Comparison of parameters of Lake in Chennai prior to and after monsoon

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ABSTRACT

Aim:The objective of this research article is to perform the effects of variation of chemical characteristics of water collected from Avadi lake compared with drinking water in pre-monsoon and post-monsoon periods. **Materials & Methods:** The samples were collected from Avadi Lake. The samples have applied chemical parameters for analysis of drinking water qualities was sample 8 (Group 1= 4 and Group 2 = 4) and calculation is performed utilizing G-power 0.8 with alpha and beta qualities are 0.05, 0.2 with a confidence interval at 95%. Analyzing the chemical characteristics of water is performed by the standard drinking water whereas the number of samples (N=4) and Avadi lake water are the number of samples (N=4). **Results:** The chemical characteristics of Avadi lake water of PH, BOD, COD, DO, Alky, and TH is 7.3, 35, 250, 450, 5.5 and 610 and the standard drinking water of PH, BOD, COD, DO, Alky, and TH is 7, 30, 10, 200, 10, and 380. The study has a significance value of $p<0.05$ i.e., p=0.022. **Conclusion:** The standard drinking water provides better outcomes in chemical characteristics of water when compared to Avadi lake water for analyzing the quality of water.

Keywords: Quality of water, Novel standard drinking water, Lake water, Chemical characteristics, Avadi Lake, Pre-monsoon, Post-monsoon.

INTRODUCTION

Water is a natural resource, the principal component of all living organisms in this world. Main source of water is from rainfall, subsequently it in excess flow through rivers, stored in lakes, ponds etc., are usually considered as sources of surface water. Physical, chemical and biological characteristics determine the quality of water (Puri, Yenkie, and Battalwar 2010). The values of some chemical parameters of water above the allowed limits can affect the human body (Mustapha and Omotoso 2005; Jinwal and Dixit 2008). Hence, it becomes essential to ensure the quality of groundwater to utilize it for various purposes. The present study was made to assess the water quality of Avadi Lake, Chennai, India before and after the monsoon season. To carry out the study, samples were collected from the lake before and after the commencement of Rains. Various chemical parameters such asHydrogen Ion Concentration (pH), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), dissolved oxygen (DO), alkalinity, and total hardness values were determined (Kumar and Preethi 2017). These parameters were then compared with the Indian Council of Medical Research (ICMR) standards to draw the final conclusion on the quality of the lake water before and after the rainy season. Water is a vital resource with numerous applications such as home, recreational,

transportation, hydroelectric power, industrial, and commercial (Logeshkumaran et al. 2015).

Several researchers are still studying the physicochemical and biological characteristics of standing and running water resources. IEEE Explore has 67 research publications while Google Scholar has 105 articles. Chen and colleagues (Chen et al. 2013) concluded that DO is the most critical metric for studying water quality and required for the metabolism of all aquatic organisms, was discovered to be Nil at seven sites. In (Ganai and Parveen 2014) the authors concluded that water temperature, CO_2, chloride, clarity, TDS, alkalinity, and dissolved oxygen are the most critical parameters influencing phytoplankton dispersal. Several authors (Toufeek 2005; Korium 2001; Singh, Agrawal, and Panwar 2008) followed the sequence of seasonal and regional changes in the physical and chemical features of water at different depths in Lake Nasser. Sayyah et al. (Toufeek and Korium 2009) investigated the major anions and cations in the northern part of Nasser Lake. Deepa P et al. (Deepa et al. 2016) did a study to analyse the seasonal changes of physicochemical characteristics of Korattur lake, Chennai, Tamil Nadu, India. Agarwal et al. (Agarwal and Garg 2016) conducted research to give relevant data and aid in understanding water properties, indicating that the water of the Bihar River can act as a helpful habitat. Manjare et al. (Manjare, Vhanalakar, and Muley 2010) studied the Physico-chemical Parameters of Tamadalge Water Tank in Kolhapur District, Maharashtra.Our institution is passionate about high quality evidence based research and has excelled in various fields(Parakh et al. 2020; Pham et al. 2021;

Perumal et al. 2021; Sathiyamoorthi et al. 2021; Devarajan et al. 2021; Dhanraj and Rajeshkumar 2021; Uganya et al. 2021; Tesfaye Jule et al. 2021; Nandhini et al. 2020; Kamath et al. 2020)

Drinking water is contaminated through the pipe distribution system directly through ground water due to addition of waste discharged from domestic, industrial and agriculture sources. The effluent contains various inorganic and organic substances in different concentrations that may affect the nature and quality of Lake Water. In the present study an attempt has been made to identify the water quality of Avadi lake in Pre monsoon and Post monsoon phase in 2020. The determined chemical parameters were compared with Indian Council of Medical Research (ICMR) standards for the drinking water to know about the quality of the lake water. Better water quality was found in the post-monsoon season than pre-monsoon season. Extent of pollution occurred due to over exploitation of groundwater, urbanization and anthropogenic activities.

MATERIALS AND METHODS

This work was carried out in the Biotechnology Laboratory, Department of Civil Engineering, and Saveetha School of Engineering. Avadi Lake was used to collect the samples. Avadi Lake is located in western part of the metropolitan city of Chennai, Tamil Nadu. The water samples were collected in sterile polyethylene bottles and kept in an ice box to avoid unpredictable changes in Chemical characteristics. For the pre-monsoon and post-monsoon seasons, data is collected on a regular basis. Chemical characteristics parameters such Hydrogen Ion Concentration (pH), Biochemical oxygen demand (BOD), Chemical oxygen demand

(COD), dissolved oxygen (DO), alkalinity, and total hardness values were analyzed in the laboratory using standard methods as prescribed by APHA, AWWA, (Vega et al. 1998), Trivedy and Goel (Trivedy and Goel 1984), and Kodarkar (Kodarkar et al. 1998). These results were compared with Indian Council of Medical Research (ICMR) limits. It involves two sample groups, each of which requires 10 samples and 20 sample tests to complete the experiment. Avadi lake water was classified as Group 1, while ordinary drinking water was classified as Group 2. The calculation is done with G-power 0.8, alpha and beta values of 0.05, 0.2, and a 95 percent confidence interval.

Chemical Characteristics of Lake Water

Hydrogen Ion Concentration (pH)

Water pH is influenced by a number of factors including rock and soil composition and the presence of organic materials or other chemicals. Higher pH results in higher alkalinity by the presence of two common minerals, calcium and magnesium, affecting the hardness of the water (WHO, 2011). The pH is an important variable in water quality assessment as it influences many biological and chemical processes within a water body and all processes associated with water supply and treatment. pH is principally controlled by the balance between the carbon dioxide, carbonate and bicarbonate ions (alkaline nature) as well as compounds such as humic and fulvic acids (acidic nature) in the groundwater. The term pH is used to indicate the acidity or alkalinity of a substance. The desirable pH may range from 6.5 to 8.5 and there is strictly no relaxation for this limit. The pH mean values of the water samples in the

pre-monsoon and post-monsoon seasons were 7.29 and 7.05 respectively. This approves that the nature of ground water samples vary from slightly acidic to slightly alkaline.

Biological Oxygen Demand (BOD)

BOD is a measure of the amount of organic matter in water that can support the growth of microbial organisms. Surface water (river, lake, and pond) with BOD values of 10 mg/l is considered moderately polluted, whereas water with BOD values greater than 20 mg/l is considered severely polluted. The lake water has a biological oxygen requirement of 46 mg/l. Because the lake water has a high BOD level when compared to the drinking water standard, it would be easy to deplete the oxygen content if any material that would react with oxygen was present. Thus, a high BOD content in the sample (46 mg/l) indicates a high concentration of organic and inorganic waste components that require oxygen for oxidation. This depicts the leakage of organic and inorganic waste elements from the wastewater into surrounding lake water. The biological oxygen demand is a critical metric that reflects the extent of water pollution caused by oxidizable organic matter and the oxygen utilized to oxidize inorganic elements such as sulfides and ferrous ions.

Chemical Oxygen Demand (COD)

The COD test estimates the amount of oxygen needed for chemical oxidation of organic matter in the absence of strong chemical oxidants. The COD test is used to assess the contamination of home and industrial waste. The amount of oxygen required for the oxidation of organic materials to create carbon dioxide and

water is used to quantify waste. With a few exceptions, all organic molecules can be oxidized by the action of powerful oxidizing agents under acidic conditions. COD is important in detecting hazardous conditions and the presence of biological resistance chemicals. The highest allowable COD value for drinking water is 10 mg/l, whereas the chemical oxygen demand of the regular drinking water standard is 250mg/l, whereas lake water contains a high level of COD (350mg/l). The cod threshold is 250 mg/l according to general environmental pollutant discharge guidelines. The fact that the lake water level is greater in samples indicates that the pollution level is considerable.

Dissolved Oxygen (DO)

DO ranged from 2.59 to 8.8mg/L during post-monsoon and pre-monsoon respectively. The average DO value for all the four seasons was 5.75mg/L. High DO values recorded during pre-monsoon may be due to changes in turbidity, TDS and temperature. The correlation between temperature and DO was not as expected, however, lower levels of DO were observed during summer and pre-monsoon which may be due to high photosynthetic activity of phytoplankton. DO is an important aquatic environmental factor, which influences the health of an aquatic ecosystem. Adequate DO is necessary for good water quality. As DO levels in water drop below 5.0mg/L, many life forms are put under stress. DO levels are influenced by water temperature, water agitation, types and numbers of aquatic plants, light penetration and amounts of dissolved or suspended solids that use oxygen such as organic matter. DO levels between 5.0 and 8.0mg/L are satisfactory for survival and growth of aquatic organisms. The low DO during post-monsoon in Avadi lake could

be related to lesser input of freshwater and also due to the biochemical oxidation of organic matter and the combined effects of temperature and photosynthetic activity.

Alkalinity (ALKY)

The total alkalinity of water refers to the total amount of carbonates and bicarbonates present. The amount of a material that elevates the pH of water determines total alkalinity. High levels of alkalinity indicate the presence of extremely alkaline industrial wastes and sewage. The decomposition of plants, living animals, and organic waste in the water body may produce an increase in carbonate and bicarbonate levels, as well as an increase in alkalinity. The alkalinity of Avadi Lake was determined to be 120 mg/l.

Total Hardness (TH)

Hardness is a very important parameter in decreasing the toxic effect of poisonous elements. The hardness of lake waters depends mainly on the presence of dissolved calcium and magnesium salts. The total content of these salts is known as general hardness, which can be further divided into carbonate hardness (determined by concentrations of calcium and magnesium hydro carbonates), and non-carbonate hardness (determined by calcium and magnesium salts of strong acids). The hardness was found to be in the range of 72 mg/lit to 380 mg/ lit in Post-monsoon and 140 mg/lit to 620 mg/lit in Pre-monsoon. In some areas of the lake, the hardness is very high, also beyond the permissible limit. It is due to rocks bearing salts of Calcium and Magnesium. ICMR has prescribed a desirable limit of total hardness is 300 mg/lit and the permissible limit in the absence of an alternate source is 600 mg/lit.

Statistical analysis

The software package utilized here for statistical implementation is IBM SPSS V26.0 (Hilbe 2004). The independent sample t test was used to determine the mean, standard deviation, and standard error mean statistical significance between the groups, and then the two groups were compared with SPSS software to obtain accurate values for the two different parameters, which were then used with the graph to calculate the significant value with maximum accuracy value (7%), mean value (7%), and standard deviation value (0.79117). Accuracy is a dependent variable, while PH, BOD, COD, DO, Alky, and TH are independent variable

Study area

Avadi lake is a lake located in Chennai district which is the capital of Tamil nadu. Chennai is one of the largest metropolitan cities in India. It is divided into major parts like central,south,west and north chennai. The latitude of Avadi lake is **13°6'21.96**and longitude 80 03 38.27" E .Chennai city corporation covers an area of 172 km2. Adyar river originates from this lake through this lake chennai city gets its water supply for drinking and other usages. It is built by Rajandra chola-1 the son of Rajandra chola and he is the prince of kodumbalur and it is the first artificial lake ever built. Its surface area is about 3800 acres . The full tank level is 85.45 ft and full capacity of 3645 million ft3. The pipelines of lake water treatment are located near the bypass of poonamallee.

This lake is dependent on northeast monsoon during the month of October, november and december rainfall. The rainfall occurs through cyclones in the bay of bengal. The water quality and quantity changes in the pre-monsoon and post-monsoon period.

RESULTS

Figure 1 shows the simple bar graph of chemical characteristics of Avadi lake water compared with standard drinking water in pre monsoon and post monsoon season. The standard drinking water of PH, BOD, COD, DO, Alky, and TH is 7, 800, 600, 100, 200, 600 and 5. The pre-monsoon chemical characteristics of Avadi lake water of PH, BOD, COD, DO, Alky, and TH is 7.3, 35, 250, 450, 5.5 and 610 and post-monsoon chemical characteristics of Avadi lake water of PH, BOD, COD, DO, Alky, and TH is 7.0, 48, 350, 480, 8.8 and 204. There is a significant difference between pre-monsoon lake water and post-monsoon lake water ($p<0.05$ Independent sample test). X-axis: pre-monsoon lake water quality vs post-monsoon lake water quality Y-axis: Median of chemical characteristics of water, for identification of keywords $\pm$ 1 SD with 95 % CI.

Table 1 shows the evaluation metrics of comparison of pre-monsoon lake water and post-monsoon lake water for analyzing the chemical characteristics of water. The pre-monsoon Lake water of PH, BOD, COD, DO, Alky, and TH is 7.3, 35, 250, 450, 5.5 and 610 and post-monsoon lake water of PH, BOD, COD, DO, Alky, and TH is 7.0, 48, 350, 480, 8.8 and 204.

Table 2 shows the statistical calculation such as Median, standard deviation and standard error Median for pre-monsoon lake water and post-monsoon lake water. The chemical characteristics of water parameters used in the t-test. The pre-monsoon quality of lake water of PH, BOD, COD, DO, Alky, and TH is 7.3, 35, 250, 450, 5.5 and 610 and post-monsoon water of PH, BOD, COD, DO, Alky, and

TH is 7.0, 48, 350, 480, 8.8 and 204. The Standard Deviation of pre-monsoon water is 1.95923 and post-monsoon water is 0.56793. The Standard Error Median of pre-monsoon water is 2.97319 and post-monsoon water is 1.58627.

Table.3 displays the statistical calculations for independent samples tested between pre-monsoon lake water and post-monsoon lake water. The significance value for chemical characteristics of water is 0.022. Independent samples T-test is applied for comparison of pre-monsoon lake water and post-monsoon lake water with the confidence interval as 95% and level of significance as 0.79117. This independent sample test consists of significance as 0.001, significance (2-tailed), Median difference, standard error difference, and lower and upper interval difference.

DISCUSSION

Figure 1 shows the simple bar graph of chemical characteristics of Avadi lake water compared with standard drinking water in pre monsoon and post monsoon season. The standard drinking water of PH, BOD, COD, DO, Alky, and TH is 7, 800, 600, 100, 200, 600 and 5. The pre-monsoon chemical characteristics of Avadi lake water of PH, BOD, COD, DO, Alky, and TH is 7.3, 35, 250, 450, 5.5 and 610 and post-monsoon chemical characteristics of Avadi lake water of PH, BOD, COD, DO, Alky, and TH is 7.0, 48, 350, 480, 8.8 and 204. There is a significant difference between pre-monsoon lake water and post-monsoon lake water (p<0.05 Independent sample test). X-axis: pre-monsoon lake water quality vs post-monsoon lake water quality Y-axis: Median of chemical characteristics of water, for identification of keywords ± 1 SD with 95 % CI.

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Conclusion

The proposed model exhibits the Avadi lake water and standard drinking water, in pre-monsoon and post-monsoon periods in

which the pre-monsoon lake water quality has the highest chemical characteristics in water. The pre-monsoon quality of Avadi Lake water of PH, BOD, COD, DO, Alky, and TH is 7.3, 35, 250, 450, 5.5 and 610 and post-monsoon quality of Avadi Lake water of PH, BOD, COD, DO, Alky, and TH is 7.0, 48, 350, 480, 8.8 and 204. The present study suggests that the Avadi Lake water showed high DO, BOD and COD in post-monsoon season and the parameters pH were within the tolerance limits suggested by the ICMR standards According to the findings of this research study, the lake water in the study area is unfit for drinking and must be recycled before being used for irrigation.

DECLARATION
Conflict of interest
No conflict of interests in this manuscripts
AUTHOR CONTRIBUTION
Author GM was involved in data collection,data analysis , and manuscript writing. Author SLV was involved in conceptualization ,data validation ,and critical review of manuscript.

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TABLES AND FIGURES

Table 1. The evaluation metrics of comparison of pre-monsoon lake water and post-monsoon

lake water for analyzing the chemical characteristics of water. The pre-monsoon Lake water of PH, BOD, COD, DO, Alky, and TH is 7.3, 35, 250, 450, 5.5 and 610 and post-monsoon lake water of PH, BOD, COD, DO, Alky, and TH is 7.0, 48, 350, 480, 8.8 and 204.

	WATER QUALITY										
	Pre-monsoon						Post-monsoon				
Test Cases											
	pH	BOD	COD	ALKY	DO	TH	pH	BOD	COD	ALKY	DO	TH
Sample1	7.2	32	246	447	5	607	6.8	44	352	477	8.6	202
Sample2	7	31	247	453	5.3	609	7.5	46	354	478	8.7	204
Sample3	7.15	33	253	451	5.7	612	7.2	50	346	482	8.8	206
Sample4	7.35	36.6	254	452	5.6	614	7.4	49	348	483	8.9	205
Test Results	7.3	35	250	450	5.5	610	7	48	350	480	8.8	204

Table. 2. The statistical calculation such as Median, standard deviation and standard error Median for pre-monsoon lake water and post-monsoon lake water. The chemical characteristics of water parameter used in the t-test. The pre-monsoon quality of lake water of PH, BOD, COD, DO, Alky, and TH is 7.3, 35, 250, 450, 5.5 and 610 and post-monsoon water of PH, BOD, COD, DO, Alky, and TH is 7.0, 48, 350, 480, 8.8 and 204. The Standard Deviation of pre-monsoon water is 1.95923 and post-monsoon water is 0.56793. The Standard Error Median of pre-monsoon water is 2.97319 and post-monsoon water is 1.58627.

Group		N	Median	Standard Deviation	Standard Error Median
	Pre-monsoon	4	7.3	0.56793	1.58627
pH	Post-monsoon	4	7	1.95923	2.97319
BOD	Pre-monsoon	4	35	0.60122	0.99727
	Post-monsoon	4	48	1.69712	0.80212
COD	Pre-monsoon	4	250	0.73002	0.50987

	Post-monsoon	4	350	1.70132	1.98278
ALKY	Pre-monsoon	4	450	0.69811	1.43432
	Post-monsoon	4	480	1.60832	1.90047
DO	Pre-monsoon	4	5.5	0.30813	1.70413
	Post-monsoon	4	8.8	1.71732	1.99654
TH	Pre-monsoon	4	610	2.45713	2.90918
	Post-monsoon	4	204	1.08742	1.19847

Table 3. The statistical calculations for independent samples test between pre-monsoon lake water and post-monsoon lake water. The significance value for chemical characteristics of water is 0.022. Independent samples T-test is applied for comparison of pre-monsoon lake water and post-monsoon lake water with the confidence interval as 95% and level of significance as 0.79117. This independent sample test consists of significance as 0.001, significance (2-tailed), Median difference, standard error difference, and lower and upper interval difference.

Group		Levene's Test for Equality of Variances		t-test for Equality of Medians						
		F	Sig.	t	df	Sig. (2-tailed)	Median Difference	Std. Error Difference	95% Confidence Interval (Lower)	95% Confidence Interval (Upper)
	Equal variances assumed	5.7	0.022	12.263	38	0.001	9.7025	0.79117		11.30414
									8.10086	
Pre-monsoon	Equal variances not assumed			12.263	37.52	0.001	9.7025	0.79117		11.30481
									8.10086	

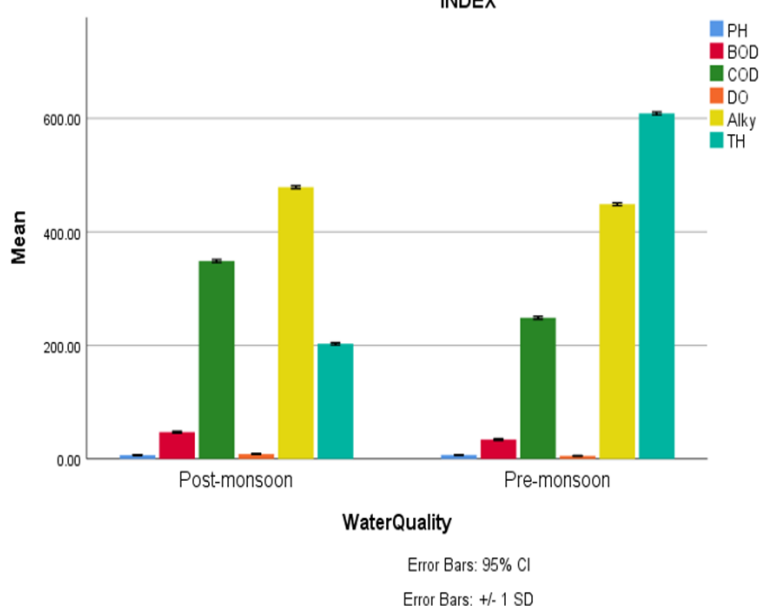|										
	Equal variances assumed	5.443	0.031	5.07	18	0.001	5.43	1.07093	3.18005	7.67995
Post-monsoon	Equal variances not assumed			5.07	15.754	0.001	5.43	1.07093	3.15683	7.70317

Fig. 1. The simple bar graph of chemical characteristics of Avadi lake water is compared with standard drinking water in pre monsoon and post monsoon season. The standard drinking water of PH, BOD, COD, DO, Alky, and TH is 7, 800, 600, 100, 200, 600 and 5. The pre-monsoon chemical characteristics of Avadi lake water of PH, BOD, COD, DO, Alky, and TH is 7.3, 35, 250, 450, 5.5 and 610 and post-monsoon chemical characteristics of Avadi lake water of PH, BOD, COD, DO, Alky, and TH is 7.0, 48, 350, 480, 8.8 and 204. There is a significant difference between pre-monsoon Lake water and post-monsoon lake water ($p<0.05$ Independent sample test). X-axis: pre-monsoon Lake water quality vs post-monsoon Lake water quality Y-axis: Median of chemical characteristics of water, for identification of keywords $\pm$ 1 SD with 95 % CI.