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Study of seasonal water quality assessment and fish pond conservation in Thanjavur, Tamil Nadu, India

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Abstract
Life on the earth is never possible without water. Water is one of the essential constituents of the environments. This study was designed to assess the quality of pond's water in Thittai panchayath village, Thanjavur District in Tamilnadu state has been evaluated on a seasonal basis from July 2015 to June 2016. The water Samples were analyzed for various physico-chemical characteristics like Colour, odor, turbidity, temperature, pH, DO, BOD, COD,Co_2 ,salinity, total alkalinity and total hardness etc. The following ranges were obtained for the parameter assessed. pH(7.1-8.5), Temperature (26.9-31.9^{0}C) Electrical conductivity(290.30-405.10µs/cm), Dissolved oxygen (6.5-7.9mg/L), BOD (4.5-6.0mg/L), COD (4.8-7.0mg/L), CO_2 (4.2-5.9mg/lit), Calcium (78-108 mg/dl), Magnesium (58-73mg/dl), Salinity (10-19ppt),Total Alkalinity (68-95mg/l),Nitrate (3.0-4.1mg/l) and Chloride (15.3-39.8mg/l).The experimental values of various physico-chemical parameters of water samples results were largely within the WHO and ICMR standards limits. This study will aid fish farmers on the necessary treatment needed to effectively use water from this source for fish farming.

Keywords: Freshwater pond, Physico-chemical characters, Alkalinity and Hardness

Introduction
Water is one of the most important and most precious natural resources. It is essential in the life of all living organisms from the simplest plant and microorganisms to the most complex living system known as the human body. Water quality analysis is one of the most important aspects in water studies. Determination of physico-chemical characteristics of water is essential for assessing the suitability of water for various purposes like drinking, domestic, industrial, irrigation and pisciculture [1]. Fish is an inexpensive source of protein and an important cash crop in many regions of world and water is the physical support in which they carry out their life functions such as feeding, swimming, breeding, digestion and excretion [2]. Water quality is determined by various physico-chemical and biological factors, as they may directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals [2]. A sharp drop or increases within these limits have adverse effects on their body functions [4]. So, good water quality is essential for survival and growth of fish. Water quality is not constant; varies with the time of the day, season, weather conditions, water source, soil type, temperature, stocking density, and feeding rate and culture systems. For a successful aquaculture venture, the dynamics and management of water quality in culture media must be taken into consideration [2]

Ponds are important wetlands located in and around human habitations as they are generally semi natural ecosystems constructed by man in landscape suitable for water stagnation. It is also referred to as a man-made or natural water body. The Earthen pond culture system has been the conventional method of fish culture in India. Due to uncontrolled increase in human population and development of township at large, these freshwater bodies are under tremendous pressure owing to their overuse on one hand and enrichment due to nutrients and organic matter on the other, leading to the cultural eutrophication [5].In most of the countries, fishes are cultivated in ponds (lentic water) but unfortunately such culturists are not so aware of importance of water quality management in fisheries. If they are properly guided and make aware about water quality management practices, they can get maximum fish yield in their ponds to a greater extent through applying low input cost and getting high output of fish yield [5]. Hence the present attempt has been made to assess the suitability of the physico-chemical characteristics of this pond water for pisciculture.

Material and Methods

Study area

This investigation was carried out to evaluate the status of the Himalayan water pond in Thanjavur district. It is situated between 10º08' to 11º12 North Latitude and 78º48' to 79º38' East Longitude (Fig.1). The water of this pond is used for agriculture, fisheries and partially domestic activities. The present study was conducted to analyze physico-chemical properties of water in the period of one year from July 2015 to Jun 2016.

Sample collection

The water samples were collected from Himalayan pond of Thittai village, Thanjavur district at monthly intervals from July 2015 to Jun 2016 during 7.00 – 9.00 am in fresh unsullied plastic bottles. The closed bottle was dipped into the water and then the cap is opened and water is allowed to fill up the bottle absolutely. The cap is then closed and the bottle is brought out of the water. The method adopted for different physico-chemical parameters were followed according to the procedure described in the APHA, AWWA and WPCF 1998 [6]. The Physico-Chemical parameters were analyzed by

1. pH: by Digital pH meter
2. Temp: by Thermometers
3. Turbidity: by Nephello Turbid Meter
4. DO: Using standard Winkler method by titration
5. Electrical conductance: Conductometer
6. CO_2: By titration method
7. Alkalinity: By titration method
8. Cl: By titration method
9. Total hardness: by using EDTA complexometric by titration
10. BOD: By titration
11. COD: Open condensation and digestion by titration
12. Nitrate: Phenoldisulphonic acid method

Fig 1: Map showing study area

Result and Discussion

Colour

Colour is an important parameter for any aquatic water body and indicates the purity of the water. National Agricultural Extension and Research states pale color, light greenish or greenish waters suitable for fish culture. Delince (1992) stated that the abundance of phytoplankton and zooplankton is responsible for the determination of the color of an aquatic body and Green, bluish green/ brown greenish color of water indicates good plankton population hence, good for fish health [7]. In the present study, the pond water color is light green so the pond water is good for fish productivity.

pH

This is the negative logarithm of hydrogen ion concentration [8]. This value is an indication of the level of acidity or alkalinity of a solution. It is an important limiting factor in fish culture. The survival and growth of fish are also depending on pH of the water. The pH of freshwater ponds can fluctuate considerably both daily and seasonally. These fluctuations are due to photosynthesis and respiration by plants and animals. Fish are known to have an average blood pH of 7.4; therefore pond water with pH within this average is optimum [8, 9]. It has been reported that the pH between 6 and 9 was appropriate for increased fish production [9]. In the present study pH value recorded ranged from 7.1to 8.0. This value is tending towards neutrally which is also within the values for optimum fish survival [10]. The highest value of pH was recorded during summer season (8.43±0.02.) and the lowest was recorded during pre-monsoon and monsoon season (7.63±0.11). The low value during monsoon season may be due to the dilution of rain water. These values compared very well with results of other workers [11, 12]. They are also within the international standards; ICMR and WHO.

Water Temperature

The temperature of an organism is defined as the level of hotness or coldness in the body of a living organism either in water or land [13]. It is an important biologically significant factor, which plays an important role in the metabolic activities of the organism. Fish is a cold blooded animal, so its temperature is dependent on the temperature of its environment. It changes with the temperature of the surroundings. The temperature changes affect the metabolism and physiology of fishes and so its productivity. The optimum water temperature for fish survival has been reported to be between 20 – 30 ºC [14]. The results obtained from this work showed temperature values ranging from 27.8^{0}C to 31.9^{0}C. The temperature was recorded maximum during summer (31.56±0.24) and minimum during monsoon season (27.63±0.25). According to Desai, water temperature may depend on the seasons, geographic location and sampling time [15]. The results are in agreement with other workers [16, 17]. The results were also within the standards (WHO and ICMR) [18, 19]. The temperature range showed that the pond water studies were good for fish productions.

Electrical conductivity

Electrical conductivity (EC) is a useful tool to evaluate the purity of water [20]. It is dependent on the ionic concentration and water temperature. A total load of salts in a water body is directly related to its conductivity [7]. Conductivity is also regarded as an indication of its freshness or otherwise of a water body [21, 22]. It has been reported that high values of conductivity are an indication of pollution [22]. Verheust 1997 reported that conductivity can be used as an indication of primary productivity and thus fish production [23]. Sikoku and Veen 2004, opined that fishes differ in their ability to maintain osmotic pressure, therefore the optimum conductivity for fish production differ from one species to another [24]. The range of electrical conductivity in the present study was between 290.30 to 405.10 µs. The EC was recorded maximum during post monsoon (368.18±28.33) and minimum during monsoon season (298.03±3.41). Similar results were observed by various workers Hulyal [25], Ramulu [26] and Ancy Mol [27]. These values fall within the WHO and ICMR limits, so the water would be regarded as safe for fish production.

Turbidity

Turbidity and the appearance of water are important considerations in pond aquaculture. This is a measure of the ability of water to transmit the light that restricts light penetration and limit photosynthesis [10]. It is the measure of the light scattered by suspended particles. It consists of suspended particles in water and is usually affected by factors such as clay particles, dispersion of plankton organism, particulate organic matters as well as pigments caused by decomposition of organic matter. The range of turbidity obtained in the present study was 20 to 35 NTU. The turbidity was recorded maximum during monsoon (32.33±0.68) and minimum during summer season (17.66±1.18). Similar results were observed by various workers Bhavimani [28] and Sangeeta [29]. According to Zweigh 20-30 NTU is suitable for fish culture [30]. There are also within the WHO limit, so the values obtained were within this range which makes these ponds suitable for fish farming.

Co_2

Carbon dioxide in a water body may be derived from the atmospheric sources, biotic respiration, inflowing ground water which seep into the pond, decomposition of organic matter due to bacteria and may also from within the water body itself in a combination of other substances mainly calcium, magnesium etc. Swann 1997, suggested that fish can tolerate concentrations of 10 ppm provided DO concentrations are high and water supporting good fish populations normally contain less than 5 ppm of free CO2 [31]. According to Ekubo and Abowei 2011 tropical fishes can tolerate CO2 levels over 100 mg L^{-1} but the ideal level of CO2 in fish ponds is less than 10 mg L^{-1} [32]. Bhatnagar 2004 suggested, 5-8 ppm is essential for photosynthetic activity; 12-15 ppm is sublethal to fishes and 50-60 ppm is lethal to fishes [33]. The free carbon dioxide in water supporting good fish population should be less than 5mg L^{-1} [34]. In the present investigation dissolved oxygen ranged from 4.2 to 6.0mg/l. The maximum value for co_2 was recorded in monsoon season (5.13±0.06) and minimum in pre-monsoon period (4.46±0.13). This result is supported by the findings of Tara [35] and Shib Abir [36].

DO

This is defined as the measure of the amount of gaseous oxygen dissolved in an aqueous solution. [37] Dissolved oxygen is an important parameter in water quality assessment and reflects the physical and biological processes of aquatic life. Oxygen is needed by fish and other aquatic organisms, and levels DO vary daily and seasonally and depends on the species of phytoplankton present, light penetration, nutrient availability, temperature, salinity, water movement, partial pressure of atmospheric oxygen in contact with the water, thickness of the surface film and the bio-depletion rates [38]. Nduka reported that the optimum dissolved oxygen for fish ponds is >4mg/L [39]. DO is known to affect such attributes as growth, survival distribution, behavior and physiology of aquatic organism [40]. The DO obtained from this study had ranged between 6.5 to 7.9 mg/L. The DO was recorded maximum during postmonsoon (7.63±0.06) and minimum during summer season (6.7±0.04). Results of the present study are similar to those reported by other Thirupathaiah [41], Ramulu [26] and Priyanka Yadav [42] .These values are within the WHO limit, so the water would be regarded as safe for fish production.

Salinity

Salinity plays an important role in the growth of culture organisms through osmoregulations of body minerals from that of the surrounding water. It is a major driving factor that affects the density and growth of aquatic organisms population [43]. It acts as a major ecological factor controlling the phytoplankton population of freshwater. According to Meck 1996 fresh and saltwater fish species generally show poor tolerance to large changes in water salinity. Often salinity limits vary species to species level [44]. During the present study the salinity ranged between 11to 19 ppt .The maximum value for salinity was recorded in summer season (16.66±0.97) and minimum in premonsoon and monsoon period (12.33±0.71). High salinity concentration was associated with fungi and bacterial density of phytoplankton population as observed by Shibu [45], Rani [46] and Shrivastava [47] also found similar results as observed in the present study.

BOD

Bio-chemical Oxygen demand is a parameter to assess the organic load in a water body. It is the measurement of total dissolved oxygen consumed by microorganism for biodegradation of organic matter [10]. It depends on temperature, the extent of biological activity, the concentration of organic matter and microbial population such as bacteria and fungi [48]. Clerk 1986, reported that a BOD level above 5 mg/L is an indication of water pollution [49]. In this study values obtained ranged from 4.5 to 6.0mg/L mg/L. The maximum demand of oxygen in the water was recorded during monsoon season was 5.66±0.160 mg/L due to the possible addition of high amount of waste along with rain-water from the surrounding and addition of organic waste in pond by certain human activities which also be responsible for the increase in BOD [50, 51]. The minimum demand of oxygen in the water was recorded during summer season was 4.8±0.12mg/L due to less vegetation. These findings are also in accordance with Ramadevi [52] and Jeyaraj [53] The BOD level between 3.0 to 6.0 mg/L has been reported as optimal for normal activities for fishes [10]. These BOD values are therefore within the values for optimum fish activities and so the fish ponds studied are being not polluted and therefore safe for fish farming.

COD

COD is an important parameter for establishing the quality of water. It determines the amount of oxygen required for chemical oxidation of organic and inorganic matter [54]. Organic matter and anthropogenic activities are the main factors responsible for higher COD [55, 56]. The high COD values indicate that some degree of non-biodegradable oxygen demanding pollutants were present in the water. During the analysis, it was observed that the COD level was ranged between 4.8 to 7.0 mg/L. The COD was recorded maximum during monsoon (6.86±0.06) and minimum during summer season (5.43±0.19). Similar results were observed by various researchers Shyamala [57] and Prameena Sheeja [58].

Chloride (Cl)

Chlorine gas is highly toxic, but the chloride ion is a common constituent of all natural water. It is considered as one of the most important inorganic anion in water and it's generally regarded as non-harmful constituent [39]. Though chloride is present in all natural water bodies, high concentration is an indication of pollution from sewage, industrial or intrusion of seawater or saline water into fresh water aquifer [59]. Chloride

content obtained from this study ranged between 15.3to 39.8mg/L. The chloride was recorded maximum during monsoon (35.86±1.83) and minimum during the post-monsoon season (23.13±3.95). These values are reasonable since higher concentration may be harmful to aquatic life. At even small concentration, it burns the edges of the gills with long term after effects [10].

Total Hardness

Total hardness of water is the parameters used to describe the effect of dissolved minerals (mainly Ca and Mg), determining suitability for domestic and industrial purposes which is attributed to the presence of bicarbonates, sulfates, chlorides and nitrates [23].Calcium and Magnesium are essential for bone and scale formation [10]. In the present study, calcium and magnesium contents ranged from 78 to 108 mg/dl and 57 to 73 mg/dl respectively. The calcium was recorded maximum during summer (104.33±1.90) and minimum during pre-monsoon season. The magnesium also maximum during summer (72.00±0.49) and minimum during pre-monsoon season (58.33±0.76). According to Wurts reported hardness ranged between 25-100 mg/l for good fish culture [60]. Bhatnagar in 2004, opined that the total hardness value of less 20 mg/L would cause stress, an optimum value of 75- 150 mg/L with a lethal value of >300 mg/L [61]. Higher values of hardness during summer (April, May and June) can be attributed to low water level and high rate of evaporation of water and addition of calcium and magnesium salts [62]. This investigation is in close conformity with the finding of Vijayalakshmi [63] and Elayaraj [64].

Alkalinity

Water alkalinity is a measure of its capacity to neutralize acids. It is a measure of buffering capacity of the water [65]. The obtained alkalinity ranged from 68 to 95 mg/l. The alkalinity values were maximum during summer (92.33±1.43) and minimum during monsoon (69.66±0.71). Higher values of alkalinity registered during summer (April, May and June) might be due to the presence of an excess of the free CO2 product as a result of decomposition process coupled with the mixing of domestic waste. The low alkalinity during the rainy season (November) may be due to dilution [66]. These findings are also in accordance with G. Subramanian [67] and Sajitha [68]. According to Bhatnagar and Devi 2013, optimum alkalinity for fish productivity is between 25 to 100 mg/L [10]. The values obtained were within this ranged which makes these ponds suitable for fish farming.

Nitrate

It is thought to be produced by autotrophic *Nitrobacter* combining oxygen with nitrite in the converter and on the walls of the pond [69]. It is important that the level of nitrate in a pond is controlled to avoid eutrophication. Nitrates are however not harmful to fish. Nitrate concentrations in this study ranged from 3.17 – 4.50 mg/L with a mean value of 3.81 mg/L. The Nitrate level was recorded maximum during monsoon (3.96±0.06) and minimum during pre-monsoon season and post monsoon (3.6±0.20 and 3.36±0.16). M. Jeyaraj [53] and Bhavimani [28], gave the favorable range of 0.1mg/L to 4.00 mg/L. The values obtained are within WHO and ICMR limits. They are also within the acceptable range as recommended by Bhatnagar and Devi 2013 [10]. The obtained values were within this ranged which makes these ponds suitable for fish farming.

Table 1: Physico-Chemical parameter analysis of fish culture Himalayan pond Thittai

Seasons	Pre monsoon			Monsoon			Post monsoon			Summer			WHO	ICMR
Parametrs	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun		
	2015	2015	2015	2015	2015	2015	2016	2016	2016	2016	2016	2016		
Color	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	-	-
Odor	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	-	-
Turbidity	22.0	20.0	21.0	32.0	35.0	30.0	25.0	20.0	22.0	15.0	18.0	20.0	5-25	5
Temperature (^{0}C)	30.5	29.1	28.5	26.9	27.9	27.8	28.6	29.0	30.4	31.0	31.9	31.8	28-35	28-37
EC (µs)	385.39	391.45	393.76	290.30	300.32	304.33	298.91	400.55	405.10	311.11	320.05	350.08	-	300
pH	7.4	7.6	7.9	7.1	7.8	7.9	8.0	7.9	8.2	8.4	8.5	8.4	6.5-8.5	7-8.5
DO (mg/lit)	7.7	7.1	7.9	7.6	6.5	7.3	7.5	7.6	7.8	6.8	6.6	6.7	5	-
BOD (mg/lit)	5.3	4.8	5.2	5.3	5.7	6.0	5.9	5.5	5.2	5.0	4.9	4.5	10	12
COD (mg/lit)	4.8	5.2	5.9	6.7	6.9	7.0	6.8	6.4	5.6	5.3	5.9	5.1	10	12
CO_2 (mg/lit)	4.2	4.4	4.8	5.1	5.0	5.3	5.2	5.0	4.9	5.8	5.9	6.0	-	-
Calcium (mg/dl)	78	81	80	83	88	94	98	96	98	100	108	105	75-200	75-200
Magnesium (mg/dl)	58	60	57	58	61	63	67	69	70	72	73	71	150	148
Salinity (ppt)	12	16	10	11	14	12	15	18	17	16	19	15		250
Total Alkalinity (mg/l)	91	83	75	70	68	71	72	83	85	95	93	89	75	100
Nitrate (mg/l)	3.1	3.8	3.9	4.1	4.0	3.8	3.4	3.0	3.7	3.8	3.0	3.6	45	20-100
Chloride (mg/l)	32.5	28.4	30.0	32.0	35.8	39.8	32.0	22.1	15.3	24.0	30.5	31.9	200 - 1000	250-1000

Table 1: Physico-chemical parameters (Mean±S.E) of Himalayan pond during July 2015 – June 2016

S. No	Seasons / Parametrs	Pre monsoon	Monsoon	Post monsoon	Summer
1	Color	Light Green	Light Green	Light Green	Light Green
2	Odor	Pleasant	Pleasant	Pleasant	Pleasant
3	Turbidity	21±0.47	32.33±0.68	22.33±1.18	17.66±1.18
4	Temperature (^{0}C)	29.36±0.47	27.63±0.25	29.33±0.44	31.56±0.24
5	EC (µs)	390.2±2.03	298.03±3.41	368.18±28.33	327.08±9.63
6	pH	7.63±0.11	7.6±0.20	8.06±0.06	8.43±0.02
7	DO (mg/lit)	7.56±0.19	7.13±0.26	7.63±0.06	6.7±0.04
8	BOD (mg/lit)	5.1±0.12	5.66±0.16	5.53±0.16	4.8±0.12
9	COD (mg/lit)	5.3±0.26	6.86±0.06	6.26±0.28	5.43±0.19
10	CO_2 (mg/lit)	4.46±0.13	5.13±0.06	5.03±0.06	5.9±0.04
11	Calcium (mg/dl)	79.66±0.71	88.33±2.59	97.33±0.54	104.33±1.90
12	Magnesium (mg/dl)	58.33±0.76	60.66±1.18	68.66±0.76	72.00±0.49
13	Salinity(ppt)	12.66±1.43	12.33±0.71	16.66±0.71	16.66±0.97
14	Total Alkalinity (mg/l)	83.0±3.77	69.66±0.71	80.0±3.30	92.33±1.43
15	Nitrate (mg/l)	3.6±0.20	3.96±0.06	3.36±0.16	3.46±0.19
16	Chloride (mg/l)	30.3±0.97	35.86±1.83	23.13±3.95	28.8±1.98

Each value is expressed as mean±standard error done in triplicates.

Conclusion

Water quality is an important part of environmental monitoring which is essential part of keeping the planet healthy and sustainable. When water quality is poor, it affects not only aquatic life but the surrounding ecosystem as well which were carried out in this study. Findings from this work revealed that regularly monitoring water parameter such as temperature, pH, DO, BOD, COD, etc provide insight to the health of the aquatic ecosystems. Present study also provides a base line data for the conservation and monitoring of the Himalayan pond. In this study, we strongly conclude that there are fluctuations during seasons. The physico-chemical parameters of the water samples from pond and WHO standard indicate that the water samples fall within the stipulated range of acceptability. Hence the water can be classified as a good, stable and healthy aquatic ecosystem and also increased fish productivity

Conflict Of Interest Statement

We declare that we have no conflict of interest.

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