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Hydrological Characteristics in relation to Fish composition in Tammadihalli tank of Bhadravathi Taluk, Karnataka

H.M. Ashashree[1] and B.R. Kiran[2]

[1]Department of Zoology, Sahyadri Science College, Shivamogga-577 203 (India)
[2]Department of Environmental Science, DDE, Kuvempu University, Shankaraghatta-577451 (India)

Abstract

Assessment of physico-chemical and fish composition characteristics of water in two sampling sites in Tammadihalli tank of Bhadravathi taluk, Karnataka was analysed during March to November 2017. This water body is situated 26 Km away from Shivamogga district of Karnataka. The main aim of this study is to understand the hydrological characteristics of tank water and to search out out the suitability of water for drinking and fisheries . Several parameters like pH, water temperature, total alkalinity, total hardness, acidity, calcium, magnesium, electrical conductivity, phosphate, nitrate, dissolved oxygen, biochemical oxygen demand, total dissolved solids, turbidity, chloride and sulphate were analysed as per standard method and compared with WHO and BIS standards. The current study revealed that the water has pH (6.9 - 7.5), water temperature (23 - 34.5° C), electrical conductivity (101 - 138 µmhos / cm), total dissolved solids (50.5 - 79 mg/l), turbidity (89 - 222 NTU), acidity (5.01 – 7.2 mg/l), alkalinity (62.2 -73.5 mg/l), dissolved oxygen (2.84 – 6.8 mg/l), biochemical oxygen demand (2.2– .2 mg/l), total hardness (49.84- 59.5 mg/l), calcium (13.45 – 28.5 mg/l), magnesium (10.45 –17.25 mg/l), chloride (39.5 – 49.7 mg/l), sulphate (39.05 – 51.35 mg/l), phosphate (0.02 - 0.06 mg/l) and nitrate (0.03 - 0.08 mg/l). In this tank few indigenous and exotic fishes were recorded. Water quality in Tammadihalli tank is influenced by hydrology, topography and other environmental factors, which cause variations in nutrients. The physico-chemical analysis of water samples from this tank showed that the water is within the safe limits of drinking, irrigation and fisheries. Hence, the current water body is included under moderately mesotrophic category.

Water quality is that the physic-chemical and biological profile of water[5] it's a measure of the condition of water relative to the wants for human necessity or function[16] the foremost common standards wont to assess water quality relate to drinkable, irrigation, fisheries, safety of human contact and for the health of ecosystems.

[1]Assistant Professor, [2]Research & Teaching Assistant

Water quality conditions in a very tank are controlled by both natural processes and human influences. Aquatic organisms and therefore the physical and chemical components of their environment are inseparably inter-related and interact with one another. Flow and water chemistry are the first factors governing life in aquatic habitats, and both are closely associated with differences due to the season.

Studies on the differences due to the season within the hydrological conditions of water body constitute a crucial aspect of fishery research especially seeable of the very fact that chemical environment exerts a substantial influence on the aquatic organisms. The physico-chemical characteristics are vital in study of any environment, especially aquatic environment. except for the final interest in understanding the conditions of water and its impact on the aquatic biota, observations on the short term changes on the physico-chemical parameters may additionally have practical implications within the pollution studies[20].

Fishes exhibit enormous diversity in terms of their morphology, habitat and biology[9]. Fish can be used for ecological assessments at all levels of biological organization; assessment procedures are available at the levels of ecosystem, populations, individuals, organs and at the cellular and molecular levels [10]. Globally, there are about 450 families of freshwater fishes and 40 of them are represented in India aswarm freshwater species. Regarding 25 of those families contain commercially important species. Number of endemic species in warm water is about 544. Freshwater fishes are a poorly studied since information regarding distribution, populace dynamics and threats is incomplete, and most of the data available is from some well-studied locations[28,35]. The main objectives of the current study is to grasp the physico-chemical characteristics of tank water and compared with WHO likewise as BIS standards and to seek out out the suitability of water for consumption and fish culture.

Study area profile :

The study area Tammadihalli is situated in Bhadravathi taluk lies in the central part of the Karnataka state, in the south-east corner of the Shivamogga district (Figure 1). The latitude and longitude coordinates of Bhadravathi town are 13°50'N and 75°42'E. Bhadravathi taluk borders Shivamogga taluk of Shivamogga district to the west, Honnali taluk of Davangere district to the north, Channagiri taluk of Davangere district to the east and Tarikere taluk of Chikmagalur district to the south.

Bhadravathi taluk is at an altitude of around 1900 ft (580 m) above sea level. Tammadihalli tank is situated 3 Km from Kuvempu university and 25 Km away from Shivamogga district of Karnataka. The total area of the water body is about 8 hectares. The climate of the tank area is almost semi-arid and comparatively milder with distinct summer, winter and rainy seasons.

Regular sampling of the Tammadihalli tank water was made from the Bhadravathi taluk of Shivamogga district region from March 2017 to November 2017. The physico-chemical parameters like pH, temperature and

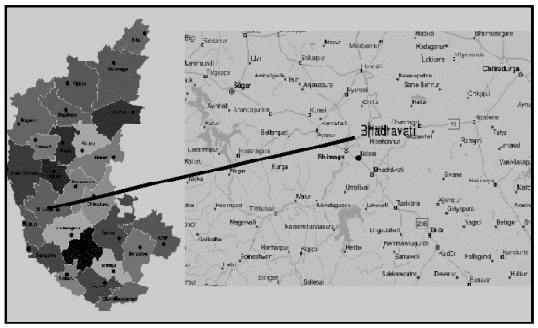

Figure 1: Study area map

dissolved oxygen were recorded at the sampling spot itself. pH was recorded by digital pH meter. Temperature of the water was recorded with the help of standard centigrade thermometer in degree celsius. For estimating Dissolved Oxygen (DO) water samples were collected in standard 300 ml, BOD bottles and was estimated by the Winkler's method. Turbidity of water were estimated by Jackson turbidity meter. While, other parameters were estimated in the laboratory by using standard methods as prescribed by Trivedy and Goel[33] and APHA [1].

The fishes were preserved in 10% formaldehyde solution for taxonomic analysis. Identification of fishes was carried out with the help of standard literature[13,29].

In any aquatic ecosystem physico-chemical characteristics has profound influence on its biotic components. It controls bio-diversity, biomass and distribution of biotic communities. The physical and chemical characteristics exert their influence both individually and collectively and their interaction produces abiotic environment which ultimately condition the origin, development and finally succession of biotic communities[20].

The atmospheric temperature was recorded maximum in the summer months. The atmospheric temperature is important and plays an important role in the environment. While, water temperature was recorded 23°C to 34.5°C. The water temperature was maximum in April and May months. Seasonally, water temperature was maximum during summer (34.5°C) at site I and minimum at Site II during rainy season with 23°C. Water temperature is the most important factor which influences the chemical, bio-chemical and biological characteristics of the water body. Similar studies on the water temperature was observed by Pawar and Pulle[26] in Pethwadaj dam, Nanded district (Maharastra). The difference in water temperature found in this study may be due to climatic factors ,effect of seasons and times of collection or due to the air temperature as reported by Jayaraman *et al*[14] and Tiwari *et al*[32].

pH of water is a measure of hydrogen ion concentration in water and indicates whether the water is acidic or alkaline. Water pH affects metabolism and physiological activities of aquatic organisms. A water pH in the range of 6.0 to 9.0 is best for growth. In the present study, water pH ranged between 6.9 at site-II and 7.5 at site-I which is as per desired limits of WHO and BIS standards. pH was high during summer season (7.5) at site I and low during winter (6.9) at site II.

The turbidity of water ranged between 89 to 222 NTU. The turbidity was recorded maximum 222 NTU in rainy months whereas, minimum value was recorded with 89 NTU in

winter months. Monsoon generally causes high turbulence and mixing of water leading to an increasing the concentration of total solids including suspended particulate matter (SPM). Study of similar lines Kamble *et al*.[17] recorded turbidity ranged from 230 to 289 NTU in Ruti dam of Maharashtra.

Electrical conductivity (EC) is the capacity of the solution to conduct electricity. The lowest EC value in the rainy season was probably due to rainfall in the catchment area. The present results are in conformity with the earlier works of Pandey and Pandey[24].

Dissolved oxygen (DO) is a basic requirement for a healthy aquatic ecosystem. Mixing helps in exchanges of oxygen. In the absence of adequate mixing oxygen levels become reduced including the formation of layers of differing oxygen concentrations. Discharge of wastes, excessive plant growth, and decomposition of plant material can reduce the oxygen concentration in the water. In the present investigation, DO level varied from 2.84 mg/L at site-I to 6.8 mg/l at site-II. DO was maximum during rainy season and minimum during summer in both the sites of the tank. The main source of DO is from dissolution from atmosphere and the photosynthesis[17]. Further, concentration of DO is inversely proportional to temperature at a given time[4,25] and the present investigation resemble their observations indicating that the higher temperature of the tank water decreased the solubility of oxygen at all two sampling sites.

Seasonally, Caslcium and Magnesium contents were high during rainy season and low during rainy/summer season in both the sites. The average calcium concentration in the water body varied from 13.45 to 28.5 mg/ L. The results indicate that the samples were well below the permissible limits of BIS and WHO. The permissible limit is 75 mg/I. Calcium is responsible for hardness of water and the addition of calcium in the fresh water system indicates that no removal has taken place; instead it has precipitated in the lake water as the ionic strength has increased[12]. The magnesium concentration in the present study was also found (10.45-17.25 mg/L) to be well within the permissible limit. The major cations present in natural waters have calcium and magnesium. Its concentration restricts water use, while it is an important component in the exoskeletons of arthropods and shells in mollusks[7,27]. Next to calcium another dominant cation in natural water is magnesium added to the lakes, by leaching of rocks in the catchments. It is vital component of chlorophyll. High concentration of magnesium imparts unpleasant taste to the drinking water[27].

Chloride content of water is one of the important ecological factors, which influences the functional physiology and reproductive activity of organisms[2,18] there by affecting distribution of planktons and animals. Chloride level as high as 250 mg/I (< 250g /I) is safe for human consumption, a level above this imparts salty taste to potable water The chloride contents of water samples ranged between 39.5 mg/L at site-I to 49.7 mg/I at site-II. Chloride content of water in Tamma-dihalli tank remained below the prescribed limits of BIS and WHO standards throughout the study period. Chloride levels were maximum during rainy season and minimum during summer season in both sites of the tank.

Total alkalinity is that the total concentration & bases in water of calcium carbonate . These bases are usually bicarbonates and carbonates, and that they act as a buffer system that forestalls drastic changes in pH. Greater production in tanks is attained in high alkalinity waters because this pH buffering capacity makes phosphorus and other essential nutrients more available to the algal bloom. Total alkalinity isn't the identical as hardness. Calcium and magnesium are primarily accountable for hardness. However, in most waters, alkalinity and hardness have similar values because the carbonates and bicarbonates chargeable for total alkalinity are usually brought into the water within the type of carbonate or magnesium carbonate. Waters with high total alkalinity aren't always hard, since the carbonates are often brought into the water within the variety of sodium or carbonate[21].

The alkalinity values ranged from 62.2 mg/L to 73.5 mg/L at site-II. The low and high alkalinity were recorded at site-II within the season, this can be because the inflow of

Table-1. Comparison of Hydrological characteristics of Tammadihalli tank water with WHO and BIS standards

Parameter	Site-I (Near inlet)	Site-II (Middle of the tank	WHO permissible limits	BIS permissible limits
Air temperatur	28.5	28.5	25.0	-
Water temperature	26.5	26.0	40.0	-
pH	7.2	6.9	6.5-8.5	6.5-8.5
Electrical conductivity	150	165	1500.0	-
Total Dissolved solids	62.8	63.7	500.0	2000.0
Turbidity	47	45	05.0	-
Acidity	5.0	6.0	-	-
Total Alkalinity	70.0	62.0	30.0	600.0
Dissolved Oxygen	4.2	5.6	4.7	-
Biochemical oxygen demand	3.34	2.8	30.0	-
Total hardness	54	52	200.0	600.0
Calcium	23.63	24.03	75.0	200.0
Magnesium	8.41	10.82	150.0	100.0
Chloride	34.11	36.95	200.0	1000.0
Sulphate	43.44	41.92	200.0	400.0
Phosphate	0.02	0.04	0.1	-
Nitrate	0.05	0.04	45.0	100.0

All the parameters are expressed in mg/L except air and water temperature (^oC), pH, turibidity (NTU) and electrical conductivity (μ mhos/cm).

more rain water in to the tank. The alkalinity is additionally directly proportional to the productivity of the water body. The high alkalinity is in winter and summer months, may cause higher productivity in these months. the identical results were also reported by Jain *et al.*[11] and Vasumathi reddy *et. al.*[34]. BOD has been to measure the organic material load in an aquatic ecosystem which support the expansion of micro organisms. within the present study, BOD levels varied from 2.2 to 6.2 mg /L and it had been minimum at site-I. it had been maximum in summer months and minimum during winter season in both the sites of the water body. Hence, the BOD values were within the bounds of WHO and BIS standards for irrigation and fish culture. Kamble *et al.*[17] were recorded the high BOD values (7.5-28.0 mg/L) from Ruti dam of Maharashtra.

Sulphates are the anion present all varieties of natural water bodies[1] and primarily associated with the categories of minerals found in watershed and are carried in to the water body by rainfall[36]. The permissible limit for sulphate is 200 mg/I. within the present study, the sulphate content varied from 39.05-51.35 mg/l. The values of the sulphate all told the water samples were within the permissible limit. Similar report was recorded by the studies of Mazher Sultana and Dawood Sharief[22]. Sulphate contents were high during time of year and low during winter season in both the sites of the water body.

The phosphate concentration in water samples varied from 0.02- 0.06 mg/L. Higher values are recorded during post monsoon and summer months. Higher concentration of salt is also because of acidic and basic salt in water of the tank[7]. The permissible limit for phosphate is 0.1 mg/I. During post monsoon periods high values of phosphate were recorded. This was contributed by the surface escape, draining the agricultural fields and mixing with the influent water of the reservoir. Mazher Sultana and Dawood Sharief[22] in Double Lake reported maximum phosphate in monsoon. Phosphate is that the key nutrient within the productivity of water in water bodies[27].

Nitrogen doesn't occur naturally in soil minerals, but could be a major component of all organic matter (both plant and animal). Decomposing organic matter releases ammonia, which is converted to nitrate if oxygen is present[3,7]. This conversion occurs earlier at higher water temperatures[6]. The denitrification reaction is being investigated because the means of reducing pollution from septic systems. Within the present study the nitrate content is found to varied from 0.03 to 0.08 mg/I and be within the permissible limit (45 mg/l). Within the present study, nitrate level was maximum with 0.08 mg/L at site-I during rainy season and minimum during winter season with 0.03 mg/L at site I.

Total Dissolved Solids (TDS) could be a measure of the combined content of all inorganic and organic substances contained in an exceedingly liquid in: molecular, ionized or micro-granular (colloidal sol) suspended form. Total dissolved solids are normally discussed just for freshwater systems, as salinity comprises a number of the ions constituting the definition of TDS. The principal application of TDS is within the study of water quality for streams, rivers and lakes, although TDS isn't generally considered a primary pollutant

(e.g. it's not deemed to be related to health effects) it's used as a sign of aesthetic characteristics of drinkable and as an aggregate indicator of the presence of a broad array of chemical contaminants[15]. Primary sources for TDS in receiving waters are agricultural and runoff, leaching of soil contamination and beginning pollution.

The foremost common chemical constituents are calcium, phosphates, nitrates, sodium, potassium and chloride, which are found in nutrient runoff, and general stormwater runoff. The chemicals is also cations, anions, molecules or agglomerations on the order of one thousand or fewer molecules, as a soluble micro-granule is created. Certain total dissolved solids arise from the weathering and dissolution of rocks and soils. Within the present investigation, TDS level varied from 50.5 mg/I at site I to 79 mg/L at site-II and it's found to be within the permissible limits of WHO standards (500 mg/ L). TDS levels were high during rainy season and low during summer season in both sites.

Hardness is defined because the concentration of multivalent metallic cations in solution. The hardness of water varies from place to put. In general, surface water bodies is softer than water. The hardness of water reflects the character of natural object with which it's been in touch[8]. Seasonally, hardness was maximum during summer season and minimum during winter season in both sites. Within the present study, value of total hardness ranged from 49.84 to 59.5 mg/l when put next to numerous standards, this water samples are well above the permissible limit of WHO and both the sites of the tank included under soft category as per hardness classification. Similar findings were reported by Mazher Sultana & Dawood Sharief[22,23].

The acidity of a water is caused by mineral acids, CO_2 and salts of strong acids and weak bases. Acidity levels in water indicate its corrosive properties and may take a number one role in regulating biological processes likewise as in chemical reactions (such as chemical coagulation and flocculation). While both acidity and alkalinity are associated with pH, they must not be confused with pH, nor should the terms be used interchangeably. Acidity may be a measure of a solution's capacity to react with a powerful base (usually caustic soda) to a re determined pH value. This measurement relies on the entire acidic constituent of an answer (strong and weak acids, hydrolyzing salts, etc.) it's possible to own highly acidic water but have moderate pH values. Likewise, the pH of a sample are often very low but have a comparatively low acidity. Acidity is analogous to a buffer in this the upper the acidity, the more neutralizer is required to counteract it[31]. In the current study, acidity values varied from a minimum of 5.01 mg/L at site-II to a maximum of 7.2 mg/L at site-II respectively. Acidity within the water samples showed maximum during summer with 7.20 mg/L at site-II and minimum during winter at site-II with 5.01 mg/L.

Thirumala and Kiran[30] have studied the Avaragere lake in Davangere for Physico-chemical and trace metal parameters at five sites, for a period of six months. This water body has been subjected to human activities periodically and water quality is deteriorated intensely. Agriculture, industrial activities and

discharging of sewage creates serious threat to the biota of the lake by altering the water quality. One-way ANOVA was calculated to know the significant difference between the samples.

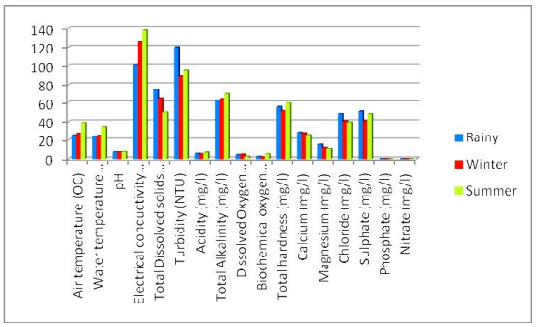

Fig. 2: Seasonal variations in physico-chemical characteristics of Tammadihalli tank water at site-I

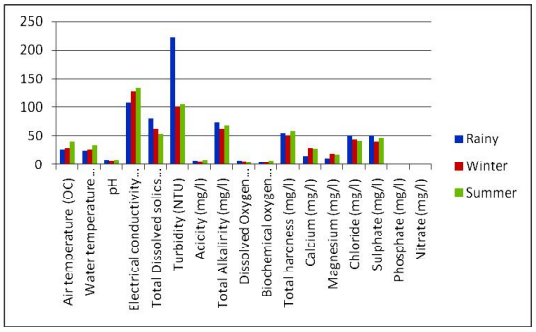

Fig. 3: Seasonal variations in physico-chemical characteristics of Tammadihalli tank water at site-II

Fish composition :

In this water body the fishes recorded were *Cyprinus carpio, Cirrhinus mrigala, Labeo rohita, Catla catla, Labeo calbasu, Salmophasia sp, Cirrhinus fulungee, Ctenopharyngodon idella, Channa punctatus, Puntius Sp. Ambassis kopsii, Labeo fimbriatus, Hypophthalmichthys molitrix, Clarias batrachus.*

Kiran and Nagaraj Parisara[19] have studied the fish fauna of the Shanthinagar pond, Karnataka in relation to physico-chemical parameters. The water of the pond is used for fishery and agriculture. They recorded 14 fishes belonging to 03 orders and o4 families. Among fish families Cyprinidae consists of 11 species and Channidae, Ambassidae, Clarridae with 01 species each. The maximum species contribution was made by family Cyprinidae. Their results indicated that higher trophic status of the pond can be attributed to anthropogenic pressure.

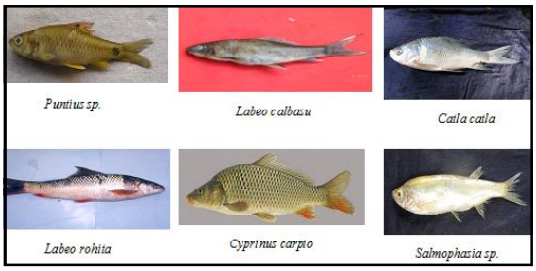

Fig 4: Fresh water fishes in Tammadihalli tank

Statistical analysis: One-way ANOVA with post-hoc Tukey HSD Test :

p-value is 0.9168 and the F-statistic of one-way ANOVA is higher than 0.05. Even though data does not suggest the presence of significantly different treatment pairs in one-way ANOVA, proceed with the multiple comparison tests. In Tukey HSD test, the p-value consequent to the F-statistic of one-way ANOVA is lower than 0.05.

Maximum turbidity within the water body indicate that higher rainfall within the study area. Thus within the present study, concludes that the tank isn't polluted, as all the parameters except turbidity are within

Table-1. One way ANOVA for hydrological characteristics of Tammadihalli tank

Treatment →	A (Rainy)	B (Winter)	C (Summer)	D (Average for both the sites)	Pooled Total
Observations	34	34	34	34	136
Sum ∑xi	1,360.4900	1,189.2920	1,274.9750	1,145.5000	4,970.2570
Mean $\bar{x}$	40.0144	34.9792	37.4993	33.6912	36.5460
Sum of squares ∑x2i	126,625.9977	82,693.0700	93,839.6116	87,052.4646	390,211.1439
Sample variance s2	2,187.4785	1,245.2308	1,394.8178	1,468.4613	1,544.9489
Sample std. Dev. S	46.7705	35.2878	37.3473	38.3205	39.3058
Std. Dev. Of mean	8.0211	6.0518	6.4050	6.5719	3.3704

Table-2. One-way ANOVA of independent treatments

Source	Sum of squares S	Degrees of freedom ν	Mean square MS	F statistic	p-value
Treatment	800.4806	3	266.8269	0.1695	0.9168
Error	207,767.6145	132	1,573.9971		
Total	208,568.0951	135			

permissible limit compared with WHO and BIS standards and therefore the water quality parameters indicate that the tank is in moderately mesotrophic stage. The water from this tank is beneficial for irrigation and pisciculture. From this observed water quality parameters it's concluded that the nutrient load within the tank is at moderate levels. the information certainly justifies the necessity to require up an in depth study on the impact of some trace metals on the freshwater lentic system of Tammadihalli tank, should be obsessed for the further study in future. an everyday monitoring of tank water quality is important. it's advocated to require urgent steps by governmental and NGO organizations to protection of this precious natural wealth.

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