Risk Assessment of Dumped Pollutants and its Ecotoxic Effects on Physiochemical Parameters of Water in Ayapakkam Lake, Chennai, Tamil Nadu, India

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Abstract: *Water is an important element for all the living organisms. Despite of its abundant availability in nature only three percentage of its total is usable source for human beings. Lakes and rivers are some of the important freshwater resources. Ayapakkam Lake is one such, where the quality of water is contaminated and its ecotoxicity level has been elevated owing to the increased garbage dumping, throwing of sewage sludge into the water. Ultimately, this affects various physiochemical parameters of water, such as Hardness, Chloride, Nitrate, Calcium, Magnesium and Dissolved oxygen. So the present study aims to analyze the water parameters and its associated effects. In addition dumped garbage were also collected and segregated based on degradation property. Results obtained from the water samples of Ayapakkam Lake show greater variations than standard values. Further statistical analysis of collected waste reveals an increased amount of Non Biodegradable waste than Biodegradable. Particularly plastics were found to be in high quantity. The overall study suggests that the Ayapakkam Lake was enormously polluted by several anthropogenic activities and it has toxified the ecosystem. Especially in developing countries like India, lakes are one of the important economical and ecological ecosystems. Disturbing the Lake ecosystem leads to worsen effect. Hence, recommendation of proper waste disposal methods must be implemented.*

Keywords: Ecotoxicity, Garbage, Sewage sludge, Degradation, Plastics.

1. INTRODUCTION

Environment comprise of land, water and atmosphere. Water covers two third of the Earth surface. In that, freshwater comprises only three percentage of the total. Hydrological cycle plays a key role in the maintaining of constant amount of freshwater bodies like Lakes and rivers. Lakes represent important ecological and economical resources. The supply of freshwater in some regions is limited because of climatic condition or it is not enough for meeting the growing population density. But in most of the places, the water supply is contaminated with the contaminants which makes it unfit for human usage. It also affects the aquatic species living in chemically contaminated water. Thus, water pollution leads deprivation of water and food, the two essential ingredients [1] [2].

The accumulation of contaminants and their adverse effects on human and the environment is termed as pollution. Pollutants are the result of activity of living organisms mainly human beings. Contaminants like plastics and other kinds of waste find their way into the environment which may cause adverse effects on human health and welfare. Different sources of contaminants are released and dumped into the environment. Natural waste are easily transformed or broken down into beneficial compounds, but most of the wastes produced due to anthropogenic activity come under the xenobiotic wastes which are foreign to natural ecosystems and they are less degraded. In some instances the conversion or degradation of such wastes may enhance the toxicity of the contaminants [1]. Rivers, streams, lakes and other water bodies of developing countries which are close to heavily populated areas become filled with waste, making the water bodies into dead or sewage streams [3] [4]. Waste filled water bodies are avoided by people because of its contamination [5].

The 280 million tons of plastic per year are produced by humans. Plastics are widely used due to their less weight, longevity, affordability and for its good insulation. Even though it has so many advantages their existences make the pernicious influence on the environment. Most of these plastic ends up in the environment harming marine life and other ecosystems. Plastics are durables due to their chemical bonds which in turn responsible for its resistant to natural process of degradation. Due to its non degradable nature, plastics are very difficult to eliminate from the nature. Earth ecosystem and freshwater biodiversity are adversely affected because of the plastic litter [6] [7]. Recent studies conducted by scientists show that the increasing plastic pollution on the freshwater bodies which was previously observed in the ocean gyres and along coastlines [8]. Various Human induced activities are responsible for the developing pollution on the surface water like rivers and lakes of India. Mixing up of untreated sewage water into the lake will harm the quality and make it polluted water [9]. Various research works have been conducted regarding water quality assessments and their pollution status with respect to lakes found in and around Chennai [10] [11] [12] [13] [14] [15].

The present work signifies the water quality analysis with special reference to Ayapakkam Lake, Which is highly polluted due to the increase of garbage dumping in and around the water body. This study is a risk assessment of pollution caused due to garbage dumping by analysing the physiochemical parameters of water and different kinds of waste dumped in the **Ayapakkam Lake** near **Chennai**. This study aim's to show the pertaining increase of ecotoxicity of the surrounding environment, which in turn causes fatal effect to the human kind.

2. MATERIALS AND METHODS

Study Area

Ayapakkam is a region near Chennai, Tamil Nadu, India. It is one of the fastest developing residential areas around Chennai. It has many sources of water around it like

Ayapakkam Lake, Ayanambakkam Lake, Thiruverkadu Lake, Parithipattu Lake and Ambattur Lake. This study was conducted in Ayapakkam Lake during the month of January, 2020.

Figure 1: Ayapakkam Lake Location in Google Map 2020

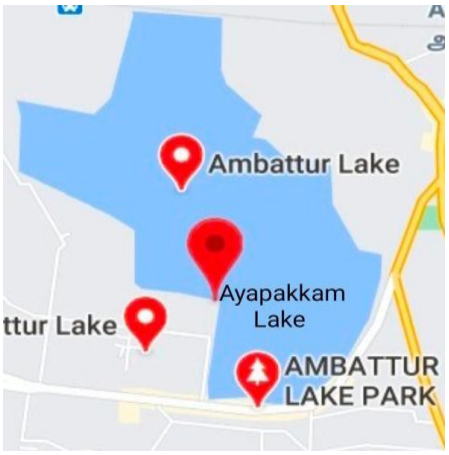

Figure 2: Satellite view of Ayapakkam Lake- Google 2020

Sample Collection and Analysis

Water samples were collected from sewage sludge running in Ayapakkam lake (figure: 1 and figure: 2) using the spot sampling procedure. Water sample was collected using the clean labelled glass bottle which was rinsed with sample thrice before collection. The sample was collected in the stagnant region of the water body. Initial testing's like pH was carried after the collection, whereas the analyses of remaining parameters were done in the laboratory. The sample was stored at 4℃ in Refrigerator before analysing it. Physical examination of the water sample was also analysed and noted. We also collected different kinds of garbage dumped within 1000 square feet of the lake area in order to understand how much pollutant is added to the lake in a period of time which eventually leads to the change in the quality of lake water. We segregated the collected pollutants into Biodegradable and Non Biodegradable waste based on its degradability nature.

3. RESULTS AND DISCUSSION

The water sample collected were analyzed for different physio-chemical parameters such as Colour, Odour, pH, BOD, COD, Alkalinity, Hardness, Chloride, Nitrate, Calcium, Magnesium and Dissolved oxygen as per Standard methods and results were compared with the Indian Standards for potable water. The results of the studies are summarized in Table 1 and 2. The mean value of the collected Non Biodegradable and Biodegradable waste in 30 days are shown in Table 3 and 4. Statistical analysis was performed using t-test is shown in Table 6.

Table 1: Analysis of Physical parameters of water sample from Ayapakkam Lake

S.NO	PARAMETERS	DRINKING WATER STANDARD	EFFULENT CONTAMINATED LAKE WATER
1	pH	6.5-8.5	8.6
2	BOD	30 mg/l	52 mg/l
3	COD	250 mg/l	380 mg/l
4	Alkalinity	200 mg/l	570 mg/l
5	Hardness	300 mg/l	690 mg/l
6	Chloride	250 mg/l	360 mg/l
7	Nitrate	45 mg/l	51 mg/l
8	Calcium	75 mg/l	200 mg/l
9	Magnesium	30 mg/l	150 mg/l
10	Dissolved oxygen	6-10 mg/l	4.5 mg/l

Table 2: Analysis of chemical parameters of water sample from Ayapakkam Lake

S.NO	PARAMETERS	DRINKING WATER STANDARD	EFFLUENT CONTAMINATED LAKE WATER
1	Colour	Clear	Yellowish green
2	Odour	Unobjectable	Foul

Figure 3: Graph representing the comparison of physiochemical parameters of Ayapakkam Lake water

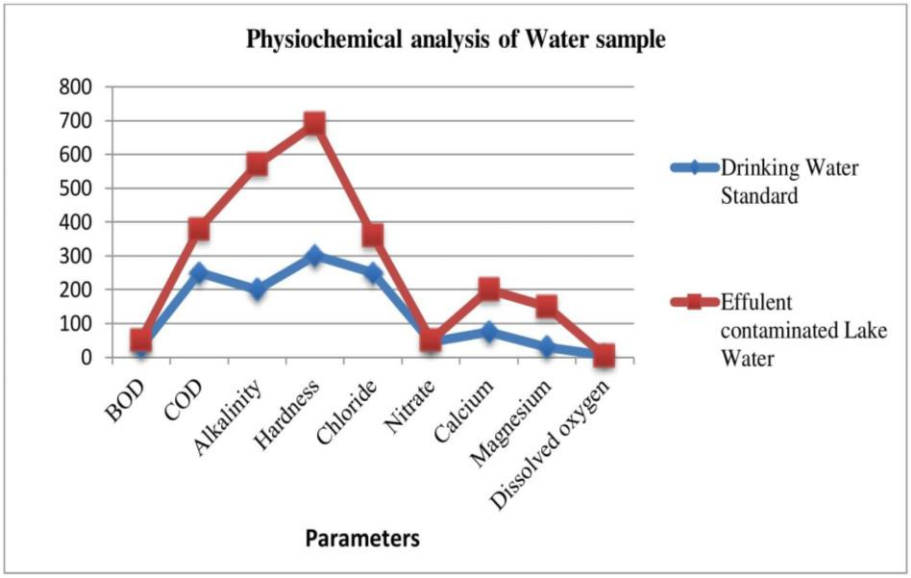

Table 3: Mean value of Non Biodegradable waste of 30 days collected from Ayapakkam Lake.

S.NO	NON BIODEGRADABLE WASTE	MEAN VALUE OF 30 DAYS
1	Plastic water bottles	19.07
2	Glass bottles	1.93
3	Thermocol	1
4	Tyre	0.4
5	Slipper	0.83
6	Milk cover	15.93
7	Oil cover	2.5
8	Other plastic cover	24.93
9	Mica bags	10.77
10	Food wrappers	13.1
11	Plastic covers	7.17
12	Plastic water bottles	8.8
13	Glass bottles	1

Figure 4: Graph representing the mean value of Non Biodegradable waste of 30 days.

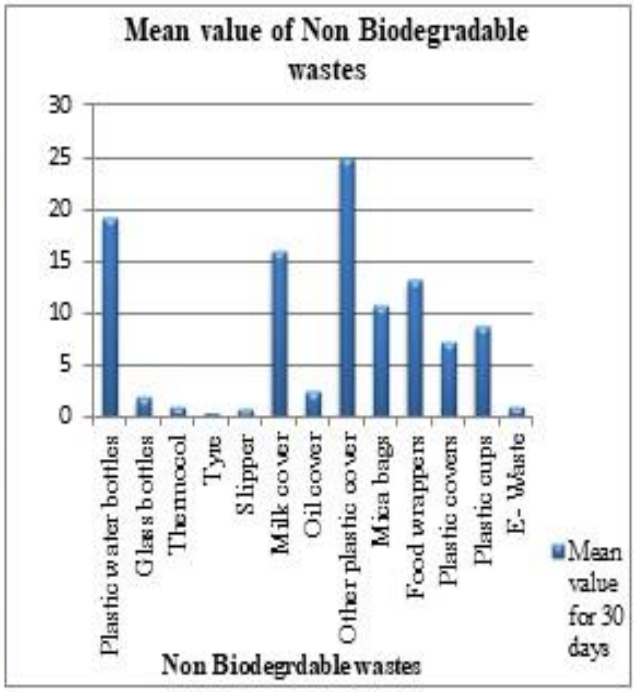

Table 4: Mean value of Biodegradable waste of 30 days collected from Ayapakkam Lake.

S.NO	BIODEGRADABLE WASTE	MEAN VALUE OF 30 DAYS
1	Clothes	9.67
2	Wooden frame	2.53
3	Newspaper	12.57
4	Remains of dead organisms	0.2

Table 4: Mean value of Biodegradable waste of 30 days collected from Ayapakkam Lake.

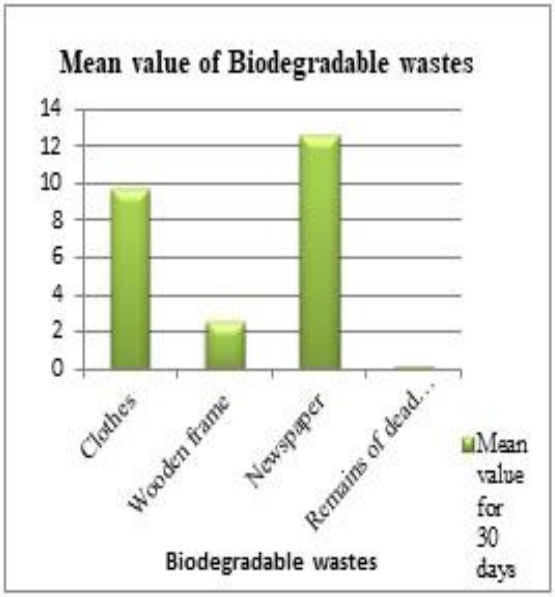

Table 5: Represents the Non Biodegradable and Biodegradable wastes with Group Statistics

	TWO DIFFERENT GROUPS	N	MEAN	STANDARD DEVIATION
DIFFERENT CATEGORIES OF WASTE COLLECTED	Non biodegradable waste	30	107.43	20.571
	Biodegradable waste	30	24.97	22.607

Table 6: Independent Sample test for the different categories of waste collected.

		F(levene's test)	Sig(significant/p value)	t(independent sample test)	df(degree of freedom)	Sig(2-tailed)
DIFFERENT CATEGORIES OF WASTE COLLECTED	Equal variances assumed	0.486	0.489	14.778	58	<.001
	Equal variance not assumed			14.778	57.491	<.001

The colour of the water sample collected from Ayapakkam Lake was found to be yellowish green. Water colour is crucial as it indicates source of water and pollutants, various wastes causes are accountable for the colour change. Whereas colour is also influenced by suspended and dissolved particles. Highly coloured water is not suitable for aquatic life which would lead to long term impaired ecosystem. Slightly foul smell was objectable in the collected water sample, which is due to the accumulation of organic and inorganic waste particles. Algal mat decay also produces a foul odour because of the release of methane gas [16].The pH of the water sample from Ayapakkam lake is 8.6 (Basic or Alkaline), this would endorse the survival of aquatic organism, but it is not only factor which is determining the aquatic population [17]. Aquatic organisms prefer pH of 6.5-8.0, beyond this range organism become physiologically stressed [18]. Photosynthesis, Respiratory activity and Disposal of industrial wastes also change the pH value [19].

Biological oxygen demand (BOD) is the amount of organic materials present in water that can brace microorganism. Surface water containing BOD more than 20 mg/l indicates water is highly polluted. The BOD of water sample is 52 mg/l; this indicates the presence of elevated level of organic and inorganic pollutants that demand oxygen for oxidation [20]. High amount of organic matter in water increases the BOD [21].

Chemical oxygen demand (COD) of water sample is 380mg/l; the value is very high when compared to drinking water standard. The presence of high COD in water sample indicates that water is contaminated heavily [20]. The COD value shows the toxic condition

and the presence of biologically resistant organic substances in water sample [14]. Both BOD and COD are important indicators of healthy lake ecosystem [15].

Alkalinity measures the ability of water bodies to neutralize the acids and bases, thereby maintaining a stable pH. The alkalinity of water sample is 570mg/l. High alkalinity preferably maintains the pH of water and it also has the ability to neutralize acidic pollution from pollutants [18]. Change in the alkalinity results in the fluctuation of pH that may cause poor growth and even death of aquatic organism [22]. Alkalinity and hardness become dreadful to aquatic life when water is affected by anthropogenic activity [23].

Hardness refers to the amount of calcium and magnesium present in water [20]. The hardness of water sample was 690mg/l. Water hardness helps to overcome the effects of other toxic elements present in water. The toxic action of fluoride ions in water can be reduced with increasing water hardness [24]. Water hardness has remarkable effect on pH and their instability makes aquatic environment stressful [25]. Elevated hardness is due to consistent addition of sewage and detergents into the lake from nearby localities [26] [27].

Chloride, Nitrate, Calcium and Magnesium are some of the total dissolved solids (TDS) in water, their presence is necessary for the aquatic organisms. But high level of TDS would reduce the water clarity thereby decreasing the rate of photosynthesis and when TDS combines with other toxic compounds stimulates the temperature of water [28]. Temperatures chiefly determine the overall health of aquatic ecosystems [29]. The value of Chloride, Nitrate, Calcium and Magnesium are as follows 360mg/l, 51mg/l, 200mg/l and 150mg/l respectively. This high value of TDS implies that the life of aquatic organism is adversely limited. High rate of evaporation and organic wastes from animal origin would increase the chloride concentration in lake water [30] [31]. Anthropogenic sources have increased the level of nitrate in aquatic environment [32]. High level of nitrate can lead to direct toxicity to aquatic organism [33]. Water conductivity is affected by the presence of inorganic dissolved solids such as chloride and calcium [17] [34]. Calcium is present naturally in water, but the disposal of sewage waste might be blameworthy for the increase in amount of calcium [35]. Significant amount of magnesium influence water quality [36].

Dissolved oxygen (DO) refers to the amount of gaseous oxygen available to aquatic organism. The DO present in water sample is 4.8 mg/l. A Low DO concentration creates hypoxic conditions for aquatic organisms. Some fish may tolerate short-term exposure to hypoxia; only few persist in low oxygen conditions [37]. High temperature, Sewage disposal and waste dumping might also be responsible for low DO value [39]. Increased microbial activity might also deplete the DO value in water [40].

The drastic change in the physiochemical parameters of water is due to various mismanaged anthropogenic activity. By comparison, the Non Biodegradable waste N= 30, with mean (M=107.43) and standard deviation (SD =20.571) were numerically larger than Biodegradable waste N=30, with mean (M=24.97) and standard deviation (SD =22.607). To test the hypothesis, the Non Biodegradable and Biodegradable waste were associated with statistically significantly different mean of waste collected; an independent samples t-test was performed. Additionally the assumption of homogeneity of variance was tested and satisfied via levene's F test $F(58) = 0.486$, $P = 0.489$. The independent sample t-test was associated with a statistically significant effect $t(58) = 14.778$, $P = <0.001$, thus the Non Biodegradable were associated with statistically significant larger mean than bio-degradable waste.

Synthetic plastics were used widely in various fields due to its physiochemical properties and economic viabilities [41]. Inappropriate disposal of low Biodegradable polymers might deteriorate the normal ecological condition [42].

4. CONCLUSION

Throughout the study, it has been observed that the waste generation kept increasing in the Ayapakkam Lake day by day. This has affected the quality of water and it can cause serious Problems in near future if not controlled properly. The ecosystem is under serious threat. The Non Biodegradable wastes will cause harmful effects to the next generation of human population hence; immediate action is required in making this region pollution free environment. Various Measures must be taken to avoid dumping of waste in the natural water resources.

Figure 7: Algal blooms because of garbage dumping in Ayapakkam Lake

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Figure 9: Plastic dumped in Ayapakkam Lake

Figure 9: Plastic dumped in Ayapakkam Lake

ACKNOWLEDGEMENT

We wish to express our sincere and profound gratitude to Subash Scout group headed by Mr. A. Veeramani and Mr. P. Kamalesh, for helping us during the sample collection process.

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