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PHYSICO-CHEMICAL CHARACTERISTICS OF FISH PONDS OF BHADRA PROJECT AT KARNATAKA

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ABSTRACT

The present study evaluated the physico-chemical characteristics of the waters in two fish ponds , located near Bhadra project region , Karnataka, which is the main water source for fish seed rearing and culture of brood fishes in this area. The present investigation was carried out during December 2006 to May 2007. The water quality parameters studied for the current study were water temperature, pH, acidity, total alkalinity, free CO_2 ,dissolved oxygen, biological oxygen demand, chloride, sulphate, phosphate, nitrate, calcium, magnesium and total hardness. The values obtained were compared with values recommended in water quality standards by WHO, BIS and USPHS. The high phosphate and nitrate concentrations were attributed to water leached surface soil runoff, as well as the addition of organic manure (cowdung and poultry manure) to the ponds . It will be necessary to delimit cattle and poultry manure access points to the ponds to reduce this type of organic pollution in the water bodies. Based on the results of present study it is concluded that the fish ponds are moderately hard to hard category.

Key words: Bhadra project ; Fish ponds ; Physico-chemical characteristics of the water

INTRODUCTION

Water is very precious for every living organisms on this earth . The available fresh water to man is hardly 0.3 to 0.5% of the total water available on the earth and therefore its judicious use is imperative. In today's scenario, unplanned urbanization, rapid industrialization and indiscriminate use of artificial chemicals cause of heavy and varied pollution in aquatic environments leading to deterioration of water quality and depletion of aquatic fauna including fish. Without the knowledge of water chemistry, it is difficult to understand the biological phenomenon fully, because the chemistry of water reveals much about metabolism of the ecosystem and explains the general hydro-biological interrelationship [1-2].

Physico-Chemical characteristics are highly important with regard to the occurrence and abundance of species. Discharge of urban, industrial and agricultural wastes have increased the quantum of various chemicals that enter the receiving water, which considerably alter their physico-chemical characteristics. Nutrients like phosphorous and nitrogen from the domestic wastes and fertilizers accelerate the process of eutrophication [3,6]. Natural factors like dust, storm, runoff and weathering of minerals are slow processes in causing eutrophication[4]. Lentic water bodies have tremendous importance, as they are recharging reservoirs for drinking water, domestic use and as infrastructure for pisciculture. Eutrophication has become a widely recognized problem of water quality deterioration [5-6]. Temperature, turbidity, dissolved oxygen, pH, chloride, and total alkalinity are significant parameters used to study the water quality [7,2]. The present study aims at making an assessment of the water quality with reference to physico- chemical characteristics of the fish ponds that situated in the WesternGhat region of Karnataka, India.

EXPERIMENTAL

Water samples from fish ponds were collected during the period of December 2006 to May 2007 from two sampling ponds . These ponds are earthern and used to culture fish seeds as well as brood fishes .Moreover, these water bodies also provide habitat for aquatic birds. Fourteen physico-chemical

parameters were analyzed by standard methods [8-9]. pH was measured using pH meter with glass electrode. The electrode was calibrated against pH 4.0, 7.0 and 9.2 buffer each time before analysis.

The water temperature was measured with a mercury-in-glass thermometer. The Dissolved Oxygen (DO) in the sample was immediately fixed with 2 ml potassium iodide and 2 ml of manganous sulphate in the field itself. The DO content was determined by Winkler's method. Immediately after the samples were brought to the laboratory, estimation of Biological Oxygen Demand (BOD), carbon dioxide (CO_2), phosphate. calcium, magnesium, total hardness, acidity, alkalinity, chloride, nitrate, sulphate were carried out.

RESULTS AND DISCUSSION

Table-1 depicts the water quality standards while, the physico-chemical characteristics of water in fish ponds are presented in Table-2.The consideration of the physico-chemical factors in the study of limnology is basic in understanding the trophic dynamics of water body. Each factor does play its individual roles but at the same time the final effect is really the result of interaction of all the factors [10-11].Water temperature plays an important role in the ponds. The variations in the temperature were influenced by factors such as air temperature , humidity, wind and solar energy [11] . Temperature fluctuation also affects the phytoplankton and zooplankton and hence affects the fish productivity. Due to the shallowness of the ponds and influx of the channel water , the temperature varies diurnally and seasonally. In present study, the surface water temperature ranged from 29ºC to 32.0ºC in pond-1 and 28 to 35.5ºC in pond-2 respectively. The temperature rises gradually from early post monsoon to the pre-monsoon month.

The pH variation must be exerting heavy stress on the inhabitant organisms in the aquatic media [12]. The pH ranged from 6.9 to 8.2 (Table 2) during the study period. pH dropped to slightly acidic in the month of December 2006 at pond-2 and kept fluctuating irrespective of the months in the entire stretches of the ponds. This must be due to animal fecal wastes added intermittently from the fishermen's for zooplankton production as they serve as food for fishes.

Compared with the total alkalinity of water samples collected at fish ponds , higher alkalinity was noted at pond-2 and it was noted in between 46 mg/L and 118 mg/L during the study period . The main sources of natural alkalinity are rocks containing carbonate, bicarbonate, and hydroxide compounds that are abundantly present [13-14]. In the present investigation, most of the values of parameters exceed the desirable limit according to BIS specifications and hence the water quality of fish ponds are not suitable for drinking purpose but suitable for fisheries. There is remarkable deterioration of the aquatic environment and increased vulnerability of life in vicinity of study areas.

Free carbon dioxide is also one of the important factor in aquatic habitat. It is highly soluble in water and is the main source of carbon path way in the nature. Plants absorbs the free carbon dioxide present in both atmosphere and water. Carbon dioxide in water bodies is contributed by the respiratory activity of animals [15]. Carbon dioxide content was minimum in both the ponds during post-monsoon month with 2.0 mg/L, the carbon dioxide level was maximum in May at pond-1(14.8 mg/L) . The carbon dioxide reached its maximum in the month of summer and minimum in the months of winter season at sampling ponds. This was compile with Gaur [16].

Dissolved oxygen (DO) plays an important role in aquatic environment and is essential for growth of phytoplankton and fish productivity . The inhabitant organisms are affected greatly due the diurnal and seasonal variation in the dissolved oxygen of the ambient water. DO is governed by the water turbulence, surface diffusion, rate of photosynthesis, BOD, water temperature and carbon dioxide concentration [17]. In the present study, DO ranged between 2.0 mg/L and 8.6 mg/L and maximum D.O was observed in the post-monsoon month at pond-1. However, dissolved oxygen on an average remained hypoxic in most of the months indicating that the fish ponds were moderately polluted. Since DO in water samples depend on water temperature, partial pressure of the gas in contact with water, the concentration of the dissolved salts, biological activities and geology of river basin. Further, concentration of D.O is inversely proportional to temperature at a given time [1,18] and the present investigation resemble their observations indicating that the higher temperature of water decreased the solubility of oxygen at all the ponds .

Biological oxygen demand (BOD) is a measure of oxygen required by microbes to degrade the organic matter under aerobic condition . BOD increases with the increased inflow of the domestic waste[19]. High BOD depletes the oxygen level to a critical condition thus indicating the pollution status of waters. BOD of fish ponds ranged from 0.8 mg/L to 6.6 mg/L . BOD was relatively low in pond-2 during February month and high during summer month due to discharge of animal faecal wastes coupled with high temperature indicating organic pollution. BOD level was relatively high in pond-1 during May 2007 with 6.6 mg/L which is above the permissible limit . BOD level of Kolar reservoir was found 1.85 mg/L as reported by Parashar et al [20].

Chloride content in fish ponds is important to know the quality of water and sources include fertilizers from surrounding areas and animal wastes. The chloride content in the studied ponds varied from 85.0 to 156.0 mg/L in pond-1, While in the pond-2 its contents ranged from 113 to 156.0 mg/L respectively , show chloride content is below than the maximum permissible limit prescribed by the WHO standards [21].

The sulphates are derived from discharge of domestic waste and surface runoff near by the surrounding areas, during rainy season which bring sulphates to the fish ponds. It is an important constituent of hardness. In the present investigation, sulphate level was maximum at pond-2 with 180.0 mg/L, this was due to the addition of organic manure, which enhance the level of sulphate .

The nutrients play a major role in primary productivity of the ponds. These are generated as a result of decomposition in natural condition that is regularly taken up by the phytoplankton in an aquatic body. However, the surface runoff and domestic waste also carry excessive nutrients like nitrate-nitrogen and phosphate indicating moderate pollution in the habitat.

Nitrate is an essential nutrient but also a good indicator of contamination from natural and human activities. Levels above 45 mg/l are considered harmful to aquatic organisms. The nitrates were ranging from 45.0 mg/L to 80.0 mg/L in the present findings. The average nitrates were found to be extremely high as compared to the tolerable limits in all the ponds. When NO_3 level is above 40 mg/L , it leads to "methaemoglobinaemia" also called blue -baby disease.

Phosphorus is an essential nutrient present in soil and water in inorganic and organic forms. Manure applications based on nitrogen requirements can result in excessive phosphorus application and the potential for runoff. In the present study, phosphate level varied from 0.51 to 1.28 mg/L respectively. The phosphate-phosphorus is added to the ponds from the domestic waste. Land runoff increases the phosphate during the monsoon season [22]. Both Nitrate and phosphate ions were higher than the WHO and USPHS standards . In monsoon months nutrients are brought in by the rain water from the surrounding area , it is attributed to certain anthropogenic activity which corroborates with the high BOD of present study. Similar results were recorded by Mishra [23] in Ulhas river.

Calcium is one of the most abundant substances of the natural waters. Being present in higher quantities in rocks, it is leached from these to contaminate water [24] .Calcium is an important element is associate different cations like carbonates , bicarbonates and fluorides to exert hardness. The calcium value fluctuated from 32.0 mg/l to 112 mg/L in pond -2 and is high when it is compared with pond-1, the values are depicted in Table 2**.** Generally **,** magnesium content is lower than calcium ions in natural water also follows the same trend in the fish ponds. However , but due to the addition of animal manures and other waste in the water bodies , which increases the values of magnesium i.e., 16.5 mg/L to 104.0 mg/L. these elements increases hardness of the water [25].

Water hardness refers to the concentration of calcium and magnesium. As calcium and magnesium bond with carbonates and bicarbonates, alkalinity and water hardness are closely interrelated and produce similar measured levels. The hardness of water is not a pollution parameter but indicates water quality.

Waters are often categorized according to degrees of hardness as follows:

0 – 75 mg/L = soft
75 – 150 mg/L= moderately hard
150 – 300 mg/L= hard
Above 300 mg/L= very hard

In the present investigation, total hardness level varied from 100.0 to 190.0 mg/L and included under moderately hard to hard category. It is observed that alkalinity and hardness levels which provides a good buffering (stabilising) effect to pH swings that occur in fish ponds due to the respiration of aquatic flora and fauna. Higher values of hardness were observed during winter months which may be due to low water level and high rate of decomposition, thus, concentrating the salts. Similar findings were observed by Chatterjee Ranjan and Raziuddin [26] and Nirmal Kumar and Cini Oomen [27] in water bodies of West Bengal and Gujarat, India. While, Parashar et al [20] reported the hardness values of Kolar reservoir as 124 mg/L. The values of hardness further suggest the higher temporary hardness than permanent hardness in the fish ponds. Hence, proper treatment could help in reduction of total hardness [24,28] .

Growth of macrophytes, unhygienic condition, silting of ponds have created nuisance. Water storage seems to be decreasing and cattle grazing is serious problem near fish ponds. Avinash Karne and Prabhakar Kulkarni [29] observed similar findings in fresh water bodies of Khatav tahsil, Maharashtra. Deterioration of water quality and eutrophication are due to addition of organic manure and agricultural runoff. Even though nature has got its own mechanisms to take care of the wastes when they are in limited quantities. The water quality parameters like nitrate and phosphate showed higher values than the permissible limits of WHO standards. Thus, it can be concluded that these characteristics of water are influenced by seasonal fluctuations. It is recommended that the proper maintenance of the water bodies is necessary

CONCLUSION

High phosphate and nitrate indicate that the present fish ponds are moderately eutrophicated. The data showed enrichment of nutrients of fish pond water is due to dumping of animal manures by the fishermens. Two aquaculture production ponds must provide a suitable environment to promote the growth of fishes. Although application of organic manure does not directly cause bacterial diseases in fish, the significantly greater abundance of pathogenic bacteria in the water and sediments of the manured ponds could lead to diseases. Should fish resistance to disease be low, the possibility of occurrence of bacterial disease is higher in these ponds. Therefore, proper fish pond management should be observed to prevent any chance of bacterial diseases. Temporal variations in water quality exist in the concentration of most of the constituents of fish ponds and the present water bodies are included under moderately hard to hard category.

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Table -1 **:** WHO, USPHS and BIS water quality standards

Parameters	WHO	USPHS	BIS
pH	6.5-9.2	7.0-8.5	6.5-8.5
Dissolved oxygen	4-6	-	6.0
Alkalinity	-	-	50-200
Hardness	100-500	200	300
Calcium	200	75	200
Magnesium	150	-	100
Phosphate	-	0.1	-
Sulphate	200-400	250	1000
Nitrate (as total N_2)	50	<10	-
BOD	-	-	5
Chloride	250	-	

All the parameters are expressed in mg/L except pH (Source: Vasanthy et al [24])

Table -2: Monthly variations in physico-chemical characteristics of fish ponds at Bhadra project, Karnataka**.**

Pond-1

Parameters	December 2006	January	February	March	April	May 2007
Water temperature (°C)	29.5	30.0	29.0	29.5	30.0	32.0
pH	6.9	7.5	7.1	7.0	7.16	7.50
Acidity (mg/L)	35.6	20.0	25.0	35.0	28.0	30.6
Total alkalinity (mg/L)	54.0	78.0	74.0	68.0	70.0	85.0
Free CO_2 (mg/L)	4.20	8.80	2.0	2.2	8.8	14.8
D.O (mg/L)	3.0	3.2	8.6	4.6	4.3	2.4
B.O.D (mg/L)	4.2	2.5	1.0	1.6	2.0	6.6
Chloride (mg/L)	156.0	99.0	85.0	156.0	98.0	100.5
Sulphate (mg/L)	90.0	92.0	100.0	120.0	150.0	124.0
Phosphate (mg/L)	0.51	0.55	0.54	0.68	0.80	1.28
Nitrate (mg/L)	61.0	63.0	62.2	71.0	78.0	80.5
Calcium (mg/L)	72.0	60.0	78.0	35.2	37.0	81.5
Magnesium (mg/L)	48.0	40.0	34.0	23.5	24.0	54.75
Total hardness (mg/L)	120.0	100.0	160.0	144.0	146.0	123.8

Pond-2

Parameters	December 2006	January	February	March	April	May 2007
Water temperature (°C)	28.0	29.0	31.5	33.0	34.0	35.5
pH	7.4	7.0	8.0	8.1	7.5	8.2
Acidity (mg/L)	25.0	30.0	18.0	14.0	35.0	28.4
Total alkalinity (mg/L)	86.0	46.0	86.0	95.0	79.0	118.0
Free CO_2 (mg/L)	4.2	8.8	2.0	4.0	6.0	8.2
D.O (mg/L)	2.0	3.5	7.8	4.6	5.2	3.6
B.O.D (mg/L)	3.2	1.75	0.8	2.0	1.2	1.80
Chloride (mg/L)	156.0	127.0	113.0	142.2	127.0	131.0
Sulphate (mg/L)	180.0	150.0	165.0	170.0	150.4	160.4
Phosphate (mg/L)	0.64	0.68	0.66	0.59	0.95	1.26
Nitrate (mg/L)	45.0	50.2	62.0	74.0	65.0	78.0
Calcium (mg/L)	32.4	44.2	32.0	112.0	104.0	58.6
Magnesium (mg/L)	17.2	19.5	16.5	104.0	78.0	33.3
Total hardness (mg/L)	170.0	190.0	160.4	154.0	138.0	165.0

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