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Water Quality Assessment of Village Pond for Aquaculture Development

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Abstract: In the present study we have investigated the physico-chemical parameters for development of aquacultural activities in village pond located at Kukeri, Navsari (Gujarat, India). In this study, important water quality parameters like temperature, turbidity, pH, dissolved oxygen, total hardness, total alkalinity, nitrate-N, nitrite-N, phosphate and silicate were analyzed and result was compared with prescribed standard values. The physico-chemical parameters were observed as temperature (25°C), turbidity (6.48 NTU), pH (8.00), dissolved oxygen (9.08 mg/l), total hardness (99.54 mg/l), total alkalinity (172 mg/l), nitrate-N (0.20 mg/l), nitrite-N (0.01 mg/l), phosphate (0.83 mg/l) and Silicate (1.65 mg/l).These findings were observed within the optimum limits for physico-chemical parameters for aquaculture except phosphate and silicate and it can be suggested that the aquatic environment of studied village pond at Kukeri, Navsari (Gujarat) is favorable for fish culture. Such kind of aquaculture practices could be helpful to provide food and employment for rural people.

Keywords: Physico-chemical parameters, Village pond, Aquaculture, Dissolved oxygen, Temperature, Turbidity, Dissolved oxygen, Total hardness, Total alkalinity

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Introduction

Water is most important natural and precious resource for every living organism on the earth. Unplanned urbanization, rapid industrialization and indiscriminate use of artificial chemicals cause heavy and varied pollution in aquatic environments leading to deterioration of water quality and depletion of aquatic fauna including fish. A healthy aquatic environment is one which supports a rich and varied community of organisms and protects public health (Ramachandra *et al*., 2002). Ponds are habitats of great importance as they provide water for domestic, industrial and agricultural uses. Inspite of their fundamental importance to humans, freshwater systems have been severely affected by anthropogenic disturbances which led to serious negative effects on the structure and function (Parikh and Mankodi, 2012). Without knowledge

of water chemistry, it is difficult to understand the status of water body for fruitful management because the chemistry of water reveals much about metabolism of the aquatic ecosystem and explains the general hydrobiology interrelation-ship (Deshmukh and Ambore, 2006). Water quality generally means that the components must be present in balance or in optimum quantity for growth of aquatic organisms (Bhatnagar *et al*., 2004). The interactions of these water quality parameters are significantly important for the composition, distribution, abundance, diversity, reproduction and migration of aquatic organisms (Rani, 2019). 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 fish (Rana and Jain, 2019). Therefore, the present study was conducted to determine the water quality of village pond for sustainable fish culture in rural area.

Materials and Methods

Village pond is located at Kukeri village, Navsari city (Gujarat, India). This water spread area of pond is about 5 ha and pond is used for the domestic and agriculture 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 9.00 a.m. from January to March, 2021. From these water samples, temperature and pH were measured at the sampling site while dissolved oxygen was fixed at same site. Other 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, Gujarat, India. These water quality parameters were following the standard methods of Trivedy and Goel (1886) and APHA (2005). To assess the quality of pond water for fish culture and pond water quality parameters were compared with prescribed optimum limit for aquaculture (Ujjania *et al*., 2007; Saha, 2010; Bhatnagar and Devi, 2013).

Results and Discussion

Temperature:

Temperature is very important parameter for fish and shrimps as it can greatly affect their growth, feeding, reproduction, and migratory behavior (Fey, 2006). 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 and below 15°C could stop the growth and death of fish might occur (Stickney, 2013). Kausar and Salim (2006) reported that water temperature between 24-26°C was the most effective for rearing of *Labeo rohita.* In present study, water temperature of village pond was noted 25ºC (Min. 24ºC, Max. 26ºC) and it is within the prescribed limit for aquaculture (Table 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 (Bhatnagar and Devi, 2013). Turbidity arising from effluents when discharged into waterbodies may hinder photosynthesis of organisms that usually participate in the phytoremediation of contaminated water (Elango *et al*., 2017). However, according to WHO (2017) it may form a shield against the hazardous effect of disinfectants on microorganisms. Turbidity of pond water was observed 6.48 NTU (Min. 5.50 NTU, Max. 7.50 NTU) which was comparatively less than the optimum value and need enhance the primary producers to develop pond for fish culture (Table 1).

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 of the most of aquatic species (Ntengwe and Edema,

Table 1: Water quality parameter of village pond at Kukeri village, Navsari (Gujarat)

S. No.	Parameters	Min	Max	Mean	*Optimum value
1	Temperature (°C)	24.00	26.00	25.00	20-35
2	Turbidity (NTU)	5.50	7.50	6.48	<30
3	pH	5.60	9.40	8.00	6.7-9.5
4	DO (mg/L)	4.05	12.60	9.08	5-10
5	Total hardness (mg/L)	76.00	156.00	99.54	30-180
6	Total alkalinity (mg/L)	130.00	200.00	172.00	50-300
7	Nitrate-N (mg/L)	0.10	0.43	0.20	0.1-3
8	Nitrite-N (mg/L)	0.04	0.09	0.01	0-0.5
9	Phosphate (mg/L)	0.04	0.07	0.83	0.05-0.4
10	Silicate (mg/L)	0.01	4.00	1.65	4-16

*Source: Bhatnagar A. and Devi P. (2013)

2008). Fishes stressed in water with a pH ranging between 4.0 to 6.5 and 9.0-11.0 and death occur at a pH of less than 4.0 or greater than11.0 (Ekubo and Abowei, 2011). The pH of studied village pond water was 8.00 (Min. 5.60, max. 9.40) which is within the optimum values and considered as supportive for aquaculture practices (Table 1).

Dissolved Oxygen (*DO*):

Solis (1988) reviewed that the amount of dissolved oxygen in water is very important for aquatic organisms and it affects the growth, survival, distribution, behavior and physiology of shrimps and other aquatic organisms. Maintaining good levels of DO in the water is essential for successful production since oxygen has a direct influence on feed intake, disease resistance and metabolism.It was noted that >5mg/l dissolved oxygen in pond water conducive for the good growth of flora and fauna (Das, 2002; Bhatnagar and Singh, 2010). In pond water, 1-3 mg/l dissolved oxygen has the sub-lethal effect on growth and feed utilization whereas >14 ppm was found to be lethal to fry and caused gas bubble disease in fishes (Bhatnagar *et al*., 2004). In studied village pond water, dissolved oxygen is recorded 9.08 mg/l (Min. 4.05, Max. 12.60) which was within the prescribed limit for aquaculture (Table 1).

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 (Shah *et al*., 2022). Optimum level of hardness 30-180 mg/l is recommended for fish culture (Bhatnagar and Devi, 2013). According to Kumar (2004), the values of total hardness in the range of 10-400 mg/l are suitable for aquaculture. According to CIFE (2013), in very soft water, the toxicity of pollutant became high whereas very hard water caused osmoregulatory stress to fish. In the current study, the value of total hardness 99.54 mg/l (Min. 76 mg/l, Max. 156 mg/l) has been noted and found within the optimum limit for fish culture (Table 1).

Total Alkalinity:

Total alkalinity is the measure of capacity of the water to neutralize a strong acid (Trivedy and Goel, 1986). The alkalinity of unpolluted pond ranges from 171.2 to 235.5 mg/l (Shastress, 1991). Alkalinity is one of the important components of water quality. It measures the total amount of base indicating pond's ability to resist large pH changes. For aquaculture, total alkalinity should be between 10-400 mg/l (Kumar 2004), though greater than100 mg/l is desired. Total alkalinity of water bodies may be increased due to the degradation of plants and other organisms and organic wastes (Chaurasia and Pandey, 2007). The total alkalinity of village pond water was noted

172 mg/l (Min. 130 mg/l, Max. 200 mg/l) and found appropriate for aquaculture (Table 1).

Nitrate-N:

Nitrate-N is an important nutrient content for biological productivity of aquatic resources as it helps to protein synthesis that required for the growth and reproduction of primary producers (Shah *et al*., 2022). It is relatively nontoxic and non-health hazardous for the fishes. The optimum nitrate-N 0.1 to 4 mg/l is recommended for fish culture (Santhosh and Singh, 2007). Nearest limit of nitrate-N was noted 0.20 mg/l (Min. 10 mg/l, Max. 43 mg/l) in studied pond and found within the prescribed limit for fish farming (Table 1).

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. It is considered as invisible fish killer at the concentration of 0.25 mg/L by damaging gills, liver, spleen, kidneys and nervous system (Eze and Ogbaran, 2010). Stickney (2013) stated that the exposure of eggs to 14 mg/l of nitrite in fresh or brackish water delayed the hatching and caused miserable effects on the cardiovascular system. Nitrite-N was found 0.01 mg/l (Min. 0.04 mg/l, Max. 0.09 mg/l) and is within the prescribed optimum limit and safe for fish culture (Table 1).

Phosphate:

Phosphate is nutrient component for fish rearing to support higher levels of biological productivity and in water it isfound either in particulate form which includes living and dead plankton or dissolved form which includes inorganic and organic phosphate. Phosphate 0.05-3 mg/l is optimum for productive aquatic environment (Bhatnagar *et al.,* 2004). The observation of phosphate in village pond was slightly higher 0.83 mg/l (Min. 0.04 mg/l, Max. 0.07 mg/l) than permissible limit which shows that it was not properly used for the growth of phytoplankton which forms food for fishes (Table 1). Also it accelerates aquatic plant growth and the occurrence of algal blooms (Dong Bai, 2023).

Silicate:

Silicate is the necessary component for development of diatoms shells and its concentration is directly affected by the diatoms blooms (CIFE, 1997). The silicate 1.65 mg/L (Min. 0.01 mg/L, Max. 4.00 mg/L) was noted in village pond (Table 1).The observed concentration of silicate was lower than permissible limit which shows that it was used for the growth of diatoms and aquatic environment of the studied pond and is productive for fish culture.

Conclusion

On the basis of the results of the present study, it can be concluded that water quality parameters of the studied pond were within the permissible limits prescribed by the different authorities for aquaculture development. It was also observed that phosphate and silicate were slightly fluctuated from the prescribed limit but these are manageable and would not impact the survivability of fishes and suitability of the village pond for fish culture. So, it can be concluded that water quality of village pond of study area has very good potential for fish culture. The study has shown that the small pond of Kukeri village, Navsari (Gujarat) has greater power of high yield if they are scientifically managed. The study has noticed the need to protect and conserve this small water body at the rural level. Hence, the policy makers, fish biologists and planners need to take immediate action and to help fish farmers to make strategies for fish culture enhancement programs.

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