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Seasonal variation in physico-chemical and microbiological parameters in ground water quality of Anthikkad, Thrissur, Kerala

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Abstract
Water is one of the precious natural resource and is a vital substance for all natural and anthropogenic activities. Groundwater is considered as the safest source of water and regular assessment of ground water quality is essential for maintaining public health. The present study was conducted to assess seasonal variation in physico-chemical and microbiological quality of ground water at Anthikkad in Thrissur district, Kerala. A total of 80 open well water samples, 40 each during pre-monsoon and post monsoon were collected and analysed for physico-chemical parameters like pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), turbidity, Biochemical Oxygen Demand (BOD) and concentration of nitrate. Samples are also analysed for microbiological qualities like Aerobic Plate Count (APC), Coliform count, *Escherichia coli* and faecal *Streptococci* count. Significant difference between seasons could be recorded for all parameters investigated except TDS, turbidity and faecal *Streptococci* count. The results obtained were compared with WHO (2008) and BIS (2012) limits for drinking water.

Keywords: Ground water, seasonal variation, physico-chemical, faecal *Streptococci*

Introduction
Water is one of the inevitable natural resources for survival and development of life on the earth. Surface and ground water constitutes the major sources of fresh water available on earth and ground water constitutes only 30% of fresh water available on earth. Groundwater is considered to be safe and free from contaminants than surface water. However, decline in the quality of drinking water sources has emerged as a threat to human life. Water quality is declining day by day due to various natural and anthropogenic activities and it has a direct impact on public health. Water pollution occurs due to the presence of dissolved or suspended solids, pathogenic microorganisms and persistent pollutants such as chemical compounds, heavy metals and pesticides and consumption of unsafe drinking water may result in serious health problems and fatal diseases.

Traditionally the people of Kerala mainly depend on ground water for their daily needs, hence most of the households were having their own well except in heavily populated areas. Thrissur district is located near the central part of Kerala. Anthikkad is one of the villages in Thrissur district where majority of geographical areas consisting of kole lands and paddy fields. The groundwater level is shallow in many locations of this village and water quality issues were reported from this area. Hence assessment of ground water quality is essential in this village to determine the safety of water.

Materials and Methods
Thrissur district lies between north latitudes 10º 10´ and 10º 46´ and east longitudes 75º 57´ and 76º 54´. Anthikkad block is located 16 km towards the south from district headquarters Thrissur. A total of 80 well water samples, 40 each during post monsoon (September-November, 2018) and pre monsoon (March-May, 2019) were collected from Anthikkad. Samples were analyzed for physical, chemical and microbiological parameters. Wells were randomly selected from the area and samples for analysis were taken directly from wells in sterile glass bottles of 250 ml capacity and for the analysis of BOD water was collected separately in amber coloured bottles. The collected samples were transported to laboratory and analyzed within 24 hours of collection. All the samples subjected to the analysis of physical parameters viz., pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO) (Multiparameter water meter, Thermo Fisher Scientific) and turbidity (EUTECH Turbidimeter), chemical

parameters viz., Biochemical Oxygen Demand (BOD) (WTW OxiTop IS BOD measurement system) and nitrate concentration (Merck Nitrate test kit) and microbiological parameters viz., Aerobic Plate Count (APC), coliform and *E. coli* and faecal *Streptococci* count as per the procedure of APHA (2012). Data was statistically analysed using SPSS version 24.0 by using multivariate ANOVA.

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Results and Discussion

The mean values of various physico-chemical and microbiological parameters of the groundwater samples are given in Table 1. The mean pH of pre monsoon and post monsoon season was 6.9±0.14 and 7.22±0.22, respectively, which was within the BIS (2012) [3] and WHO (2008) [9] acceptable range of 6.5 to 8.5. The pH of the water is influenced by the source of the water, type of soil, bedrock, types of contaminants (Kale, 2006) and volume of water (Mahasim *et al*., 2005) [6]. Highest pH value was recorded during post monsoon season which could be due to dilution of water as a result of precipitation.

Total dissolved solids content is related to the amount of inorganic substances present in the water. According to BIS (2012) [3] maximum permissible limit of TDS of drinking water was 2000 mg/L, while WHO (2008) [9] set the corresponding TDS value as 1500 mg/L. The mean TDS obtained in pre monsoon and post monsoon season was 211.67±24.51 and 260.31±29.99 mg/L, which was found within the permissible limit. Post monsoon increase in TDS was attributed to the leaching of salts from soil and also from near by polluting areas, these might percolate into the groundwater and lead to increase in TDS values (Vishnu *et al*., 2014) [8].

The DO content of water is one of the most important parameters for indirectly assessing the pollution level. Highest mean DO of 13.49±0.33 mg/L was recorded during post monsoon season, while pre monsoon mean DO was 10.09±0.40 mg/L. As per BIS (1992) [3] minimum value of DO for water source is 4 mg/L. Mean DO was above the minimum limit throughout the study.

Table 1: Seasonal variation in mean physico-chemical and microbiological parameters of ground water

Sl. No.	Parameters	Season (Mean±SE)	
		Pre monsoon	Post monsoon
1	pH	6.9^{a}±0.14	7.22^{b}±0.22
2	TDS (mg/L)	211.67^{a}±24.51	260.31^{a}±29.99
3	Dissolved oxygen (mg/L)	10.09^{a}±0.40	13.49^{b}±0.33
4	Turbidity (NTU)	3.7^{a}±1.93	2.87^{a}±1.84
5	BOD (mg/L)	2.62^{a}±0.15	4.97^{b}±0.13
6	Nitrate (mg/L)	1.29^{a}±0.11	2.25^{b}±0.25
7	APC (log10 cfu/mL)	4.0^{a}±0.10	3.66^{b}±0.09
8	Coliform count (MPN index/100mL)	116.21^{a}±43.82	658.22^{b}±112.4
9	*E. coli* count (MPN index/100mL)	36.13^{a}±23.45	76.77^{b}±29.82
10	Faecal *Streptococci* count (MPN index/100mL)	74.29^{a}±26.89	93.34^{a}±32.75

Means bearing different superscripts in a row differ significantly (p<0.05

DO concentration of water was affected by water temperature, dissolved salts, atmospheric pressure, altitude, suspended matter, and aquatic flora and fauna. According to Bajracharya *et al*. (2018) [1] DO content was increased with decreasing temperature. This could be the reason for the increase in DO value during post monsoon, since there was less temperature during post monsoon season than pre monsoon season.

Turbidity provides an estimate of cloudiness of the water that causes the transmitted light to reduce. Turbidity occurs due to the presence of clay, colloidal organic particles and microorganisms (Vishnu *et al*., 2014) [8]. Pre monsoon mean turbidity of 3.7±1.93 NTU was obtained, while lower post monsoon recorded a lower mean turbidity of 2.87±1.84 NTU. The maximum permissible limit of turbidity specified by BIS (2012) [3] and WHO (2008) [9] was 5.0 NTU. In both season mean turbidity was found within this range. The cause of increased turbidity during the pre monsoon season in the present study could be because of reduction in the water level and subsequent increase of suspended particulate matter (Yashoda *et al*., 2014) [10].

Biochemical oxygen demand is a measure of organic pollution of water. The pre monsoon and post monsoon mean BOD value observed in the study were 2.62±0.15 and 4.97±0.13 mg/L, respectively. Maximum permissible limit of BOD of drinking water recommended by BIS (1992) [2] is 3.0 mg/L. In the present study post monsoon season showed an increase in BOD and the value was above BIS recommended limit. Increased presence of organic contaminants coming along with the run-off water might be responsible for elevated BOD during post monsoon season. Contrary findings were obtained by Pathak and Limaye (2011) [7] in Madhya Pradesh, who reported higher BOD during pre monsoon season because of increased biological activity at elevated temperature.

Nitrate is one of the common ground water contaminants originated from natural source as well as anthropogenic activities. Assessing the nitrate concentration of water gives an indication of level of organic contamination of water. High nitrate concentration of 2.25±0.25 mg/L was detected during post monsoon than pre monsoon season nitrate concentration of 1.29±0.11. mg/L. The pre monsoon and post monsoon concentration of nitrate obtained was 1.29±0.11 and 2.25±0.25 mg/L, respectively, which was within the BIS (2012) [3] and WHO (2008) [9] acceptable limit of 45 and 50mg/L, respectively. The highest mean nitrate concentration during post monsoon season attributed to seepage from sources like domestic sewage, agricultural runoff and application of nitrogenous fertilizers containing compounds in the vicinity of the well.

Aerobic plate count is an indication of total number of viable microorganisms present in water, which includes members of the natural microbial flora of water source and organisms coming from contaminating environment. The mean APC of pre monsoon and post monsoon was 4.0±0.10 and 3.66±0.09 log10 cfu/mL, respectively. BIS and WHO have not specified any limit for drinking water since it does not provide direct count of pathogenic organisms. The reduction in well water volume and subsequent relative increase in concentration of

microorganisms might be responsible for pre monsoon increase of APC.

Coliform should be absent in drinking water samples as per BIS (2012) [3] and WHO (2008) [9] standards, while in the present study 91.25% cent of samples from Anthikkad were found to be positive for coliform with elevated count of 658.22±112.4 MPN index/100mL during post monsoon season. Shallow nature of wells in this area is favouring the seepage of pollutants from neighouring sources like septic tanks and manure pits, thus increasing the coliform count. The higher coliform count of post monsoon season might be attributed to more percolation and seepage of contaminants through the soil. Alternatively, pre monsoon decrease in coliform count could be ascribed to depletion in the ground water level and evaporation of near by waste water sources due to intense heat of summer (Kumaria *et al.*, 2014) [5].

Escherichia coli was detected from 37.5% of samples analyzed from Anthikkad. Hence the samples were not meeting the BIS (2012) [3] and WHO (2008) [9] guidelines, as they were recommending complete absence of *E. coli* in water. Post monsoon showed a relatively higher mean count of 76.77±29.82 MPN index/100mL and this increase could be attributed to seepage from nearby kole lands, paddy fields, manure pits and septic tanks.

The presence of faecal *Streptococci* in water is a measure of recent faecal contamination of water. Even though significant difference in mean faecal Streptococci count between post monsoon and pre monsoon was not observed, mean faecal Streptococi count was higher in post monsoon season than that of pre monsoon. As per WHO (2008) [9] faecal *Streptococci* should not be present in water, while 60% of samples showed the presence of faecal Streptococci in Anthikkad.

Conclusions

The groundwater quality of the study area showed seasonal variation for all the parameters except TDS, turbidity and faecal Streptococci count. All the microbiological parameters were found above the recommended limit in Anthikkad. Therefore, people living in these areas have a high risk of getting waterborne diseases. So, water, must be treated before consumption and public should be made aware of importance of water quality and protection of water sources from pollution.

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