Indian J. Applied & Pure Bio. Vol. 39(3), 1870-1879 (2024). **ISSN: 0970-2091**
A web of Science Journal

Water quality surveillance of a fresh water pond in Shivamogga taluk of Karnataka

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Abstract

Appraisal of physico-chemical characteristics of water in two sampling sites in fresh water Santhekadur pond of Shivamogga taluk, Karnataka was carried out during February 2017 to October 2018. This water body is situated 5 Km away from Shivamogga with the total area of about 8 hectares. Several water quality parameters were estimated as per standard procedure and compared with WHO and BIS standards. The water temperature was between 22.5^{O} and 32.5^{O} C. pH of the water ranged from 6.70 in site II to 7.12 in site I, which is in the desired limit values of WHO and BIS standards. The turbidity of water ranged 89 to 125 NTU. The lowest EC value in the rainy season. The oxygen content varied between 2.54 mg/l in site I and 6.8 mg/l in site II. The calcium concentration in water varied between 15.85 and 20.25 mg/L. Magnesium concentrations (5.9-10.76 mg/L) was also within acceptable limits. The chloride content ranged from 14.7 mg/l at Site II to 38.7 mg/l at Site I, Alkalinity ranged from 52.5 mg/L at site I to 64.5 mg/L at site II, with lower alkalinity at site I due to increased rainwater inflow into the pond during the rainy season. BOD values varied between 1.93 and 5.8 mg/L and were lowest at site I. Sulfate content varied between 30.05 and 40.48 mg/L Phosphate concentrations in water samples varied from 0.018 to 0.05 mg/L. Nitrate content was highest with 0.8 mg/L at site II during the rainy season and lowest with 0.025 mg/L at the site I during the winter season. TDS content varied between 40.6 mg/l at site I and 68 mg/l at site II, The total hardness values compared with different standards were 40.8–49.5 mg/l. Acidity levels varied from a minimum of 3.98 mg/L at site I to a maximum of 6.4 mg/L at site II. Water quality is influenced by environmental factors, which cause variations in nutrients. Seasonal variations in water quality are due to extrinsic and intrinsic factors of the water body. The physico-chemical analysis of water in this pond showed that the water is within the safe limits of irrigation, fisheries and is included under mesotrophic category.

Key words : Santhekadur pond, physico-chemical characteristics, Shivamogga taluk,

Water quality is the physico-chemical and biological description of water [5]. The most common standards used to assess water quality relate to drinking water, irrigation, fisheries, safety of human contact and for the health of ecosystems.

Water quality in ponds are controlled by natural processes and human influences. Natural factors such as the source of water in the pond, rock and soil type in the watershed influence some of the water quality characteristics. Rather, the most serious water quality problems arise from land use or other activities at or near bodies of water. The effects of these activities can often be minimized through early detection of problems through proper pond management and testing[34]. The physical and chemical components of aquatic organisms and their environment are closely linked and interact. Water currents and water chemistry are the main determinants of life in aquatic habitats, and both are closely related to seasonal fluctuations.

Studies on the variations in the hydrological conditions of water body constitute an important aspect of fishery research especially in view of the fact that chemical environment exerts a considerable influence on the aquatic organisms. The physico-chemical characteristics are very important in study of any environment, especially aquatic environment. Apart from the general 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 also have practical implications in the pollution studies[22]. The main objectives of the present study is to know the physico-chemical characteristics of pond water and compared with WHO[41] as well as BIS [9] standards and to find out the suitability of water for drinking and fisheries.

Study area profile :

Santhekadur pond is situated at Latitude of 13° 52' N, Longitude 75° 45' E in the Shivamogga city at the distance of 5 km respectively.

Figure 1. Study area map

Regular sampling of the Santhekadur pond water was made from the Shivamogga district during February 2017 to October 2018. The physico-chemical parameters like pH, temperature and dissolved oxygen were recorded at the sampling spot itself. pH was recorded by pocket 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 turbidity meter. Other parameters

were estimated in the laboratory using standard methods of Trivedy and Goel[38] and APHA[1].

Statistical analysis :

One-way ANOVA with post-Hoc Tukey HSD with Bonferroni and Holm multiple tests for physico-chemical characteristics of Santhekadur pond water is analysed by statistical software of astatsa.com

Seasonal fluctuations in physico-chemical characteristics of Santhekadur pond water at sites-I and II is depicted in Table-1 and Figure 2. The physico-chemical properties of any aquatic ecosystem have a significant impact on its biological components. Controls species diversity, biomass, and community distribution. Physical and chemical properties influence individually and collectively, and their interactions create an abiotic environment that ultimately determines the emergence, development, and eventual succession of biological communities[22].

Air temperatures ranged from 26°C to 39.5°C, with an average of 28°C. It was highest during the summer. Temperature is important and plays an important role in the environment. The water temperature was measured between 22.5^{O} and 32.5^{O} The highest water temperatures were in April and May. Seasonally, water temperatures were highest at site II during the summer season (32.5 °C) and lowest at site I during the rainy season at 22.5 °C. Water temperature is the most important factor influencing the chemical, biochemical and biological properties of water bodies. A similar study on water temperature was observed by Pawar and Pulle[30] at Petwadaj dam in Nanded district (Maharastra). The water temperature variations found in this study could be due to normal climate variations, seasonal effects, differences in water sampling timing, or, as suggested by Jayaraman *et al*.,[13]. Atmospheric temperature effects reported by Tiwari *et al.*[36].

The pH value of water is a measure of the hydrogen ion concentration in the water and indicates whether the water is acidic or alkaline. The pH value of water affects the metabolism and physiological activities of aquatic organisms. A water pH range of 6.0 to 9.0 is optimal for growth. In this study, the pH of the water ranged from 6.70 in site II to 7.12 in site I, which corresponds to the desired limit values of WHO and BIS standards. pH was higher in the rainy season at site I (7.12) and lower at site II during the winter (6.66). The EPA criteria for pH are 6.5-9.0 for fish life. The findings are similar to Kataria[18], Rama *et al*.,[32].

The turbidity of water ranges between 89 to 125 NTU. The turbidity was recorded maximum 125 NTU in rainy months whereas, minimum value was recorded in the month of January. Monsoon generally causes high turbulence and mixing of water leading to an increasing the concentration of total solids including suspended particulate matter . Study of similar lines Kamble *et al*.,[16], recorded turbidity ranged from 230 to 289 NTU in Ruti dam of Maharashtra. WHO recommended turbidity value of 5.0 NTU and Indian standards recommends 10 NTU in drinking water[9]. High turbidity of 85 NTU in river water was reported by Trivedi[37] after flowing

of industrial wastes, However, Kataria[19] also noted 12.8 -180 NTU in Betwa river. The surface run off resulted in increasing the turbidity value during monsoon.

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[28] reported ECvalue of 150 -256 µmhos/cm in Hathainkheda dam water. Higher the concentration of salts in water, a higher will be the EC. No acceptable limit has been set up for EC in drinking water.

Dissolved oxygen (DO) is a fundamental requirement for healthy aquatic ecosystems. The amount of oxygen available to aquatic organisms depends on factors that affect the solubility of oxygen in water. When water is mixed, oxygen is exchanged with air. If sufficient mixing does not occur, the oxygen content will decrease, such as the formation of layers with different oxygen concentrations. Excretion of waste products and excessive plant growth due to nutrient enrichment, followed by death and decay of plant material. This consumes a large amount of oxygen and reduces the oxygen concentration in the water. In this study, the oxygen content varied between 2.54 mg/l in site I and 6.8 mg/l in site II, and the oxygen content in both locations of the pond was maximum in the monsoon season and least in hot summer. The main sources of DO are dissolution from the atmosphere and photosynthesis[16]. This is because the oxygen content in a water sample depends on the water temperature, the partial pressure of gases in contact with the water, the concentration of dissolved salts, biological activity, and the geology of the river basin. Additionally, the DO concentration at a given time is inversely proportional to temperature[4,29] and the present study resemble their observations showing that the higher the temperature. is similar to Oxygen solubility decreased at every second sampling site. Oxygen is soluble in good quality water[21] with 7 mg/L at 30°C. Similar findings were reported by Vaishnav and Sahu[39].

Seasonally, the calcium and magnesium contents of both locations were higher in the rainy season and lower in the summer. The average calcium concentration in water varied between 15.85 and 20.25 mg/L. The results show that the sample was significantly below the WHO[41] acceptance limits. The permissible limit is 75 mg/l. Calcium is responsible for water hardness, and addition of calcium to freshwater systems indicates that removal is not occurring. Instead, it precipitated in the lake water as the ionic strength increased[12]. Magnesium concentrations in this study (5.9– 10.76 mg/L) were also well within acceptable limits. The most important cations found in natural water are calcium and magnesium. Its main source is leaching of rocks in the watershed. While its concentration limits water consumption, it is also an important component of the exoskeleton of arthropod and mussel shells[7,31]. In addition to calcium, magnesium is also a major cation in natural waters and is added to lakes by leaching from rocks in the watershed. It is an important component of chlorophyll. Very high concentrations of magnesium give drinking water an unpleasant taste[31].

The chloride content of water is one of the important ecological factors that

influences the functional physiology and reproductive activities of the organisms living there by influencing the distribution of plankton and animals[2,20]. Chloride content up to 250 mg/l (< 250 g/l) is safe for human consumption, but above this it adds a salty taste to drinking water. The chloride content of the water samples ranged from 14.7 mg/l at Site II to 38.7 mg/l at Site I, and the chloride content of water in the Santécadour pond was within the BIS and WHO standards throughout the study period. was below the agreed limit. At pond locations, chloride levels were highest in rainy season and lowest in the summer. Desirable limit for chloride is 250 mg/L by ISI [9].

Total alkalinity is the total concentration of calcium carbonate and base in water. These bases are typically bicarbonate and carbonate, which act as a buffer system to prevent rapid pH changes. Water with high total alkalinity is not necessarily hard water, as carbonates can be introduced into the water in the form of sodium or potassium carbonate[23]. Alkalinity ranged from 52.5 mg/L at site I to 64.5 mg/L at site II, with lower alkalinity at site I due to increased rainwater inflow into the pond during the rainy season. Alkalinity is also directly proportional to the productivity of a water body. Winter and summer are more alkaline, making these months more productive. The same results were also reported by Jain *et al*.[10,11] and Vasumathi Reddy *et al*.,[40].

BOD was used to measure organic matter loading in aquatic ecosystems that support microbial growth. In this study, BOD values varied between 1.93 and 5.8 mg/L and were lowest at site I. In both watershed locations, water levels were highest in summer and lowest in winter. Therefore, the BOD values were within the WHO and BIS standards for irrigation and aquaculture. Kumble *et al.*, (2009) recorded high BOD levels (7.5–28.0 mg/L) in Luthi dam, Maharashtra. BOD depicts the pollution of water due to organic source. In summer season the volume of pond water decreases and increases of concentration of organic matter.

Sulfate is a natural anion present in all types of natural water bodies[1], mainly occurring in watersheds and associated with the types of minerals that enter water bodies through precipitation[42]. The permissible limit for sulfates is 200 mg/l. In this study, the sulfate content varied between 30.05 and 40.48 mg/L. Sulfate values were within acceptable limits for all water samples. A similar report was also recorded in the study of Mazher Sultana and Dawood Sharief [24]. At both watershed locations, sulfate levels were higher during the rainy season and lower during the winter.

Phosphate concentrations in water samples varied between 0.018 and 0.05 mg/L. Higher values are measured during summer months. High salinity may be due to acidic and alkaline salts present in pond water[7,17]. The permissible limit for phosphate is 0.1 mg/l. High phosphate levels were recorded during the post-monsoon period. Contributing to this was surface water, which drained farmland and mixed with inflows from reservoirs. Mazher Sultana and Dawood Sharief [24,25] reported maximum monsoon phosphate levels in Double Lake. Phosphate is an important nutrient for water productivity in aquatic environments[31]. The findings are similar with Kataria[19] noted the phosphate ranged from 0.064 -1.04 ppm

in Tawa reservoir.

When organic matter decomposes, ammonia is released and is converted to nitrate in the presence of oxygen[3,7]. This conversion occurs more rapidly at higher water temperatures[6] Some bacteria convert nitrate back into nitrogen gas under anaerobic conditions in the presence of soluble organic matter. This reaction, called denitrification, is one of the main ways nitrogen is lost from certain lakes and some soils. This reaction is being studied as a means to reduce pollution in septic ponds. In the present study, nitrate content was found to vary between 0.026 and 0.8 mg/l, well within the permissible limit (45 mg/l). In this study, nitrate content was highest with 0.8 mg/L at site II during the rainy season and lowest at 0.025 mg/L at the site I during the winter season. Kataria[19] noted 0.2 - 0.8 ppm nitrate in Kolar reservoir and 0.030-1.48 mg/L in Tawa reservoir. Kataria[18] reported nitrate in the range of 0.08 -0.48 ppm in drinking water of Piparia.

Total dissolved solids (TDS) is a measure of the total content of all inorganic and organic substances in a liquid in molecular, ionized, or particulate (colloidal sol) suspension. Total dissolved solids is usually only discussed for freshwater systems because salinity includes some of the ions that form the definition of TDS. The primary use of TDS is the study of water quality in streams, rivers, and lakes. Although TDS is generally not considered a major pollutant (*e.g.*, it is not thought to have health effects), it is used as an indicator of the aesthetic properties of drinking water and as a component of a wide range of chemical

Table-1. Descriptive statistics and One way ANOVA of water parameters

Treatment	A(pH, EC,Tur)	B(TA,DO, BOD)	C(TH, Ca,Mg)	D(SO_4, PO_4,NO_3)	Pooled Total
Sum	474.4700	185.5800	194.8900	97.9600	952.9000
Mean	52.7189	20.6200	21.6544	10.8844	26.4694
Sum of squares	43,346.9329	8,687.2922	6,406.3183	3,186.8874	61,627.4308
Sample variance	2,291.6752	607.5791	273.2605	265.0809	1,040.1342
Sample std. Dev.	47.8714	24.6491	16.5306	16.2813	32.2511
Std. Dev. of mean	15.9571	8.2164	5.5102	5.4271	5.3752

Source	Sum of squares	Degrees of freedom	Mean square	F value	P-value
Treatment	8,903.9321	3	2,967.9774	3.4536	0.0279
Error	27,500.7651	32	859.3989		
Total	36,404.6972	35			

Tabl-2. Tukey HSD data

Treatment pair	Tukey HSD q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	3.2848	0.1141370	insignificant
A vs C	3.1790	0.1320538	insignificant
A vs D	4.2811	0.0238000	* p<0.05
B vs C	0.1059	0.8999947	insignificant
B vs D	0.9963	0.8911720	insignificant
C vs D	1.1021	0.8499004	insignificant

Table-3. Bonferroni and Holm data: only pairs relative to pH, EC, Turbidity are simultaneously compared

Treatments pair	Bonferroni and Holm T statistic	Bonfer-ronip-value	Bonferroni inference	Holm p-value	Holm inference
A vs B	2.3227	0.0801314	insignificant	0.0534209	insignificant
A vs C	2.2479	0.0948172	insignificant	0.0316057	* p<0.05
A vs D	3.0272	0.0145364	* p<0.05	0.0145364	* p<0.05

contaminants. It is used as an overall indicator of presence[14]. The main sources of TDS in receiving waters are agricultural and urban runoff, leaching of soil contaminants, and point source water pollution. The most common chemical components are calcium, phosphate, nitrate, sodium, potassium, and chloride, which are found in nutrient runoff and general stormwater runoff. The chemical may be a cation, anion, a molecule, or an aggregate of up to 1,000 molecules, as long as soluble particulates are formed. Certain naturally occurring total solids are formed by the weathering and dissolution of rocks and soils. In the present study, the TDS content varied between 40.6 mg/l at site I and 68 mg/l at site II, which was within the permissible limit of WHO standards (500 mg/l). In both locations, TDS levels were higher during the rainy season and lower during the summer. Kataria[19] reported TDS ranged from 132 -198 mg/L in Tawa reservoir of Hoshangabad district.

Water hardness varies depending on location. Generally, surface water is softer than groundwater. The hardness of water reflects the nature of the geological formations it comes into contact with[8]. Seasonally, in both locations, harshness was highest in summer and lowest in winter. In this study, the total hardness values compared with different standards were 40.8–49.5 mg/l. The available water samples were well above the WHO [41] permissible limits and both pond locations were classified in the "soft" category in each hardness class. Similar results were reported by Mazher Sultana and Dawood Sharief [24], Raina *et al.*,[32] recorded total

hardness in Jhelam river ranged from 80.6 to 20.36 mg/L.

Water acidity is caused by mineral acids, carbon dioxide, and salts of strong acids and weak bases. The acidity of water indicates its corrosive properties and can play a leading role in controlling biological processes and chemical reactions (such as chemical coagulation and flocculation). Acidity and alkalinity are both related to pH, but should not be confused with pH or use the same terms. Acidity is a measure of a solution's ability to react with a strong base (usually sodium hydroxide, NaOH) to a new set pH. This measurement is based on the total acidic content of the solution (strong and weak acids, hydrolyzed salts, etc.). Water may be present that is highly acidic but has a medium pH level. Similarly, a sample may have a very low pH but a relatively low acidity. The higher the acidity, the more neutralizing agent is required to counteract it[35]. In the current study, acidity levels varied from a minimum of 3.98 mg/L at site I to a maximum of 6.4 mg/L at site II. The acidity of water samples showed a maximum value in summer at Site II. The lowest winter value of 4.02 mg/L at Site I. Singh and Kataria[33] have attempted to assess water quality of 'Kaliyasot dam' for a period of one year during three seasons. The various physico-chemical parameter shows that Kaliyasot reservoir (Madhya Pradesh) water was affected by various human activities domestic wastes effluents Their result has concluded that the water of Kaliyasot dam is less polluted and is suitable for irrigation purpose. Padmanabh Dwivedi and Santosi Sonar[27] reported the physico-chemical and biological parameters in water reservoir around hills, Doimukh (Dist. Papum pare) Arunachal Pradesh,

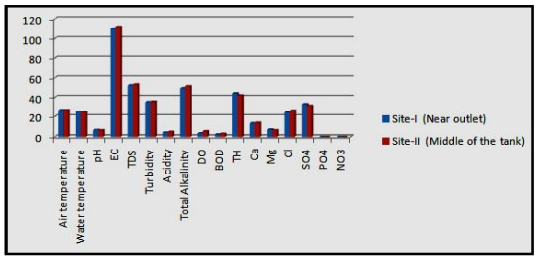

Figure 2. Average physico-chemical characteristics of Santhekadur pond water

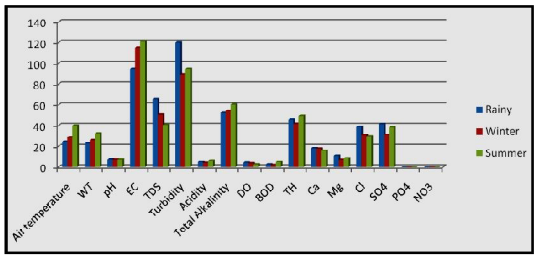

Figure 3. Seasonal variations in physico-chemical characteristics of Santhekadur pond water at site-I

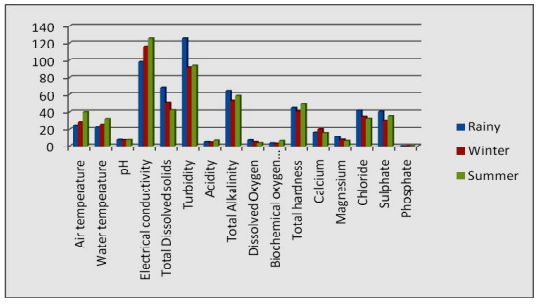

Figure 4. Seasonal variations in physico-chemical characteristics of Santhekadur pond water at site-II (All the parameters are expressed in mg/L except air and water temperature (°C), pH, turbidity (NTU) and electrical conductivity (µmhos/cm)

One-way ANOVA with post-hoc Tukey HSD Test with Bonferroni and Holm multiple tests for physico-chemical characteristics of Santhekadur pond water :

The results are depicted in Tables-1 to 3 and Figs. 2-4. The p-value is < than 0.05, suggesting that treatments are significantly different.

Maximum turbidity of the water body indicates high rainfall and surface runoff in the study area. Hence, the current study concludes that the pond is not polluted as most of the parameters except turbidity are within acceptable limits as compared to WHO, NEERI[26] and ISI standards and the water quality parameters indicate that the pond is at mesotrophic stage. Water is suitable for irrigation and fish culture. From the present observed water quality parameters it can be concluded that the nutrient load of the pond is moderate. This data undoubtedly justifies the need for a detailed study on the impact of water quality parameters on Santhekadur freshwater pond and further studies should be carried out in future. Regular monitoring of pond water quality is essential, and government and non-governmental organizations are calling for urgent action to protect this valuable natural resource.

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