) in plastic bottles during morning hours between 7.00 a.m. to 10.00 a.m. from January to March, 2021. From these water samples temperature, pH and dissolved oxygen were measured or fixed at the sampling site while remaining parameters like turbidity, dissolved oxygen, total hardness, total alkalinity, nitrate, nitrite, phosphate and silicate were analyzed at the Research Laboratory, Department of Aquatic Biology, Veer Narmad South Gujarat University, Surat. These all water quality parameters were analysed to follow the standard methods⁸⁹. To assess the viability of pond water quality for fish culture unit development the resulted values of pond water quality parameters were compared with prescribed optimum limit for aquaculture^{4,10,11}.

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Results and Discussion

Temperature: The metabolism of fishes are mainly affected by temperature. Therefore, it can be stated that growth, feeding, reproduction and migratory behavior of aquatic organisms including fish and shrimps were greatly influenced by the temperature of water in aquatic environment¹². As high temperature lowered the oxygen in water which caused fish stress and death. Temperature in the range of 26° C to 32° C found ideal for aquaculture below 15° C could stop the growth and death might occur of fish¹³. In present study, water temperature of village pond was noted 26.20° C and it was within the prescribed limit for aquaculture (Table-1 and Figure-1).

Turbidity: Water turbidity refers to quantity of suspended materials like sand, clay, debris and plankton which interferes the light penetration in the water column and photosynthesis, stratification in temperature and dissolved oxygen are affected⁴. The planktonic turbidity is desirable when not excessive, but turbidity caused by suspended clay particles is not desirable for fish farming because it cause clogging of gills or tissues injury of aquatic organisms. Turbidity of pond water was observed 4.70 NTU (Table-1 and Figure-1) which was comparatively less than the optimum value and need enhance the primary producers to develop pond for fish culture.

pH: The neutral or slightly alkaline water is the best for aquaculture and fish productivity therefore, 6.5-9.0 pH is recommended for survival the most of aquatic species^{14,15}. Water with <4 and >11 pH can't be supportive to most aquatic life^{16,17}. The pH of studied village pond water was 7.80 (Table-1 and Figure-1) which was within the optimum values and considered as supportive for aquaculture practices.

Dissolved oxygen: Dissolved oxygen (DO) is one of the most important water quality parameter for aquaculture and growth, survival, distribution, behaviour and physiology of fishes in aquatic environment is affected DO^{18} . It was noted that >5mg/L dissolved oxygen in pond water conducive for the good growth of flora and fauna^{19,20}.

In pond water, 1.0-3.0mg/L dissolved oxygen is the sub-lethal effect on growth and feed utilization where as >14ppm was found to be lethal to fry and caused gas bubble disease in fishes⁵. In study village pond water, dissolved oxygen was reported 10.37mg/L (Table-1 and Figure-1) which was slightly more than the optimum level and addition of large amount of water could be managed the level of dissolved oxygen in pond water.

Total hardness: Hardness is the measure of divalent metallic cations like calcium (Ca^{2+}) and magnesium (Mg^{2+}) in water which are essential for the metabolic activities like bone and scale formation. A moderately hard water of 100-200mg/L CaCO₃ was found appropriate for optimal normal hatching, high

viability and maximum larval development of fish whereas optimum level of hardness 30-180mg/L is recommended for fish culture⁴. In the current study, the value of total hardness 115.20mg/L (Table-1 and Figure-1) was noted and found within the optimum limit for fish culture.

Total alkalinity: Alkalinity is measure the total amount of base indicating pond's ability to resist large pH changes and considered as one of the important components of water quality. For the aquaculture, total alkalinity should be between 10-400 mg/L^{21 22}.

The alkalinity with 300 mg/L of water did not affect the fish but interfered with some chemical $action^{23}$. The total alkalinity of village pond water was noted 266.00mg/L (Table-1, Figure-1) and found appropriate for aquaculture.

Nitrate-N: Nitrate-N is an important nutrient content for biological productivity of aquatic resources as it helps to proteins synthesis that required for the growth and reproduction of primary producers. It is relatively nontoxic and non-health hazardous for the fishes. The optimum nitrate-N 0.1 to 4.0mg/L is recommended fish culture²⁴. Nitrate-N was noted 0.15mg/L (Table-1 and Figure-1) in studying pond and found within the prescribed limit for fish farming.

Nitrite-N: Nitrite-N is the intermediate product of nitrification process of aerobic *nitrosomonas* bacteria. It is unstable form and converted in ammonia or nitrate depending upon the conditions of the water so availability it is not recommended and considered as invisible fish killer at the concentration of 0.25 mg/L by damaging gills, liver, spleen, kidneys and nervous system²⁵. Nitrite-N was found 0.13mg/L (Table-1 and Figure-1) and was within the prescribed optimum limit and safe for fish culture.

Phosphate: Phosphate is nutrient component for fish rearing to support higher levels of biological productivity and in water it found either in particulate form includes living and dead plankton or dissolved form includes inorganic and organic phosphate. Phosphate 0.05-3.0mg/L is optimum for productive aquatic environment⁵.

The observation of phosphate in village pond was 0.10mg/L (Table-1 and Figure-1) and found suitable for productive aquatic habitat.

Silicate: Silicate is the necessary component for development of diatoms shells and its concentration is directly affected by the diatoms blooms²⁶. The silicate 3.00mg/L (Table-1, Figure-1) was noted in village pond.

The observed concentration of silicate was slightly lower than permissible limit which shows that it was used for the growth of diatoms and aquatic environment of the studied pond is productive for fish culture.

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Parameters			Maan	Optimum value			
	a	b	с	d	Е	Mean	(Reference no)
Temperature (°C)	27.00	28.00	29.00	20.00	27.00	26.20	20-35 (4)
Turbidity (NTU)	5.00	7.20	3.70	3.30	4.30	4.70	<30 (4)
рН	4.90	8.70	7.80	8.14	9.50	7.80	6.7-9.5 (4)
DO (mg/L)	8.11	7.70	12.17	16.22	7.65	10.37	5-10 (4)
Total hardness (mg/L)	20.00	16.00	190.00	180.00	170.00	115.20	30-180 (4)
Total alkalinity (mg/L)	430.00	120.00	200.00	300.00	280.00	266.00	50-300 (4)
Nitrate-N (mg/L)	0.03	0.17	0.10	0.09	0.41	0.16	0.1-3 (4)
Nitrite-N (mg/L)	0.09	0.14	0.07	0.28	0.09	0.13	0-0.5 (4)
Phosphate (mg/L)	0.00	0.10	0.20	0.00	0.10	0.10	0.05-0.4 (10)
Silicate (mg/L)	4.00	3.00	2.00	2.00	4.00	3.00	4-16 (4)

Table-1: Water quality parameter of village pond at Degam, Navsari (Gujarat).





Figure-1: Graphical presentation of different water quality parameters in village pond.

Conclusion

On the basis of these results, it can be concluded that water quality parameters of the studied pond were within the limit of permissible limits prescribed by the different authorities for aquaculture development. It was also observed that turbidity, dissolved oxygen and silicate were slightly fluctuated from the prescribed limit but these are manageable and would not be impacted the survivability of fishes and suitability of the village pond for fish culture. So, it can be concluded that the aquatic environment of studied village pond at Degam, Navsari (Gujarat) is conducive and suitable for fish culture and findings of the present study could be help to provide cheap animal protein for consumption, revenue generation for village and employment for rural people. Furthermore, is recommended that constant monitoring of water quality of pond water can help to develop the village pond for fish farming and also enhance the fish production.

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