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A Study On The Physico-Chemical Parameters And The Microbial Flora Of A Eutrophic Lake –Pallavaram Lake (Periyar Lake), Zamin Pallavaram, Chennai, Tamilnadu, India.

S.Rasulmeera[1], R.Kungumapriya [1],K.Revathi [2]*, K.Sundaravalli [2] , A.Anitha[2] , J.Allen smith[2]

[1] PG and Research Department of Zoology, Pachaiyappa's College,Chennai.
[2] CRL, Meenakshi Academy of Higher Education and Research ,Chennai.
*Corresponding Author – K.Revathi
E-mail : reva63@rediffmail.com

ABSTRACT
Water may be a critical resource within the lives of individuals who both enjoy its use and who are harmed by its misuse and unpredictability (flooding, droughts, salinity, acidity, and degraded quality). Consequently, consumption of polluted water puts lives and livelihoods in danger because water has no substitute. There are some ways during which water intended for human consumption can get polluted. These include wastes from industries like mining and construction, food processing, radioactive materials from power generating industries, domestic and agricultural wastes and by various microbiological agents. The pollution scenario in India is equally critical posing great threat to human health, aquatic life, vegetation and ecological balance. during this paper, the consequences of polluted lake water and analyzed by various analytical tests that this lake water was highly contaminated by the open defecation activities and mixture of domestic wastes which has been confirmed by the presence of microbial agents like Escherichia coli and Staphylococcus aureus hence itΓÇÖs not suitable for human consumption has been proved.

Keywords: pollution, Microbial agents, aquatic life, Escherichia coli and Staphylococcus aureus.

1. Introduction

Water covers about 70% Earth's surface. Safe beverage may be a basic need for all humans. Water may be a finite and vulnerable resource. Lake pollution was a significant pollution problem, it affects the abiotic and biotic factors of various aquatic systems in several degrees and its ultimately effect on man remains quite drastic in medical, aesthetic and economically sense. The pollution may be a serious threat everywhere the planet within the light of limited water availability and increasing generation of waste water being discharged either ashore or into rivers, lakes, water bodies or sea thereby polluting the water available in rivers, lakes, water bodies, and spring water. The WHO reports that 80% diseases are waterborne. Lakes contain 50.01% of all the water on the Earth's surface, they hold 49.85% of the liquid surface water. (Rachna Bhateria & Disha Jain,2016). Industrialization, discharge of domestic waste, radioactive waste, increase, excessive use of pesticides, fertilizers and leakage from water tanks are major sources of pollution. Organic manuring also results in severe depletion of dissolved oxygen, high biological and chemical oxygen demand, and high ammonia levels (Boyd, 1982). Heavy metals released from domestic, industrial and other man-made activity may contaminate the natural aquatic system extensively (Velez,1998). Contamination of water with a good range of pollutants has become a matter of concern over previous couple of

decades (Vutukuru,2005). so as to gauge the adverse effects of the pollutants on aquatic organisms, there's a worldwide trend to enrich physical and chemical parameters with biomarkers in aquatic pollution monitoring (Abdel,2012). In previous couple of decades increase in population density, heavy industrialization and agricultural activities have resulted in additional and more waste entering in freshwater resources (Chavan,2014).

2. Aim & Objectives of Present Study

- To assess a number of the physio-chemical parameters like pH, Alkalinity, Calcium, Nitrates, Fluorides, Phosphates, etc.
- To spot the microbial flora of the lake.
- To spot the water plant varieties growth within the lake.
- To find the phyto-plankktons and microbial fauna.

The water samples were collected from the Pallavaram Lake (Periyar Lake) during the amount between October 2020 to March 2021 during and after the monsoon period.

3. Materials

Collection of Water Samples: Water samples were collected from three different sampling sites (Site I, Site Il and Site II) in plastic containers and were delivered to the laboratory with ordinary care and were stored at 20℃ for further analysis. Water samples of about 10 litres were collected for a period of 6 months from October 2020 March 2021. The sampling sites were designated as follows:

Site I: Water samples collected from the primary entrance of Pallavaram Lake.

Site II: Water sample collected from the second entrance of the located on the other side of the primary entrance of Pallavaram Lake.

Site lll: Water sample collected from the peripheral side located on the central art of the Pallavaram Lake.

Water Samples for isolation and identification of microbes (Bacteria): Water samples of about 3 litres were collected from site I, site II and site III in sterile bottles and were delivered to the laboratory. Microbial analyses were administered on an equivalent day of collection for a period of 6 months from October 2020 to March 2021. Collection of Phytoplankton: Phytoplankton were collected by using phytoplankton net from Site I, Site II and Site III of Pallavaram Lake (Periyar Lake), Zamin Pallavaram and Identified. Collection of Macro flora (Aquatic Plants): Aquatic plants were collected by hand picking method from site I, site II and site III of Pallavaram Lake (Periyar Lake), Zamin Pallvaram and identified. Collection of Macro fauna: Crabs and Snails are collected by hand picking. Fishes, Prawns and aquatic insects were collected using casnet of two metres diameter and mesh size 14 of inch. The fishes were collected randomly from the sampling sites I, II and II and identified.

Methods

Physio - Chemical Characteristics of water samples from site I site II and site III of Pallavaram Lake (Periyar Lake) were determined by following the quality methods outlined

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by APHA (2010). The bacterial species isolated and identified by Spread Plate Method and identification of gram positive or gram negative done by using Gran's Method.

Results

Results of the analyses of Physico-Chemical parameters of water samples from Site I, Site II and Site III of Pallavaram Lake (Periyar Lake), ZaminPallavarm for a period of 6 months (October 2020 - March 2021).

Physical Parameters.

Colour: Colour of the water samples collected from Site I of Pallavaram Lake (Periyar Lake) is slightly green. Site II of Pallavaram Lake (Periyar Lake) is additionally slightly green and whereas Site III the color of the water sample is dark green. Odour: Samples collected from Site I and Site II has faint smell, whereas sample has sewage smell in Site III.

Water Temperature: Water temperature from Site I shows a minimum of 27℃ (October 2020), Site II shows an optimum temperature of 31℃ (December 2020) and whereas in site III water temperature shows a maximum of 32℃ in (March 2021).

pH: The pH value of water samples recorded in Site I and Site II has alkaline in nature whereas in Site III has highly alkaline (9.1) in nature (March 2021).

Chemical Parameters

Electrical Conductivity (EC): The electrical conductivity of water decreased in Site I and Site II during (October to November 2020) where is that the electrical conductivity increases Site III during (February to March 2021).

Turbidity: Turbidity from Site I and II shows a rather turbid where as in site III shows highly turbid. .

Total Dissolved Solid (TDS): Total dissolved solids within the water Samples within the Site I ranges from 830 g/L (October 2020), in Site II the entire dissolved solids range from 850 g/L and whereas in Site III the entire dissolved solids range from 858 g/L (March 2021) revealing that TDS level in both sites are normal than the permissible limits (900 g/L) (WHO,1971).

Total Suspended Solid (TSS): Total suspended solids within the water samples within the Site I range from 932 g/L (October 2020), in Site II, the entire suspended solids range from 936 g/L (December 2020) and whereas the entire suspended solids range from 998 g/L (March 2021) revealing that TSS level in both sites are normal than the permissible limits (1200 g/L) (APHA, 2010).

Dissolved Oxygen (DO): Dissolved oxygen levels within the water samples within the Site I range from 3.10 mg/L (October 2020), in Site II, the dissolved oxygen levels from 3.40mg/L (December 2021) and where as in Site III ranges from 3.65 mg/L (March 2021) revealing that the dissolved oxygen level in both sites are but the permissible limits (50 mg/L) (BIS,1991).

Biological Oxygen Demand (BOD): In site I, biological oxygen demand levels from 1.30 mg/L (October 2020) in Site II the values range from 1.15 mg/L (December 2020) and whereas in site III the values range from 2.0 mg/L (March 2021) revealing that the BOD level is normal than the permissible limits (2.0 mg/L) (Singh,2007).

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Chemical Oxygen Demand (COD): In Site I, Chemical Oxygen demand levels from 1.20 mg/L (October 2020), in Site II the values range from 1.35 mg/L (December 2020) whereas in Site III it ranges from 2 mg/L (March 2021) revealing that the COD level in less than the permissible limits (2 mg/L) (Singh,2007).

Total Alkalinity: The total alkalinity levels in Site I ranges from 225 mg/L (October 2020), in Site II the values range from 230 mg/L (December 2020) whereas in Site III the values range from 240 mg/L (March 2021) Whereas in Site III values range from 260 (µmol/L) (October 2021), In Site II the values range from 230 (µmol/L) (December 2020). Whereas the values range from 240 (µmol/L) in the Site III. (March 2021) revealing that the total hardness level is lesser than the permissible limits 350 (µmol/L) (Singhal, 1986).

Calcium: The amount of calcium in the water sample of Site I ranges from 85 (µmol/L) (October 2020), In Site II, the values range from 88 (µmol/L) December 2020). Whereas the values range from 95 (µmol/L) (March 2021) in Site I revealing that the Calcium level is lesser than the permissible limits 150 (µmol/L) (Angadi,2005).

Nitrate: The amount of nitrate in the water sample of site I ranges from 25 (µmol/L) (October 2020), in Site II the values range from 30 (µmol/L) (December 2020). Whereas in Site III values range from 35 (µmol/L) (March 2021) in Site I revealing that the nitrate level is lesser than the permissible limits (200 (µmol/L)) (Anderson, 1988).

Phosphate: The amount of phosphate content in Site I ranges from 225 (µmol/L) (October 2020), in Site II it ranges from 235 (µmol/L) (December 2020). Whereas in Site III it ranges from 265 (µmol/L) (March 2020) revealing that the phosphate level is normal than the permissible limits (400 (µmol/L) (Moss, 1989).

Fluoride: Fluoride levels in the water samples in Site I ranges from 200 (µmol/L) (October 2020), in Site II the Fluoride level ranges from 228 (µmol/L) (December 2020). Whereas in Site III the Fluoride level ranges from 280 (µmol/L) (March 2021) revealing that the Fluoride level in both sites is lesser than the permissible limits (500 (µmol/L) (CPCB,1995).

Salinity: Salinity levels in the water samples in Site I ranges from 8 % (October 2020), In Site II the Salinity level ranges from 10 % (December 2020). Whereas in Site Ill the salinity level ranges from 17 % (March 2021) revealing that salinity level in both sites are less than the permissible limits (36%) (WHO,1971).

Silicates: The amount of silicate in the water samples of Site 1 ranges from 20.19 (µmol/L) (October 2020), In site II, the values range from 22.10 (µmol/L) (December 2020). Where as in site the values range from 23.15 (µmol/L) (March 2021) revealing that the Silicate level is lesser than the permissible limits 200 (µmol/L) (Singhal, 1986).

Isolation and Identification of Microbes (Bacterial Species) from water samples of Pallavaram Lake (Periyar Lake), ZaminPallavaram.

Bacterial Species:

The results of isolation and the identified species were *Escherichia Coli* (Site I), *Staphylococcus aureus* (Site II) and *Staphylococcus aureus* (Site III).

Identification of Phytoplankton from water samples of Pallavaram Lake (Periyar Lake), ZaminPallavaram: The results of identification of phytoplankton from Site I, Site II and llI of water samples of Pallavaram Lake. The identification of phytoplankton is represented by three classes such as Bacillariophyceae. Chlorophyceae and Cyanophyceae.

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Identification of Macrofauna from water samples of Pallavaram Lake (Periyar Lake), ZaminPallavaram: The results of the study revealed that only one species of crab namely Paratelphusa (Oziotelphusa) hydromusalcocu was identified in Site II. Whereas 2 species of snails namely Bithynia, Helisoma were recorded only in Site II. 2 Species of fishes namely *Gambusiaaffinis* and *Tilapia mossambica* were identified from both sites I and II of water sample collected from Pallavaram Lake (Periyar Lake), ZaminPallavaram.

Identification of Microflora from water samples of Pallavaram Lake (Periyar Lake), ZaminPallavaram: The results of the study revealed that 4 species of aquatic plants namely Pistia. Lantana, Water Lily, Hydrilla, Vernonia, etc.

Plate 1: Collection of Water Samples ofPallavaram lake from Site I, Site II and Site III.

SITE I

SITE II

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SITE III

Table.1. Physico-Chemical Parameters of Pallavaram Lake During Oct 2020- Mar 2021

S.NO	Parameters	Site I	Site II	Site III
	Physical Examination			
1.	Colour	Slightly greenish.	Slightly greenish	Darkly greenish
2.	Odour	Faint smell	Faint smell	Sewage smell
3.	pH	8.2	8.6	9.1
4.	Temperature (℃)	27	31	32
	Chemical Examination			
5.	Electrical Conductivity (µmol/cm)	1400	1400	1500
6.	Turbidity	Slightly turbid	Slightly turbid	Highly turbid
7.	TDS (g/L)	830	850	858
8.	TSS(g/L)	932	936	998
9.	DO (mg/L)	3.10	3.40	3.65
10.	BOD (mg/L)	1.30	1.45	2.00
11.	COD (mg/L)	1.20	1.35	2.00
12.	Salinity (‰)	8	10	17
13.	Alkalinity (mg/L)	225	230	260
14.	Calcium (µmol/L)	85	88	95
15.	Phosphate(µmol/L)	11.8	12.5	13.1

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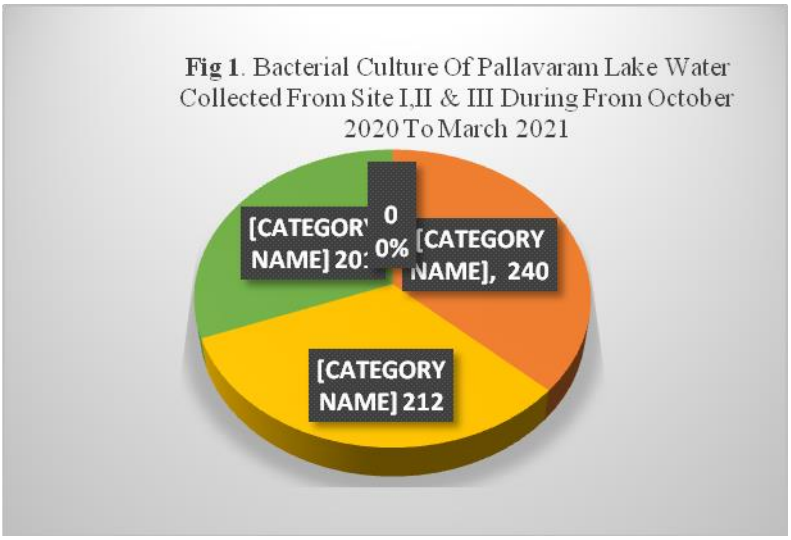
16.	Nitrate(µmol/L)	18.72	18.92	19.2
17.	Fluoride(µmol/L)	116	128	130
18.	Silicate(µmol/L)	20.19	22.10	23.15



Statistical analysis

Bacteria Enumeration = Bacterial sp. (no. of colonies) ×360
No.of species

Table.2. Microbial Parameters of Pallavaram Lake During Oct 2020- Mar 2021

S.No	Bacterial Sp.	No. of Colonies
1.	Escherichia coli(A)	240
2.	Staphylococcus aureus(B)	212
3.	Staphylococcus aureus(C)	201
	Total	**653**

Plate 2. Isolation and Identification of Microbes (Bacterial Species) from water samples of Perungalathur Lake (Peria Eri), Perungalathur.

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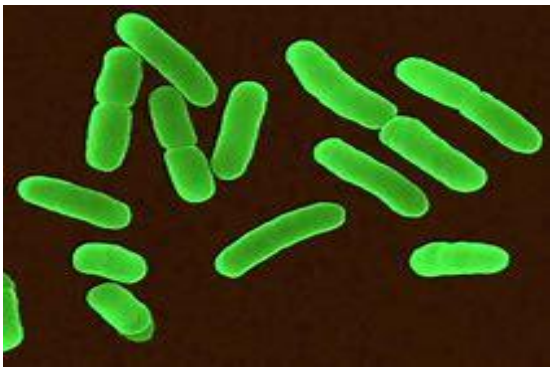
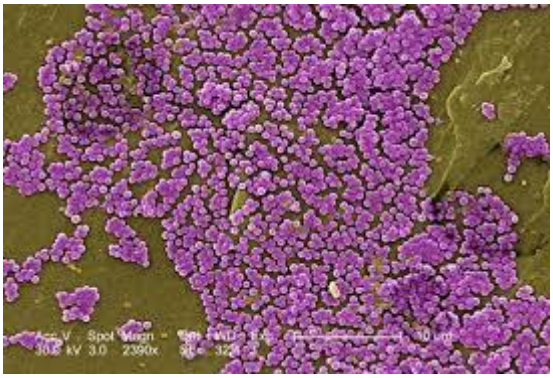
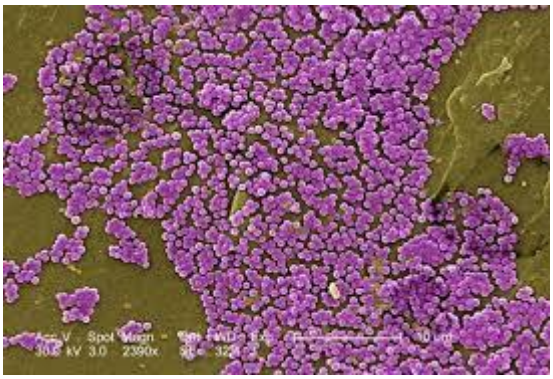


***Escherichia coli (*Site I)**



***Staphylococcus aureus* (Site II)**



***Staphylococcus aureus* (Site III)**

4. Discussion

Water is an essential thing for living organisms. Rapidly developing countries like India were facing severe problems of pollution of rivers and lakes use of unplanned urban, industrial and agricultural growth in the catchment, lack of concern for the environment and ineffective regulatory control mechanism (Wani,2002). Not only there was an increasing concern rapidly deteriorating supply of water but the quality of utilizable water is also fast diminishing. The wide array of pollutants being discharged into the aquatic environment may have Physico-Chemical, biological and pathogenic effect (Goel,2000). Hence, it was an imperative that proper monitoring and control of pollution of various aquatic bodies following strict enforcement standards. Excessive nutrient levels in aquatic system can also cause ecological

problems, they may lead to extensive growth of aquatic weeds such as Eurasion milfoil, water hyacinth, water chestnut etc. Oil spills have tilled water birds, mammals, fish and vegetation which were present in the water. The untreated effluents of different industries might be highly dangerous when discharged into open water bodies (Murugan,2006). The essential resource was becoming increasingly scare in impairment of water quality and have stressed the importance of alkalinity, dissolved oxygen, phosphate, nitrate in the abundance of Euglenophyceae. (Zafar,1964) has emphasized the importance of alkalinity in the abundance of euglenoids and states that a higher pH favors their growth. Analysis of different Physico-Chemical parameters of water bodies helps to evaluate its pollution load and whether it is suitable for drinking or not. Quality of drinking water, which was declared as potable is set against certain standards like (APHA,2010) (WHO,1971).

Greenish colour of the Lake water might be due to presence of impurities and phytoplankton presence of floating and suspended materials make the water turbid and non-transparent.

The results of this study revealed that the turbidity of water samples from site I & site II is slightly turbid and highly turbid in site III which is mainly caused by suspended particles such as clay, silt, finely divided organic and inorganic matters, plankton and other microscopic organisms, decaying vegetation, organic matter and high planktonic growth and it is in accordance with the findings (Iqbal,1995) (Radhika et.al,2004). A decrease in the conductivity in sites I, II and III of water samples might be due to the absorption of settled minerals by the submerged macrophytes, which were present in abundance. The above findings were in accordance with the observations (Kaushik,1999) (Radhika et.al,2004). High values of alkalinity in this study in sites I, Il and III of water samples was due to evaporation and entry of more domestic water when the rate of flow of water is low. In the present study TDS of sites 1, II and III was high from October 2020 to December 2020. Higher values of TDS were due to the addition of sewage with the lake water (Mamta Tiwari, 2005) and low level of TDS in January and March 2021 might be influenced by physical forces such as evaporation (Radhika et.al,2004).

TSS consists of particles of different sizes ranging from coarse to fine colloidal particles of various organic complexes and plankton (Radhika et.al,2004). TSS in the present study were found to be within the permissible limits in both sites I and II of water samples.

The dissolved oxygen is one of the important parameters in water quality assessments (Solanki,2006). Decrease allochthonous in the dissolved oxygen level in sites I, II and III in this study might be the result of utilization of dissolved oxygen for the decay of autochthonous and materials that get dumped (Radhika et.al,2004). A low value of dissolved oxygen was also due to the increased microbial activity in the water (Mamta Tiwari, 2005) (Naga Prapurna,2002). A low content of dissolved oxygen was a sign of organic pollution (Bhatt,1999). Dissolved oxygen depiction could also be attributed to the phytoplankton respiration and sediment oxygen demand (Wani,2002). Values of Biological oxygen demand directly given the extent of pollution in water samples. Biological oxygen demand values of the site I, II and III in the present analysis were above the permissible level as suggested by (CPCB,1995) for drinking, bathing and swimming (Radhika et.al,2004). Higher value of

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Biological oxygen demand might be due to higher rate of organic decomposition (Bhatt,1999). Low chemical oxygen demand values recorded in sites I, I and III in the present study might be the result of sedimentation of organic materials to the bottom, which was in the agreement with the findings of (Ajmal, 1988) (Dakshin, 1979) (Radhika et.al,2004).

Calcium was a very important element influencing the flora of ecosystem which played a potential role in metabolism and growth and in the present study calcium level in sites I, II and II were below the permissible limit (CPCB,1995). Very low concentration of nitrate in sites 1. II and III in this study might be due to the utilization of nitrate for the luxuriant growth of macrophytes (Radhika et.al,2004).

The presence of fluoride concentration in a water source was used as an indicator of organic pollution by domestic sewage (Chandrasekar,2003) (NEERI,1979). There was a direct relation between fluoride concentration and pollution level. Low fluoride values (October 2020 to March 2021) in both the sites in the present study coincide with the findings of (Kaushik,1991) and this high concentration of fluoride given an undesirable taste of water (Mamta Tiwari, 2005). Low concentration of fluoride ion (January to February 2021) in this study in the lake water indicated the low amount of organic waste of animal origin (Radhika et.al,2004).
Increase of phosphate in sites I, II and III in this study might be due to decayed phytoplankton and concentration of zooplanktons. Lower concentration of phosphate in this study might be clue to higher consumption of phosphates by macrophytes (Bhatt,1999). From the analysis of physicochemical characteristics from three sites of water samples of Pallavaram Lake (Periyar Lake), ZaminPallavaram. TDS, BOD, Alkalinity were found to be higher than the permissible limits for drinking water standards prescribed by (CPCB,1995) indicated that the high pollution goal of the water samples. The study was further extended to analyses the microbes, microflora and macro fauna of water samples of Pallavaram Lake as they act as bio indicators of pollution of water.

The present study revealed that the presence of prominent bacterial forms in the Pallavaram Lake were Escherichia coli and Staphylococcus aureus which was in accordance with the work of (Sultana,2002).The presence of microbial pathogens in the present study indicated that the contamination of water with the faecal matter, because it was very clear that people of this area defecate, discharge and wash in the same area, which includes definitely discharge of diverse micro flora of bacterial taxa like Escherichia coli and Staphylococcus aureus which were pathogens as stated by (Goel,2000). In the present study, E. coli fulfils the condition to the best possible extent which act as an ideal indicator of faecal pollution. The advantage of testing E. coli rather than specific pathogens which would be present in both healthy as well as diseased human intestine in large numbers and billions of them are excreted daily by an average person (Goel,2000) (Sengupta, 2002). In general, for every pathogen in contaminated water, there were billions of Escherichia coli, survive longer in water than most pathogens. Hence, it could detect recent and earlier pollution.

Among the phytoplanktons, Chlorophyceae and Bacillariophyceae were dominant followed by Cyanophyceae in the both sites of water samples of Lake and data indicated that the lake was tending towards eutrophication (Abbasi,1996). Variation in the phytoplankton population in this study might be clue to temperature variation (Bhatt,1999). Presence of aquatic plants in three sites I, II and III of Pallavaram Lake indicated the pollution level of the lake (Sultana,2002). There was a lack of diversity in the fish found in the lake in this study which was supported by the work of (Abbasi,1999). The presence of crabs, snails act as bioindicators of the pollution of Pallavaram Lake (Periyar Lake).

Though, the water samples from sites I, II and III of Pallavaram Lake are polluted, the water of site III was highly polluted than site I & II of Pallavaram Lake. Thus, from various analysis that were carried out in the water of Pallavaram Lake such as Physico-Chemical characteristics, abundance pattern of microbes, phytoplankton, the investigated lake appears to be nutritionally rich. High habitational influenced due to dumping of garbage. Faecal contamination, rich growth of macrophytes and macrofauna enrich the nutrient contents of water thereby raising the trophic level of the lake (Jelani,2005) indicated the pollution status of the Pallavaram Lake, ZaminPallavaram.

5. Summary and Conclusion

This study was designed to evaluate pollution status of Pallavaram Lake called as "Periyar Lake". The lake when it was observed between the period of October 2020 - March 2021 shows more eutrophic in nature which was an alarming situation and if this continuous, for a longer period of time the underground water channels will in turn supply only polluted water to the surrounding locality, and safe groundwater will become a distant dream.

6. Recommendations

Continuous monitoring of the pollution level is a must in order to promote better living conditions around the lake along with improvement of aquatic life in the lake. The government organizations are to plan for time-to-time monitoring of the water quality along with a check on the influents, standards, with a view to reduce the external contribution into the pollution levels of Pallavaram Lake (Periyar Lake), ZaminPallavaram.

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References

[1]. Abbasi, Bhati, Khuni&Soni, (1996). Studies on the Limnology of Kuttiadi Lake (North Kerala). *Ecological Environmental and Conservation*, 2, 17-27.

[2]. Abbasi, S.A., Khan, F.J., Sentilevelan, K., &Shabuden, A. (1999). Physiochemical studies of Chilka lake. *Indian Journal of Environmental Health*,14(3),176-183.

[3]. Abdel Moniem, A.M., Al-kahtani, M.A., &Dimenshany, O.M. (2012). Histopathological biomarkers in gills and liver of Oreochromisniloticus from polluted wetland Environments, Saudi Arabia. *Chemosphere*,88,1028-1035.
[4]. Ajmal, M., Razi-ud-dis. (1988). Studies on the pollution of Hindon river and Kalinadi (India). *Ecology and pollution of Indian rivers*,1.87-111.
[5]. Anderson, D.M., Cembella, A.D., & Hallegraeff, G.M. (1998). *Physiological Ecology of Harmful algal blooms.* (Vol.2, 1st Edition., 647–648.
[6]. AngadiShiddamaliayya, Patil. (2005). Limnological study of papnash pond, Bidar (Karnataka). *Journal of Environmental Biology,* 26, 213-216.
[7]. APHA, Standard methods for the examination of water and waste water. *American Public Health Association*, 201-205.
[8]. Bhatt, L.R., Lacoul, Pathak, H.D., & Jha, P.K. (1999). Physicochemical Characteristics and Phytoplanktons of Taudaha Lake, Kathmandu. *Pollution Research*,18(4),353-358.
[9]. BIS. (1991). Indian standards for Drinking water. *Bureau of Indian Standards*. New Delhi, IS:10500.
[10]. Boyd, C.E. (1982). Water quality management in pond fish culture, Amsterdam. Elsevier scientific Publishing Company, 198-201.
[11]. Chavan, V.R., Muley, D.V. (2014). Effect of heavy metals on liver and gill of fish *Cirrhinusmrigala*. *International Journal of Current Microbiology and Applied Science*,3, 277-288.
[12]. Chandrasekar, J.S., Lenin Babu, K, Soma Shekar, R.K. (2003). Impact of urbanization on Bellandur Lake, Bangalore-A Case study. *Journal of Environmental* Biology, 24(3).223-227.
[13] CPCB. (1995) Pollution control: Acts, rules and modifications issued under *Central Pollution Control Board*, New Delhi.
[14]. Dakshini, K.M.M., Soni, J.L. (1979). Water quality of sewage drains entering Yamuna in Delhi. *IndianJournal of Health*, 21(4),354–360.
[15]. Goel, P.K. (2000). *Water pollution Causes, Effects and Control*.56-67.
[16]. Iqbal, S.A., Katariya, I.C. (1995). Physico- Chemical analysis and water quality assessment of upper lake of Bhopal. *International Journal of Environmental Pollution*,1(7),12-15.
[17]. Jeelani, M, Kaur, H, &Sarwar, S.G. (2005). Distribution of Phytoplankton in the Dal Lake, Kashmir, India. *Pollution Research*, 24(1),79-82.
[18]. Kaushik, S, Saksena D.N. (1999). Physico - Chemical Limnology of certain water bodies of central India, Delhi",333-336.
[19]. Kaushik S, Agarker, M.S., &Saksena, D.N. (1991). Water quality and periodicity of phytoplanktonic algae in chambal tank Gwalior, Madhya Pradesh. *Bionature*, 11, 87- 94.
[20]. Mamta Tiwari. (2005). "Assessment of Physico Chemical status of Kharpura Lake, Ajmer into its impact on public health. *Ecology Environment And conservation*, 11(3-4), 491-493.
[21]. Moss, B, Balls, H. (1989) "Phytoplankton distribution in a flood plain lake and river system II Seasonal changes in Phytoplankton communities and their control by hydrology and nutrient availability. *Journal of Plankton Research*, 11(4),839-867.

[22]. Murugesan, A, Ramu, A., & Kannan, N. (2006). Water quality assessment from Uthamapalayam Municipality in Theni District, Tamil Nadu, India. 25(1),163-166.
[23]. Naga prapurna, Shashikanth K. (2002). Pollution level in Hussain Sagar Lake of Hyderabad - A Case study. *Pollution Research*, 21(2),187-190.
[24]. NEERI. (1979). Water and waste water analysis. *National Environmental Engineering Research Institute*, Nagpur. Course manual,134.
[25]. Radhika, C. G., Mini, I, & Ganga Devi, T. (2004). Studies on abiotic parameters of a tropical fresh water lake - Vellayani Lake, Thiruvananthapuram district, Kerala. *Pollution Research*, 23(1). 49-55.
[26]. RachnaBhateria, Disha Jain. (2016). Water quality assessment of lake water: A review. *Sustainable water resource management*, 2,161-173.
[27]. Sengupta, B. (2002). Water quality in India status and trends", Public Central pollution control Board, Ministry of Environment and Forest, *Pollution Control*, 31-49.
[28]. Singh, R. P, Mathur, P. (2007). Investigation of variations in Physico - Chemical Characteristics of a freshwater reservoir of Ajmer City, Rajasthan. *Indian Journal of Environmental Science*, 9,57-61.
[29]. Singhal, R.N., Swaranjeet Davis, R.W. (1986). The physico-chemical environment and the plankton of managed ponds in Haryana, India. *Proceedings of Indian Academy of Science*,253-263.
[30]. Solanki, V. R, Sabitha Raja, & Masood Hussain. (2006). Studies on temperature fluctuation and dissolved oxygen levels in Bellal lake of Bodhan, Andhra Pradesh. *Pollution Research*, 25(1), 91-93.
[31]. Sultana M. (2002). Ecotoxicological studies of the freshwater Double Lake (Erettai Eri), Kolathur Chennai, India. *Indian Journal of Environmental Pollution*, 144-148.
[32]. Velez, D, Montoro R. (1998). Arsenic speciation in manufactured sea food products, A review. *Journal of Food Product*,61(9),1240-1245.
[33]. Vutukuru, S.S. (2005). Acute effect of Hexavalent Chromium on Survival, oxygen Consumption, Hematological Parameters and some biochemical profiles of the Indian Major Carp, *Labeorohita*. *International Journal of Environmental Research*, 2(3), 456-462.
[34]. Wani, Bhargava, Gairola, &Kundangar.(2002).Status of water quality in Dal Lake. *Indian Journal of Environmental Pollution*, 22(2),121 - 128.
[35]. WHO. (1971). International standards for drinking water, *World Health organization*, Geneva, 3d edition, 233-236.
[36]. Zafar. (1964). Ecology of algae in certain fish pond India. *Hydrobiology*, III - periodicity, 30(1), 96-112.
[37] Differential expression of Helios, Neuropilin-1 and FoxP3 in head and neck squamous cell carcinoma (HNSCC) patients A.A.Mohamed Adil, Anil Kumar Bommanabonia, Anandraj Vaithy, Sateesh Kumar 3biotech 9 (178)
Protagonist of Immuno-Profiling, Immuno-Scoring, and Immunotherapy Towards Colitis-Associated Cancer: Systematic Review, Mohamed Adil a.a, AK Pandurangan, M Waseem, N Ahmed Diagnostic and Treatment Methods for Ulcerative Colitis and Colitis 2020

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Emerging Role of Mitophagy in Inflammatory Diseases: Cellular and Molecular Episodes, Mohamed Adil AA, S Ameenudeen, A Kumar, S Hemalatha, N Ahmed, N Ali 2020 Curr Pharm Des. 2020;26(4):485-491. doi: 10.2174/1381612826666200107144810

Increased Expression of TGF-β and IFN-γ in Peripheral Blood Mononuclear Cells (PBMCs) Cultured in Conditioned Medium (CM) of K562 Cell Culture AAM Adil, L Vallinayagam, K Chitra, S Jamal, AK Pandurangan, N Ahmed Journal of Environmental Pathology, Toxicology and Oncology 38 (2)

Cancer immunotherapy: Targeting immunosuppressive tumor microenvironment NA A.A Mohamed Adil Oncobiology and Targets 2014