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RESEARCH ARTICLE

A Comparison between Turbidity, and Electrical Conductivity of Pond Water and RO Water in Thandalam for Enhanced Sustainability

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ABSTRACT

Aim: The aim of this study is to check the potability of pond water and RO water. This is carried out by comparing the Electrical Conductivity (EC) and turbidity of two different sources of water. **Materials and methods:** Twenty number of samples from a local pond and potable water sources were tested for turbidity and electrical conductivity using turbidity meter and conductivity meter, respectively. **Results and Discussion:** On performing an independent samples t-test on the two groups considered, it is observed that there exists a significant difference between the turbidity and the EC ($p < 0.05$). Turbidity was higher in pond water (21.20 ± 2.51) than that of RO water (6.55 ± 0.33). The concentration of EC is also higher for pond water (1.67 ± 0.35) than that of RO water (0.15 ± 0.33). **Conclusion:** This study shows that the pond water is not potable when compared to RO water. The pond water requires treatment prior to domestic use in order to improve sustainability.

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Introduction

Earth is covered with three-fourth of water, out of which only one percentage is available as potable water. Due to increase in population, and human activities for appropriate economic growth, the demand for water increases (Bhagde et al. 2020). The rate of water scarcity increases day by day continuously. In order to overcome this problem, it is required to treat the water from various sources of water and improve the quality of water, leading to enhanced sustainability (Sajitha and Vijayamma 2016; Apriani, Hadi, and Masduqi 2018). Identification of appropriate treatment techniques is of immense importance and the treatment applied to the water varies depending on a number of influencing factors from source of water to physico-chemical parameters of water.

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In order to identify specific treatment applicable, it is required to analyse the various physical, chemical and biological characteristics of water. A profound number of applications use the testing of EC and turbidity. With the testing of these parameters, it is possible to improve the water treatment methods, increase the desired efficiency in water quality and also recharge the ponds artificially (Li, Hägg, and Persson, n.d., 2020). Turbidity is used as a means to monitor and regulate the water treatment processes and distribution system according to (Burlingame, Pickel, and Roman 1998). The physico-chemical characteristics of the water further serves as an input to the mapping and monitoring groundwater potential zones using remote sensing and GIS and can be applied for a diverse environmental engineering applications (Machiwal et al. 2018; Lakshmi and Reddy 2018).

A number of research articles have been published emphasizing the physico-chemical parameters being studied for water quality and enhancing potability of water. The total number of articles published in this topic over the past 5 years in science direct and google scholar is 250 and 125 respectively. Turbidity is a measure of the ability of the water to scatter and absorb the light passing through it. Turbidity makes the water cloudy or muddy and is mainly caused due to the presence of suspended and dissolved materials such as clay, organic matter, planktons and other microorganisms. Turbidity, therefore, relies hugely on the amount of suspended solids present in the water. However, pollutants cannot be identified with turbidity (Pérez–Sicairos et al. 2011). The standard value of turbidity according to BIS standards is 5 NTU. Seventeen parameters were used to test the quality of water which is used to calculate WQI The water samples that are collected from 5 locations on monthly basis and statistical analysis showed that there is no significant difference found in physical and chemical parameters of water quality among the different blocks and months (Nandal et al. 2020). In another study, the physico-chemical parameters of groundwater in Thirupathur district is carried out. It has been observed that the groundwater is dominated by Na+, Ca+ and Cl- (Nandal et al. 2020). Three urban pond samples were used to determine the quality and it is found that the pond water from location 3 is of poorer quality than other locations in Nadia district of West Bengal (Saha, Mandal, and Sahoo 2017).

Previously our team has a rich experience in working on various research projects across multiple disciplines (Sathish and Karthick 2020; Varghese, Ramesh, and Veeraiyan 2019; S. R. Samuel, Acharya, and Rao 2020; Venu, Raju, and Subramani 2019; M. S. Samuel et al. 2019; Venu, Subramani, and Raju 2019; Mehta et al. 2019; Sharma et al. 2019; Malli Sureshbabu et al. 2019; Krishnaswamy et al. 2020; Muthukrishnan et al. 2020; Gheena and Ezhilarasan 2019; Vignesh et al. 2019; Ke et al. 2019; Vijayakumar Jain et al. 2019; Jose, Ajitha, and Subbaiyan 2020). Now the growing trend in this area motivated us to pursue this project.

The physical characteristics of pond and RO water is yet to be characterised in Thandalam village, Sriperumbudur district. Analysing the turbidity and EC of water samples will help to identify the potable nature of the water. A number of studies on water quality have already been studied in the previous years but have not been tested in Thandalam village. The aim of this study is to check the potability of water by comparing turbidity and EC of two sources of water in Thandalam village, Sriperumbudur district. In particular, the physical parameters such as Electrical Conductivity (EC) and turbidity are taken into consideration (Saha, Mandal, and Sahoo 2017). The results of the tests are then compared with BIS standards to suggest suitable treatment to the water.

Materials and Methods

The tests were conducted in Water Quality Analysis laboratory, Saveetha School of Engineering, SIMATS, Tamil Nadu, India. The two groups of water are group A - pond water and group b - RO water. A total of 20 samples for each group, i.e., 20 samples of pond and RO water each were collected in and around Thandalam. The samples were collected (N=20) for the Group 1(Pond Water) at regular intervals of 5 m across the pond. In addition, 20 samples (N=20) of Group 2 (RO water) were taken from different places along the village. The sample size was taken as 20 after being calculated for a pre-test power of 80% with an alpha value of 0.05 in clinical.com (Kane, Phar, and BCPS n.d.). The input for the sample size calculation is the mean and standard deviation of the parameters from previous established studies (Sarkar, Ghosh, and Mondal 2020) with a mean of 123.11±21.2 for pond A and a mean of 218.50 µs/cm. This led to a sample of 2, however, 20 samples for each group were taken. This resulted in a total of 40 samples.

The samples for both groups are kept in reagents that do not alter the qualities of the water during the testing.

Turbidity of the water samples were tested using Turbiditimeter. Electrical Conductivitimeter with positively charged electrolyte was used to test for Electrical Conductivity. The values of turbidity and EC are plotted in Fig. 4 and 5, respectively. EC is measured with an EC measuring equipment, where the samples of water are placed in the beakers and a probe is inserted to check the drop in voltage, which is later calculated as resistance and hence, conductivity is inferred. As per the BIS standards, there are no limiting values for EC and turbidity ranges from 1 to 5 NTU. The testing set up for the measurement of turbidity and EC is shown in Fig. 1 and 2. Table 1 shows the results thus obtained from the tests.

Fig. 1. Turbiditimeter set-up to test turbidity for both the groups of water samples. A total of twenty iterations of the turbidity measurements were taken to avoid discrepancies

Fig. 2. Electrical conductivitimeter setup with electrolyte for testing EC in both groups of water samples. Twenty numbers of iterations were taken and averaged to obtain the EC values.

Table 1. Turbidity and Electrical Conductivity Values obtained for the two sources of water, pond and RO water as tested in the laboratory

Sl. No	Pond Water		RO Water	
	Turbidity	EC	Turbidity	EC
1	21.56	1.47	6.4	0.1
2	20.8	1.473	6.6	0.1
3	20.1	1.478	7.1	0.12
4	20.67	1.463	6.9	0.19
5	20.78	1.467	6.75	0.2
6	21.21	1.47	6.5	0.173
7	22	1.179	6.6	0.123
8	18	1.469	6	0.1579
9	21.78	1.473	6.2	0.13
10	21	1.437	6.3	0.179
11	19	1.47	6.1	0.21
12	21.78	1.49	6.4	0.128
13	18	1.43	6.6	0.147
14	16	2.12	7.1	0.128
15	19	2.6	6.9	0.15
16	22.8	1.96	6.75	0.159
17	24.3	1.923	6.5	0.1978
18	25.7	1.978	6.6	0.2
19	25.6	2.16	6	0.21
20	24	1.923	6.75	0.147

A statistical analysis between the two groups of water is performed using SPSS version 25. An independent samples t-test was carried out with independent variables as EC and turbidity from pond water and RO water. No dependent variables are considered in this study.

Results

Figures 1 and 2 show the laboratory set-up used for carrying out the measurements of the two parameters considered in this study. The electrolyte, Sodium Chloride (NaCl) used for the EC tests is also displayed in the Fig. 2. The results of the tests conducted in the laboratory are displayed in Table 1. And it is evident that values of turbidity and EC are higher in pond water than that of RO water. Table 2 shows the mean values for the two parameters, their standard deviation and the standard error in mean obtained as a result of the independent-samples-t-test on the samples. Table 3 portrays the mean and standard deviation of the two parameters, turbidity and EC tested from two different sources of water for 20 different samples (N=20). Mean of the turbidity and EC of pond water is higher than RO water (Mean = 21.20 and 6.55 respectively). The correlation between the EC and turbidity of the two groups is also observed to be too low (R^2 = 0.0551 and R^2= 0.0538 for turbidity and EC, respectively) as shown in Figures 3 and 4. Hence, it may be said that the pond water quality is relatively poorer than that of RO water.

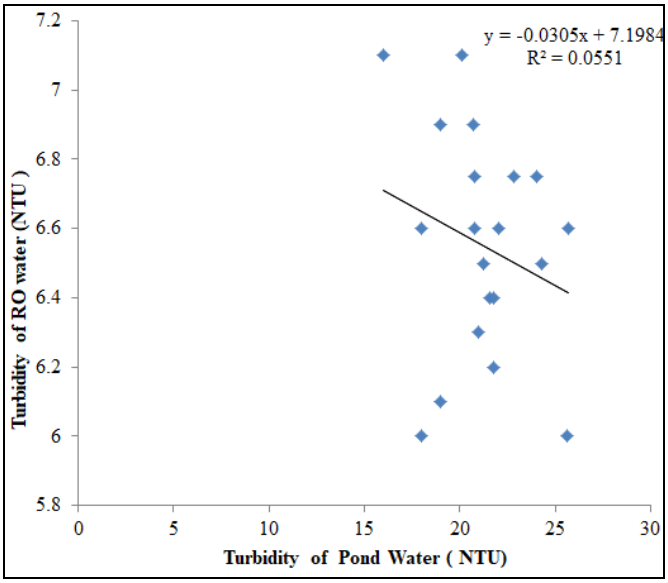

Fig. 3. Coefficient of correlation between the turbidity of pond and RO water. The graph shows a poor correlation of 0.23 between the turbidity of two groups.

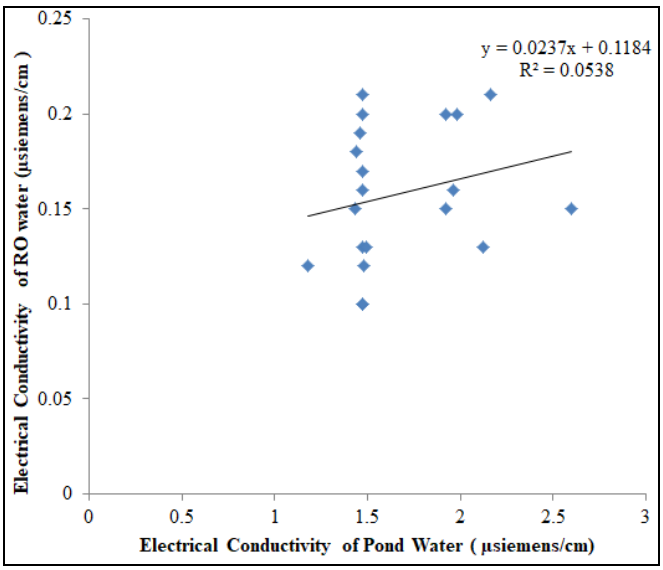

Fig. 4. Coefficient of correlation between the EC of pond and RO water. The graph shows a poor correlation of 0.23 between the EC of two groups suggesting that the two groups do not agree with each other.

Table 2. Groups statistics showing the mean, standard deviation and standard error mean values for the two groups considered in the study with 20 samples for each group, namely, pond water and RO water. The confidence interval is kept at 95%. It is observed that pond water is much more unsuitable for consumption than the RO water.

Group Statistics					
	Source of water	N	Mean	Standard deviation	Std. error mean
Turbidity	Pond water RO water	20 20	21.2040 6.5525	2.51448 0.32625	0.56225 0.7295
EC	Pond water RO water	20 20	1.6717 0.1575	0.35234 0.3590	0.7879 0.00803

Table 3: The results of an independent samples-t-test run on the samples that there is a significant difference between the pond water and RO in terms of turbidity ($p < 0.05$). Also, there is a significant difference between EC between pond water and RO water ($p < 0.05$). Hence it can be inferred that pond water is less potable than RO water.

Independent-samples-t-test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Turbidity Equal Variances Assumed Equal Variances Not Assumed	19.369	0.000	25.842 25.842	38 19.640	0.000 0.000	14.65150 14.65150	0.56697 0.56697	13.50373 13.46743	15.79927 15.83557
Turbidity Equal Variances Assumed Equal Variances Not Assumed	44.113	0.000	19.120 19.120	38 19.395	0.000 0.000	1.51417 1.51417	0.07919 0.07919	1.35385 1.34864	1.67448 1.67969

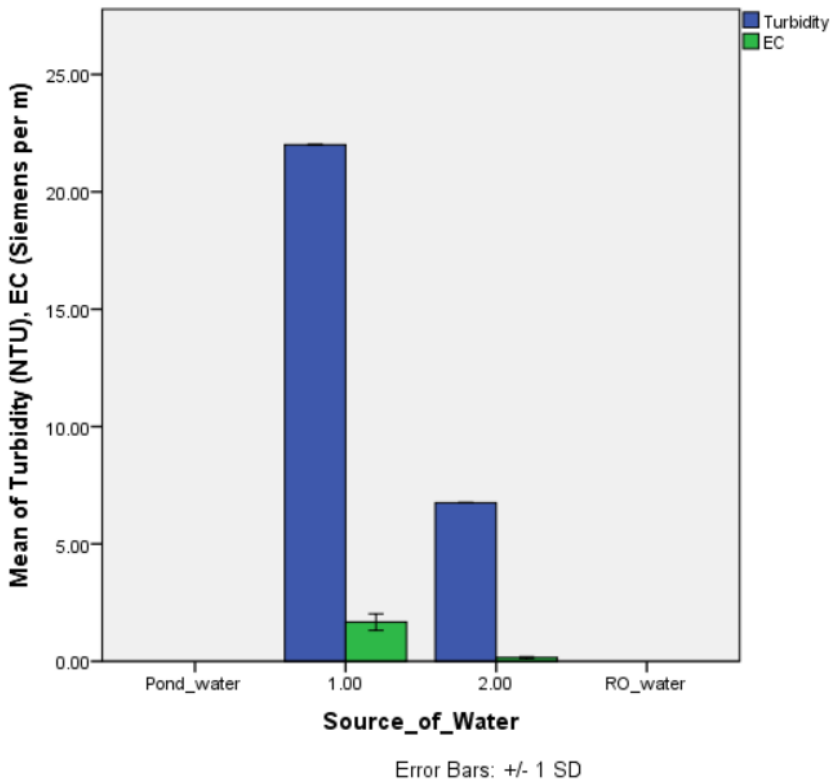

Fig. 5. A simple bar mean graph of the turbidity (represented in **blue**) and EC values (represented in **green**) for pond water and RO water by SPSS Version 25 with SD±1. There was a statistical significance between the pond water and the RO water ($p<0.05$, independent samples-t-test). It is observed that pond water seems to have higher turbid concentration than RO water. Similar high values for EC also suggests that pond water is not potable

The t-test performed on the results showed that there exists a statistically significant difference between the two groups at a confidence level of 95% and p is less than 0.05 as shown in Fig. 5.

Discussions

The results of this study showed that electrical conductivity and the turbidity of pond water seemed to be higher than that of RO water in Thandalam, Sriperumbudur taluk (p-values <0.05, independent samples t-test).

This study is supported by (Rajesh, Chakravarthi, and Subashini 2018) that found samples from several water sources in and around Sriperumbudur is not potable due to turbidity being on higher end with permissible limits around 1 to 5 NTU. Another study by (Anbalagan and Balaraman 2017) observed that the turbidity values are higher and that the water needs to be treated before consumption. Although there are no limiting values for EC, EC values were higher as noted in (Sivakumar et al. 2014) who reported higher concentration of salts which lead to increase in EC values in groundwater samples in Sriperumbudur district. According to (Reyes-Toscano et al. 2020), EC is higher for high concentration of dissolved solids, however in this work, this does not stand correct. Again, the EC measured in certain ponds of coastal Bangladesh ranged between 1.50 - 14.25 µsiemens/cm which is similar to the starting values of this study. To identify the potability of the pond water, it is required to compare the EC and turbidity values and in some cases, both the parameters measured in the pond water samples were more than standards and in certain cases, it was below the standards suggesting the water samples from the pond is not potable.

(Sajitha and Vijayamma 2016) claim that pond water quality in Athiyanoor district of Kerala, the EC values ranging between 42 - 137 µsiemens/cm yielded better Water Quality Indices suggesting that pond water is potable and suitable for domestic use. The same is the case with pond water in (Barde and Solanki 2021). However, a majority of the studies have concluded that the pond water in the region requires treatment before consumption (Udhayakumar et al. 2016).

The factors affecting water characteristics are sampling locations and number of samples, climatic conditions such as temperature and presence of dissolved and suspended solids, size and shape of particles and composition of the particles. (A. Malar, T. Suriya, R. Meenakshi, S. Laxmi Priya 2015; Rawat, German Amali Jacintha, and Singh 2018) also observed higher concentration of salts which lead to increase in EC values in groundwater samples in Sriperumbudur.

Our institution is passionate about high quality evidence based research and has excelled in various fields ((Vijayashree Priyadharsini 2019; Ezhilarasan, Apoorva, and Ashok Vardhan 2019; Ramesh et al. 2018; Mathew et al. 2020; Sridharan et al. 2019; Pc, Marimuthu, and Devadoss 2018; Ramadurai et al. 2019). We hope this study adds to this rich legacy.

In this study, the samples were taken during the post-monsoon period. In order to investigate the seasonal variations pre-monsoon samples may be studied which will encompass the differences in the quality of water. Also, a high number of samples may be used to cater to study the diversity in range of values obtained in the tests. In this study, only electrical conductivity and turbidity are studied. More number of samples may be studied to address the diversity in range of values and water quality index with other parameters might be analysed to identify the potability of water. In addition, to address the seasonal variations a spatio-temporal study on the physico-chemical properties of water may yield better visualisation for the purpose of enhanced understanding (Chawla, Karthikeyan, and Mishra 2020; "Delineation of Groundwater Potential Zones in Semi-Aridregion (Ananatapuram) Using Geospatial Techniques" 2021).

Conclusion

In this study, it is concluded that turbidity and EC were found to be in higher concentration in pond water than that of RO water and hence, pond water is not suitable for consumption or domestic purposes. It is suggested that water needs to be treated appropriately which could increase potability of water in ponds in the Sriperumbudur Taluk, Tamil Nadu and increase sustainability.

Declarations

Conflict of Interests

No conflict of interests in this manuscript.

Authors Contributions

Author PP was involved in data collection, data analysis, manuscript writing. Author SVL was involved in conceptualization, data validation, and critical review of the manuscript.

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