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Comparative studies on physico-chemical properties of water samples collected from different fish ponds of Kosi area, (Bihar), India

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Abstract: Physico-chemical properties of water samples from 20 randomly selected ponds were comparatively analyzed for its quality and suitability for aquaculture. The variation in the physico-chemical parameters of the aquaculture ponds above or below standard values has potential effects on the health and productivity of aquaculture. It has been found that the pond water was acidic to neutral in nature (pH varied from 6.0 to 7.2) and could be suitable for aquaculture. The dissolved oxygen (DO) concentration was suitable for fish production but more DO level should be present for all aquatic life especially for fish production. Chemical oxygen demands (COD) of all pond waters were within the permissible limits for fish production.

Keywords: - Pond, Water Quality, Fish Production, Kosi

INTRODUCTION

Water quality describes the chemical, physical, and biological parameters of water, generally in terms of suitability for aquaculture. Water quality is one of the most overlooked aspects of pond management until it affects fish production. Several important variables influence water quality for fish including water temperature, dissolved oxygen, phytoplankton, photosynthesis, pH, carbon dioxide, ammonia, alkalinity and hardness. Each water quality factor interacts with and influences other parameters, sometimes in complex ways. What may be toxic and causes mortalities in one situation can be harmless in another. At present time, surface waters of the state are polluting by various ways. Elevated levels of heavy metals in aquatic systems have resulted from a number of land use activities including agriculture, urbanization, impoundments, mining, and industrial activities. Heavy metals effects include reduced growth rates, impaired reproduction, and sometimes death. Bioconcentration and bioaccumulation of these elements in the food chain can put terrestrial consumers, including humans, at risk. In humans, prenatal exposure to high mercury levels, particularly in fish-eating populations, has been associated with developmental problems related to the central nervous system (WHO, 2004)[1]. However, it is essential to assess the quality of surface water as well as its suitability for fish production. Therefore, the objectives are to assess the water quality of ponds of Kosi region for fish production.

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MATERIALS AND METHODS

Water samples were collected from 20 ponds of the region May and June 2017. Samples were collected in 5 liter plastic bottles that had been cleaned with hydrochloric acid (1:1) and then rinsed with tap water followed by rinsing with distilled water. Before collecting each sample, plastic bottles were rinsed 3 to 4 times with sample. All reagents used in chemical analysis were of analytical grade. Samples were analyzed in Post graduate Department of Zoology, BNM University. The water parameters were analysed by standard methods (APHA, 1998)[2].

RESULTS AND DISCUSSION

The Summary of Physico-chemical characteristics of water samples are shown in Tables 1and 2.

Table -1 Water parameters of selected ponds

	Temp (°C)	pH	DO (mg/l)	COD (mg/l)	EC (µs/cm)	TDS (mg/l)	Alkalinity (mg/l)	Hardness (mg/l)
Min	21.5	6.0	6.4	3.2	50	32	18	28
Max	27.6	7.2	8.9	7.9	490	274	88	212
Mean	25.3	6.5	7.7	5.6	145	89	32	70
SE±	0.5	0.2	0.3	0.4	17	10	5	10

Table -2 Anionic constituents of pond water

	NH_3 (mg/l)	NO^2 (mg/l)	NO_3 (mg/l)	Cl^- (mg/l)	HCo_3 (mg/l)	SO_4^{-2} (mg/l)	Po_4^{-3} (mg/l)
Min	0.23	0.01	3.64	0.55	0.85	0.03	0.011
Max	2.72	0.10	10.50	2.10	1.67	1.67	0.27
Mean	1.24	0.04	6.66	1.03	0.31	0.31	0.05
SE±	0.20	0.006	0.38	0.08	0.09	0.09	0.03

The water temperatures ranged from 21.5 to 27.6ºC and the pH of the samples ranged from 6.0 to 7.2. DO concentrations varied from 6.4 to 8.9 mg/l. In this investigation, the COD values of the water samples ranged from 3.2 to 7.9 mg /l. Higher COD values indicate that waters of these ponds were to some extent polluted with non-biodegradable chemical pollutants. The EC and TDS ranged from 50 to 490 µS/cm and 32 to 274 mg/l, respectively. Phosphate (PO_4^{3-}) level of water samples was in between 0.011 and 0.270 mg/l. Nitrite nitrogen values ranged between 0.01 and 0.10 mg/l while nitrate levels in surface water varied from 3.64 to 10.50 mg/l. On the other hand extensive epidemiological data support the current guideline values for NO_3 —N of 10 mg/l (WHO, 2004)[1]. Higher concentrations of NO_3 —N and trace amount of ammonia nitrogen were noticed in all ponds. As most of the study areas were in intensive irrigation, the fertilizers used for agriculture may be the source for the elevated concentration of nitrate in a few locations (Chandna *et al*., 2010)[3]. During the present study, major chemical contents such as NO_3 —N, NO_2 —N and phosphorus values were within suitable level from pollution point of view. An appreciable amount of HCO_3 was present in all water samples, though CO_2 was negligible in most cases. The concentrations of HCO_3- were from 0.85 to 6.20 meq/L while Cl and SO_4^{2-} concentrations ranged from 0.55 to 2.10 meq/l and 0.03 to 1.67 meq/l, respectively. In the study area, the pH range recorded from 6.0 to 7.2. The pH of 6.0 to 8.5 is acceptable for most pond life (Alabaster and Lloyd, 1980)[4]. Fish can become in stress in water with a pH ranging from 4.0 to 6.5 and 9.0 to 11.0. Long term conditions above 9.0, can cause kidney damage to the fishes. When pH rises over 11, the gills, lens and cornea of fish eyes are destroyed (Jhingran, 1988)[5]. Lower pH increases the toxicities of hydrogen sulphide (H_2S), copper and other heavy metals to fish. Alkalinity found to range from 18 to 88 mg/l. Alkalinity is water's ability to resist changes in pH and is a measure of the total concentration of bases in pond water including carbonates, bicarbonates, hydroxides, phosphates and borates. A suitable range of alkalinity is 50 to 300 ppm (APHA, 1998; Boyd and Tucker, 1992)[2,6]. In the study area, hardness ranged from 28 to 212 mg/l. Calcium and magnesium are essential to fish for metabolic reactions such as bone and scale formation. Total alkalinity was high and total hardness was low, pH was raised to extremely high levels during periods of rapid photosynthesis. Desirable level of total hardness and total alkalinity for fish culture generally was fallen within the range of 20-300 ppm. Total alkalinity and total hardness raised by liming (Joseph *et al.,* 1993)[7]. In the study area, the temperature recorded to range from 21.5-27.6°C.

However, the ideal range of temperature is between 20°C-25°C and the acceptable range is 22°C-30°C (Alabaster and Lloyd, 1980)[4]. In study area it was recorded that water temperature increased in the pond water, the toxicity of ammonia was increased and the amount of dissolved oxygen decreased. Water temperature influenced the onset of fish spawn, aquatic vegetation growth and the biological demand for oxygen in ponds. In addition, plants and animals used more oxygen due to increased respiration rates. These factors commonly resulted in less available oxygen for fish during the study period. The value of DO of the study area varied from 6.4 to 8.9 mg/l. This range was suitable for fish culture in the study area (Jhingran, 1988)[5]. He found that growth and production is optimum at more than 5 mg/L in pond culture. Above 5 mg/l, almost all aquatic organisms can survive indefinitely, provided the allowable limits of other environmental parameters. Higher concentrations of phosphorus, nitrogen and iron can occur in the deeper portions of ponds when anoxic conditions convert bound and solid forms in sediments into soluble forms thus released into the water column. Total dissolved solids (TDS) ranged from 32 to 274 mg/l. The high amount of dissolved solids in water increases the water density; it influences osmoregulation of freshwater organisms and reduces solubility of gases. In the study area, the concentrations of ammonia varied from 0.23 to 2.72 mg/l. According to Alabaster and Lloyd (1980), ammonia poisoned fish congregates close to the water surface, gasp for air and are restless. In some cases, hemorrhages occur mainly at the base of the pectoral fins. Fishes are able to withstand levels of unionized ammonia of up to 0.6 to 2 mg/l for only short periods (Alabaster and Lloyd, 1980)[4]. In the study area, the concentrations of nitrite ranged from 0.01 to 0.10 mg/l. Nitrite can be deadly, particularly to the smaller fishes, in concentrations as low as 0.25 ppm. Vamos and Szollozy (1974)[8] documented that in nitrite poisoned fish, a brownish colour of blood on the gills is indicative of the increase of methaemoglobin, as nitirite bound to haemoglobin giving rise to methaemoglobin that reduces the oxygen transporting capacity of the blood. Concentrations of nitrate from zero to 200 ppm are acceptable. The NO_3 concentration in the water samples of the study area ranged from 3.64 to 10.50 mg/l which were slightly higher than the limit of 5 mg/l (UCCC, 1974)[9] that may be due to continuous uses of nitrogenous fertilizers for agricultural field crops. Even in very small concentrations of chlorine (< 0.5 mg/l), it burns the edges of the gills of fish and kills the beneficial nitrifying bacteria in the pond. The Cl concentration was much lower than the DOE standard. All the chloride (Cl-) values were within the permissible limits of 200 mg/l (Gupta, 2005)[10]. The buccal spasm hinders respiration, so that the fish suffocate and ultimately dies (Bohl, 1989)[11]. The total phosphorus content of the study area ranged from 0.081-0.840 mg/l, these high levels of phosphate originated from municipal wastewater discharges from nearby locality or from sediments of ponds. The increase in nutrients of water was spurted in algal productivity i.e., eutrophication. Bird droppings, natural run-off, fall of leaves and twigs from surrounding vegetation, continuous discharge of domestic waste, bathing, washing were principal sources of N, P and K in the wastewater of the study area.

CONCLUSION

Nitrate shows an elevated concentration in most of the ponds. Fertilizer application in agricultural fields and decay of organic matter are the probable origin of these nitrate concentration. These anions and cations concentrations might be helpful for algal production. Based on different water quality parameters, we concluded that all the pond water samples of the Kosi region of Bihar were suitable for fish production.

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