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EXPERIMENTAL ANALYSIS OF SEASONAL VARIATION IN PHYSICO-CHEMICAL & MICROBIOLOGICAL CHARACTERISTICS OF DOMESTIC TREATED SEWAGE EFFLUENT

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ABSTRACT

The present research deals with the study of physico-chemical and bacteriological characteristics of sewage water collected from three different sites of treated pond during two consecutive seasons. Seasonal variations indicated that the most of the nutrients (viz., total N, phosphates) and salts (nitrates, chlorides and sulphates) are present abundantly at winter and the physical characters like TDS (600 mg/L) are more at summer seasons. The pH meter (Elico® LI 20) and EC meter are calibrated with pH buffer(4.0, 7.0 and 9.2) and saturated KCl before taking the reading. Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Total dissolved solids (TDS), Total suspended solids (TSS),Total alkalinity (TA), Nitrates (NO3), Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Chlorides(Cl-), Sulphates (SO42-) were analyzed Multiple comparisons made using analysis of variance showed that the treated sampling pond point varies significantly from other two ponds and Raw sewage. The total coliform count for the treated samples were >2400 (MPN/100ml) in raw sewage. This study concludes that the physicochemical characters and microbiological characters are outrageous in the raw sewage and upon the treatment the undesirable characters are reduced. Studies on the sewage characteristics of treatment plants are crucial to know the pollutant levels upon the various time scales and the treatment status which is necessary to improve the state of the art of the treatment process.

KEYWORDS: Physio-Chemical, Bacteriological, Sewage water, . Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Total dissolved solids (TDS), Raw sewage, Treatment plant.

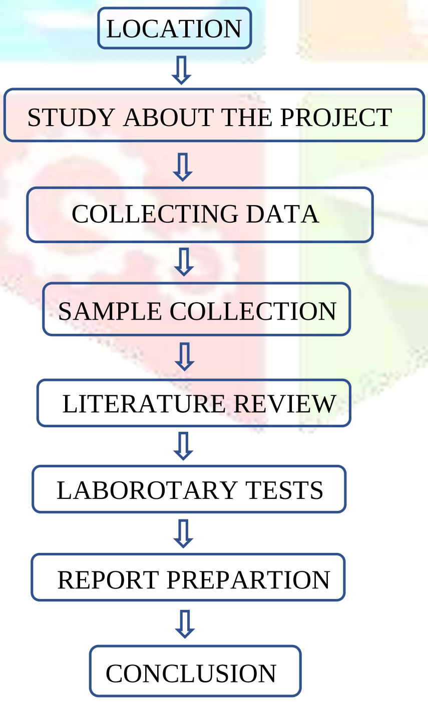
1. INTRODUTION

All around the world, water scarcity is an increasing problem and it is interlinked with water contamination and pollution. As per WHO estimates, the average water use for a person is about 280 litres per day. After usage, the water is returned to environment as “wastewater”. This domestic wastewater from its origin to treatment system on its way blended with some of the industrial wastes, pharmacy wastes and also agricultural runoff and termed as “sewage water”. Finally, the sewage water is heavily polluted with heavy metals, pharmaceutical compounds, nutrients and all the local wastes specific to the particular locality.

Sewage water is complex in nature which requires specialized treatment systems depending on the composition. Sewage composition shows discrepancy from one location to another and it is heavily influenced by biotic and abiotic factors. Biotic factors include humans and their socio-economical behaviour whereas the abiotic factor encompasses all the wastes from food wastes to industrial wastes that are added on its way to treatment.

Globally, 1.8 billion people are using a source of drinking water that is contaminated with faecal matter. Faecal contamination indicates the mixing of untreated or improperly treated sewage with drinking water. This shows the importance and necessity of proper functioning of the sewage treatment plants. The treatment system design should be based on the sewage water characteristics and also the location where it is operated. The raw wastewater characteristics give the sewage composition of the particular region whereas the treated effluent characteristics help to improve the existing treatment system. Keeping the above mentioned points, the present study was designed to check the physico-chemical characteristics of sewage water taken from three different sewage treatment plants in two different seasons before and after treatment.

2. METHODOLOGY



3. SAMPLE COLLECTION

Samples were aseptically collected from three different points viz., collection tank (raw sewage water) and output (treated sewage) at sewage treatment plant, Mayiladuthurai sewage treatment plant. For seasonal variation studies the samples were collected from the same sites during post-monsoon (November, 2019) and Pre monsoon (March, 2020). Samples were collected in the morning (8 A.M to 11 A.M) and stored in sterile polytetrafluoroethylene bottles at 4°C for analysis. The sampling was done over a period of 10 days to rule out the possibilities of incidental sewage flow. Samples were analyzed for physico-chemical and biological characteristics in Fermentation laboratory, Department of Environmental sciences, Department of Micro-Biology in A.V.C College of Engineering, Anna University, Mayiladuthurai, Tamil Nadu.

4. LOCATION

The samples are collected in the village of Mannampandal, in the town of Mayiladuthurai, in the coastal district of Nagapattinam within the Indian state of Tamilnadu.

FIG (1) Shows the municipal treatment plant

Location – Surrounding area of municipal sewage treatment plant, Mannampandal, Mayiladuthurai.

Latitude - 1143° N

Longitude – 79.689° E

5. STANDARD TEST

According to CBGW standard (Central Board of Ground Water), the following test are conducted to determine the quality of ground water. The chemical characteristics of pH, TDS, total hardness, calcium, potassium, sodium, total alkalinity. The physical characteristics of turbidity and electrical conductivity.

SL.NO	PARAMETERS	UNIT
1.	pH	-NIL-
2.	Total Dissolved Solids	Mg/L
3.	Electrical Conductivity	Micro mho/Cm
4.	Total Alkalinity	Mg/L
5.	Total Hardness	Mg/L
6.	Turbidity	NTU
7.	Calcium	Mg/L
8.	Magnesium	Mg/L
9.	Nitrate	Mg/L
10.	Chloride	Mg/L
11.	Fluoride	Mg/L
12.	Sulphate	Mg/L
13.	Potassium	Mg/L
14.	Sodium	Mg/L

TABLE (TEST PARAMETERS)

5.1 Physico – Chemical analysis

The pH and Electrical conductivity were measured using the pH meter and EC meter. The pH meter (Elico® LI 20) and EC meter are calibrated with pH buffer(4.0, 7.0 and 9.2) and saturated KCl before taking the reading. Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Total dissolved solids (TDS), Total suspended solids (TSS),Total alkalinity (TA), Nitrates (NO3), Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Chlorides(Cl-), Sulphates (SO42-) were analyzed by standard methods given in table. For heavy metal analysis, 10 ml of samples were taken in 100 ml conical flask followed by adding 15 ml of aqua-regia (HCl : HNO3 @ 3:1). Then the acid digested content was filtered through Whatman No.40 filter paper and the heavy metal was analyzed using an Atomic Absorption Spectrophotometer (AAS) with air- acetylene flame (PERKIN ELMER).

5.2 Bacteriological analysis

The media used for the bacteriological analysis of water include nutrient agar (NA), lactose broth (LB), Rose bengal agar and Kenknight medium for bacteria, coliforms, fungi and actinomycetes respectively. Serial dilution method was used for total viable count of bacteria, fungi and actinomycetes and MPN method was followed for enumeration of coliforms. The sterility of each batch of test medium was confirmed by incubating one uninoculated tube or plate along with the inoculated tests. The uninoculated tubes or plates were always examined to show no evidence of bacterial growth.

6. TESTAND RESULT

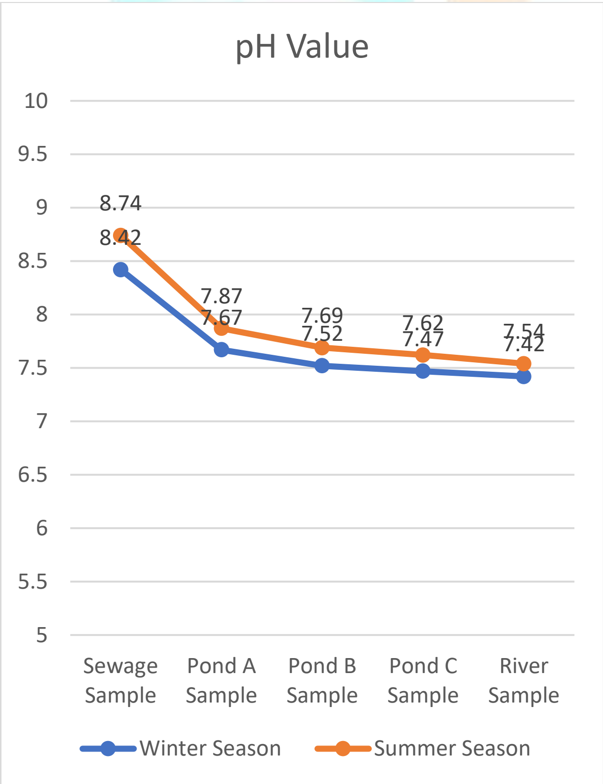
6.1 pH

pH is determine to know the hydrogen ion concentration. It determines the acidic and alkalinity nature of the water. As per IS10500-2012 the desirable limit is 6.5-8.5.

pH is measured by p^H digital meter using a glass electrode which generate a potential varying linearly with the pH of the solution in which it is inversed.

pH VALUE			
SL.NO	SAMPLE	WINTER SEASON	SUMMER SEASON
1.	SEWAGE WATER	Brownish Black	Brownish Black
2.	POND A	Pale Green	Pale Green
3.	POND B	Pale Green	Pale Green
4.	POND C	Pale Green	Pale Green
5.	RIVER WATER	Light Pale Green	Light Pale Green
*Note; Acceptable value = 6.5, Permissible value = 8.5			

TABLE (1) – pH GRAPH



GRAPH (1) – pH GRAPH

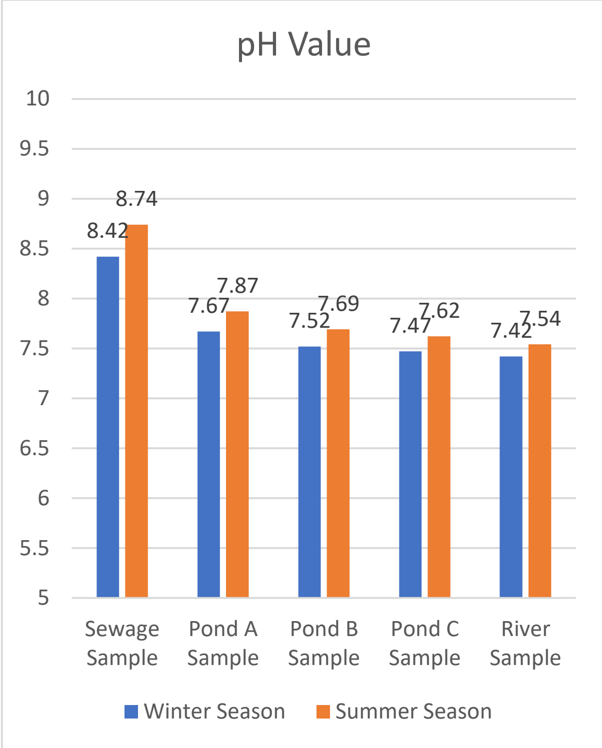


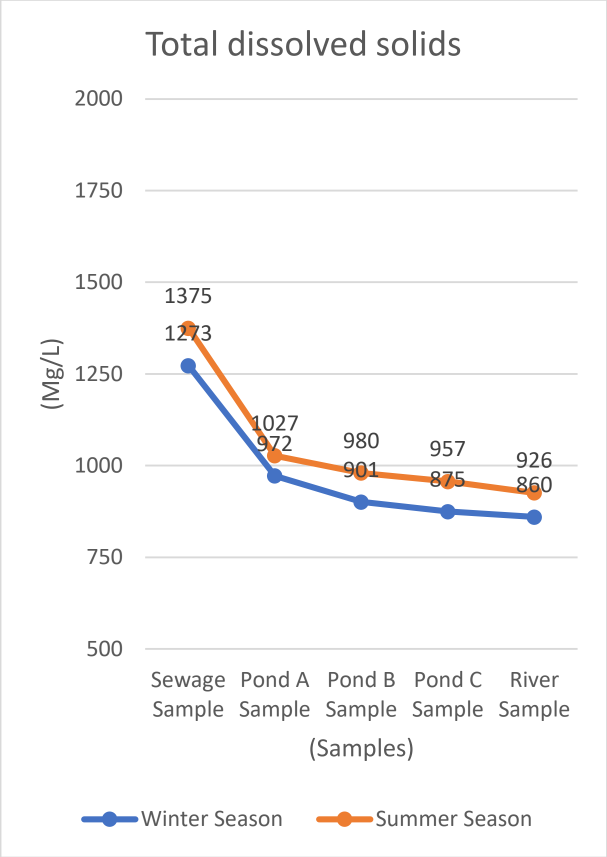
FIG (1) – pH GRAPH

6.2 TOTAL DISSOLVED SOLIDS

The minute solid particles which suspended, volatile, fixed and settled solids in water is known as TDS. Its desirable limit is 500mg/lit and permissible limit is 2000mg/lit.

TOTAL DISSOLLVED SOLIDS			
SL.NO	SAMPLE	WINTER SEASON in (Mg/L)	SUMMER SEASON in (Mg/L)
1.	SEWAGE WATER	1273	1375
2.	POND A	972	1027
3.	POND B	902	980
4.	POND C	875	957
5.	RIVER WATER	860	926
*Note; Acceptable value = 500 Mg/L, Permissible value = 2000 Mg/L			

TABLE (2) – TOTAL DISSOLVED SOLIDS



GRAPH (2) – TOTAL DISSOLVED SOLIDS

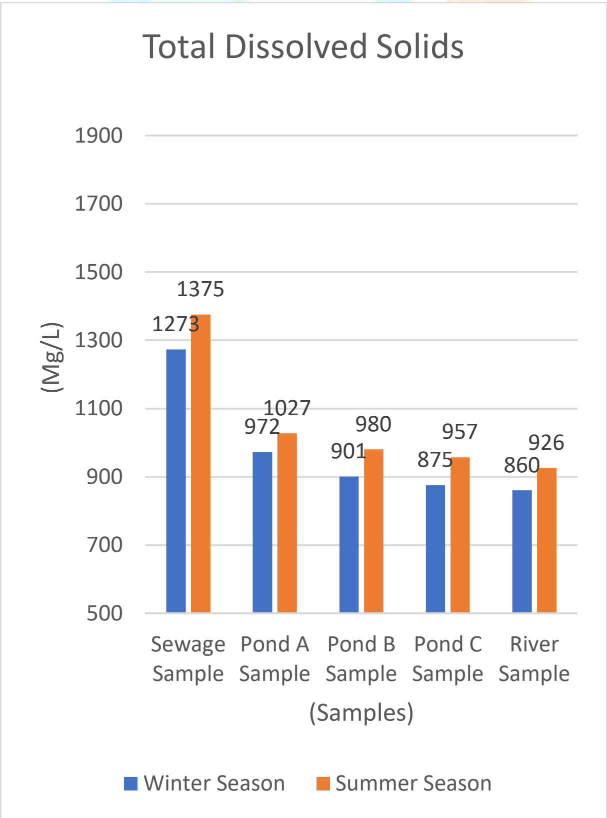


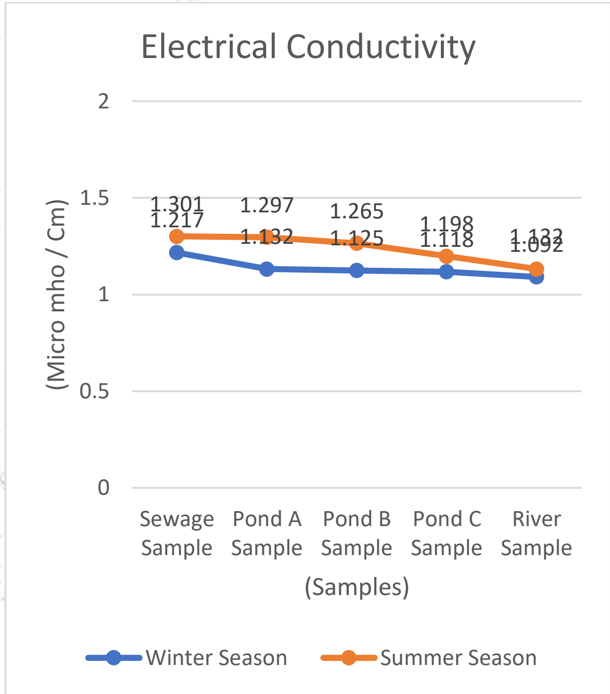
FIG (2) – TOTAL DISSOLVED SOLIDS

6.3 ELECTRICAL CONDUCTIVITY

Electrical conductivity defines the ions present in the water sample. It determines the ions conducting the current passing through it. It is measured by conductivity meter. Its desirable limit is 0 mS/cm and permissible limit is 2mS/cm.

ELECTRICAL CONDUCTIVITY			
SL.NO	**SAMPLE**	**WINTER SEASON in (Micro mho/cm)**	**SUMMER SEASON in (Micro mho/cm)**
1.	SEWAGE WATER	1.217	1.301
2.	POND A	1.132	1.297
3.	POND B	1.125	1.265
4.	POND C	1.118	1.198
5.	RIVER WATER	1.092	1.32
*Note; Acceptable value = 0 Micro mho/cm, Permissible value = 2 Micro mho/cm			

TABLE (3) – ELECTRICAL CONDUCTIVITY



GRAPH (3) – ELECTRICAL CONDUCTIVITY

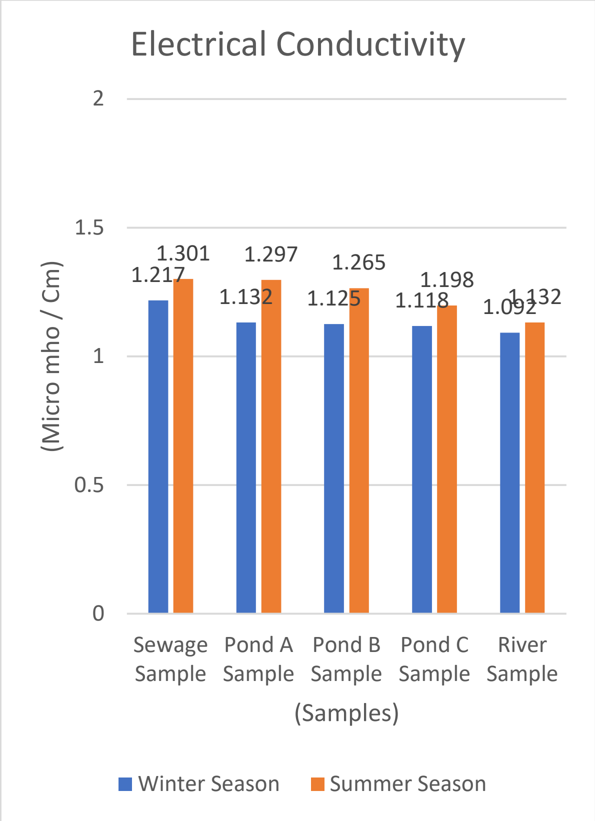


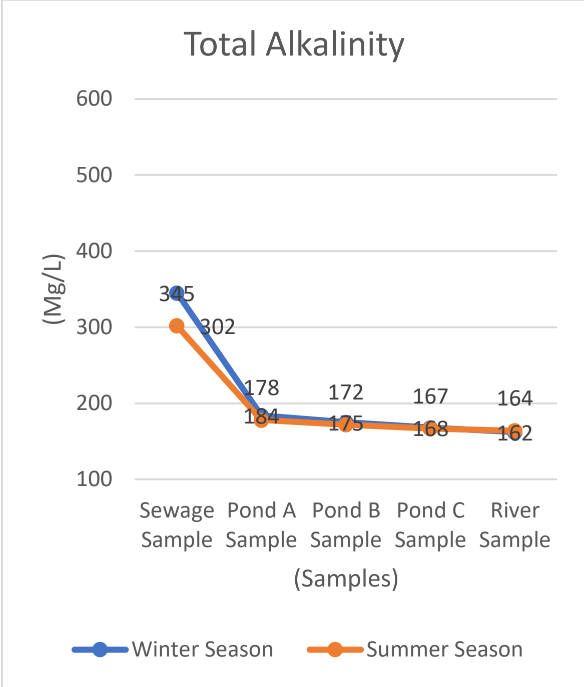
FIG (3) – ELECTRICAL CONDUCTIVITY

6.4 TOTAL ALKALINITY

Total alkalinity is defined as the presence of hydroxide, carbonate and bicarbonate. It is also determined by the titration method by using phenolphthalein and methyl orange as indicator. The desirable limit is 200mg/lit and the permissible limit is 600mg/lit.

TOTAL ALKALINITY			
SL.NO	**SAMPLE**	**WINTER SEASON in (Mg/L)**	**SUMMER SEASON in (Mg/L)**
1.	SEWAGE WATER	345	302
2.	POND A	184	178
3.	POND B	175	172
4.	POND C	168	167
5.	RIVER WATER	158	164
*Note; Acceptable value = 200 Mg/L, Permissible value = 600 Mg/L			

TABLE (4) – TOTAL ALKALINITY



GRAPH (4) – TOTAL ALKALINITY

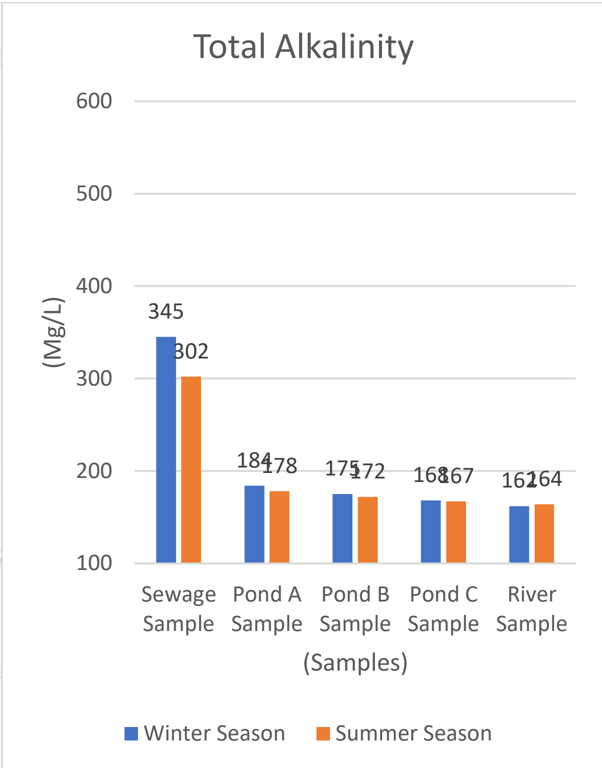


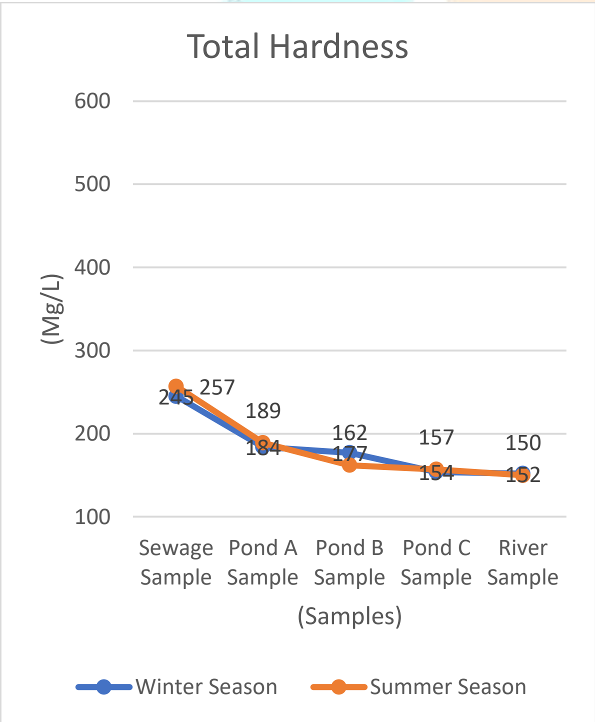
FIG (4) – TOTAL ALKALINITY

6.5TOTAL HARDNESS

Total hardness is defines as the presence of sulphate, nitrates and chlorides of calcium and magnesium. It's also due to presence of carbonates and bicarbonates. It is measured by volumetric titration of EDTA solution against water sample. Its desirable limit is 200mg/lit and the permissible limit is 600mg/lit.

TOTAL HARDNESS			
SL.NO	**SAMPLE**	**WINTER SEASON in (Mg/L)**	**SUMMER SEASON in (Mg/L)**
1.	SEWAGE WATER	245	257
2.	POND A	184	189
3.	POND B	177	162
4.	POND C	154	157
5.	RIVER WATER	152	150
*Note; Acceptable value = 200 Mg/L, Permissible value = 600 Mg/L			

TABLE (5) – TOTAL HARDNESS



GRAPH (5) – TOTAL HARDNESS

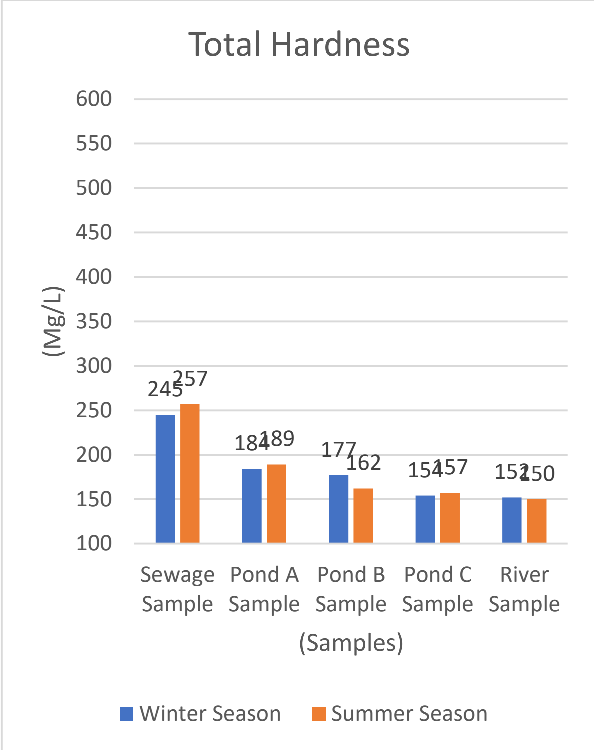


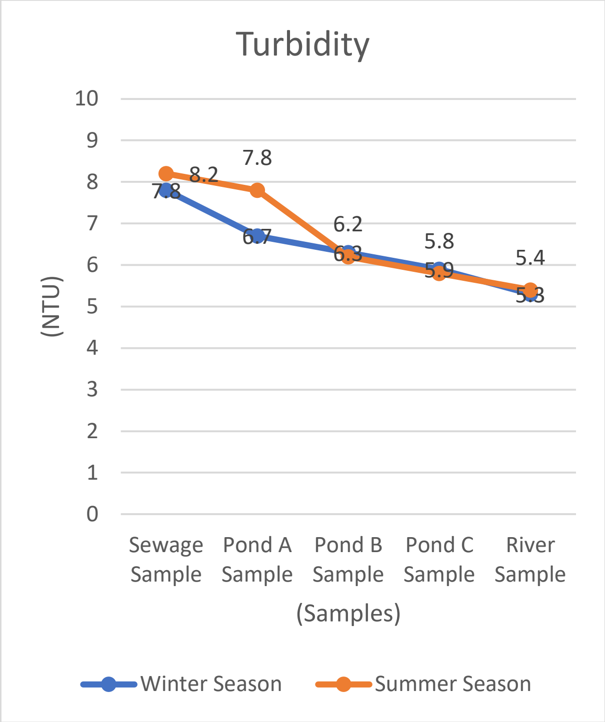
FIG (5) – TOTAL HARDNESS

6.6 TURBIDITY

Turbidity is caused by the presence of colloidal particles which can be determined by passing the light through the water. It is measured by nephelometric turbidity meter. Its desirable limit is 1NTU and the permissible limit is 5NTU.

TURBIDITY			
SL.NO	**SAMPLE**	**WINTER SEASON in (NTU)**	**SUMMER SEASON in (NTU)**
1.	SEWAGE WATER	7.8	8.2
2.	POND A	6.7	7.8
3.	POND B	6.3	6.2
4.	POND C	5.9	5.8
5.	RIVER WATER	5.3	5.4
*Note; Acceptable value = 1 NTU, Permissible value = 5 NTU			

TABLE (6) – TURBIDITY



GRAPH (6) – TURBIDITY

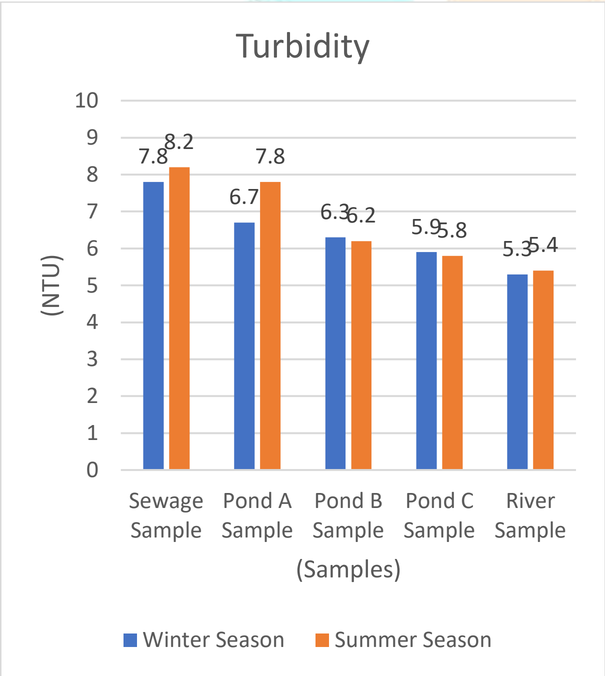


FIG (6) – TURBIDITY

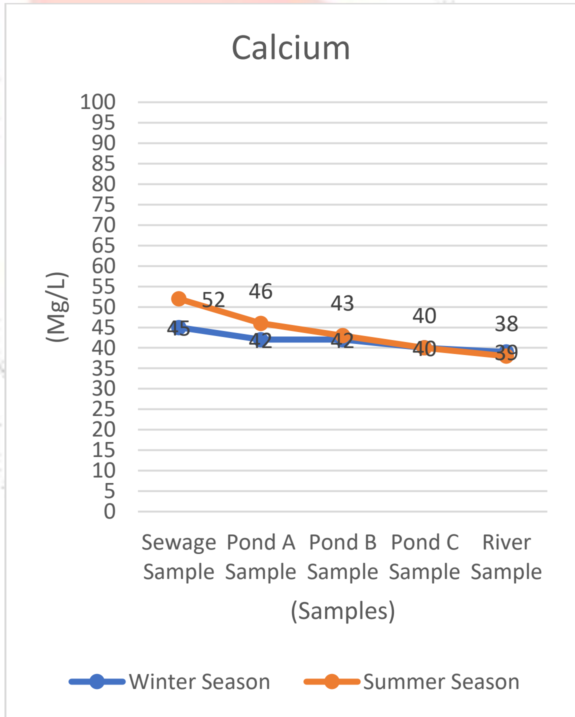
6.7 CALCIUM CONTENT

Calcium is a mineral contains in water. It is one of the hardness content mineral. Excessive calcium may affect the metals and lack of

Calcium is unfit for drinking purpose. It is measured by flame photometer. Its desirable limit is 75mg/lit and the permissible limit is 200mg/lit.

CALCIUM VALUE			
SL.NO	**SAMPLE**	**WINTER SEASON in (Mg/L)**	**SUMMER SEASON in (Mg/L)**
1.	SEWAGE WATER	45	52
2.	POND A	42	46
3.	POND B	42	43
4.	POND C	40	40
5.	RIVER WATER	39	38
*Note; Acceptable value = 75 Mg/L, Permissible value = 200 Mg/L			

TABLE (7) – CALCIUM



GRAPH (7) – CALCIUM

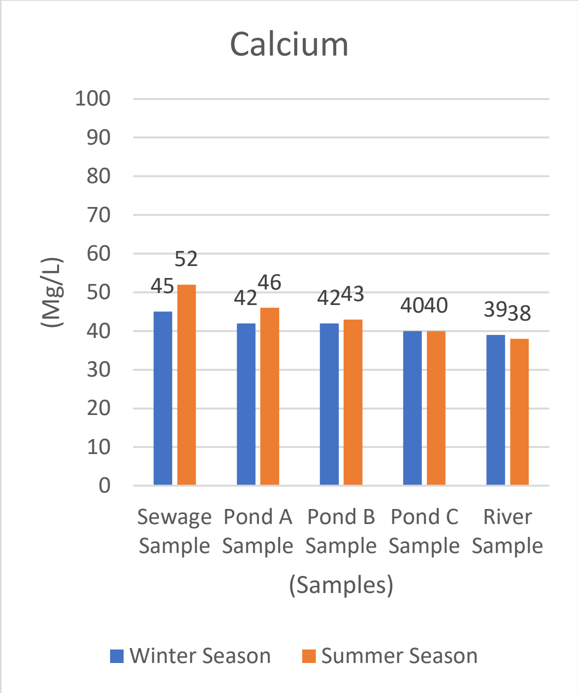


FIG (7) – CALCIUM

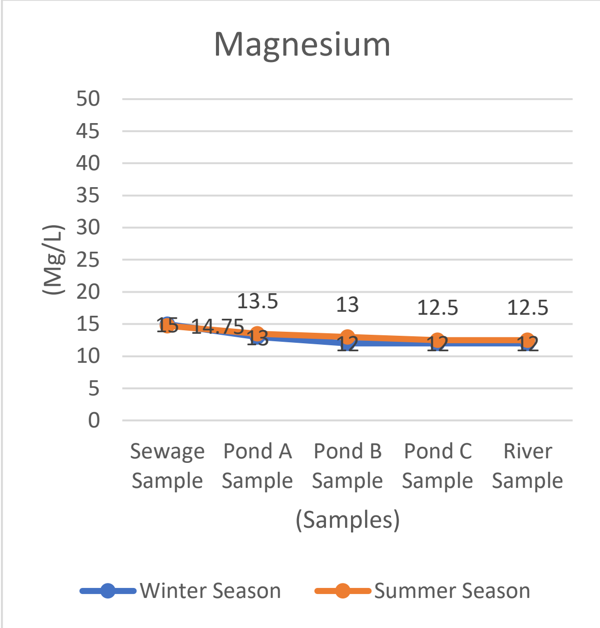
6.8 MAGNESIUM CONTENT

Magnesium is a mineral contains in water. It is one of the hardness content mineral. Excessive Magnesium may affect the metals and lack of

Magnesium is unfit for drinking purpose. It is measured by flame photometer. Its desirable limit is 30mg/lit and the permissible limit is 100mg/lit.

MAGNESIUM VALUE			
SL.NO	**SAMPLE**	**WINTER SEASON in (Mg/L)**	**SUMMER SEASON in (Mg/L)**
1.	SEWAGE WATER	15	14.75
2.	POND A	13	13.5
3.	POND B	12	13
4.	POND C	12	12.5
5.	RIVER WATER	12	12.5
*Note; Acceptable value = 30 Mg/L, Permissible value = 100 Mg/L			

TABLE (8) – MAGNESIUM



GRAPH (8) – MAGNESIUM

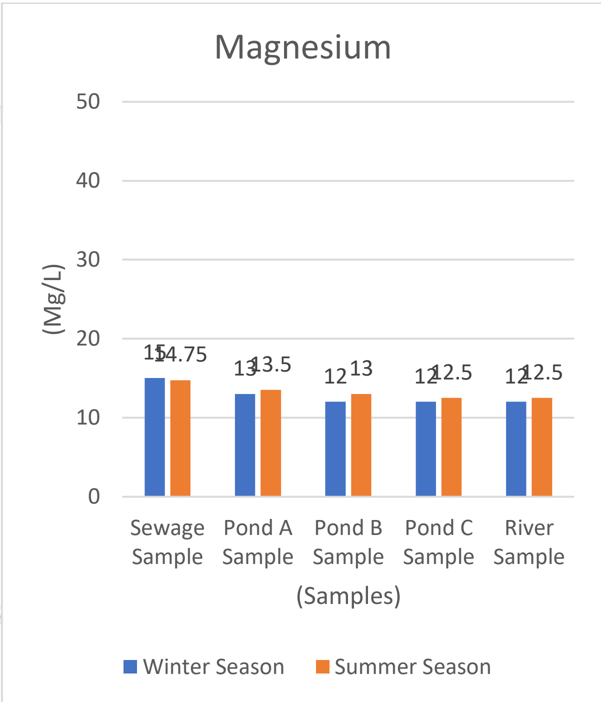


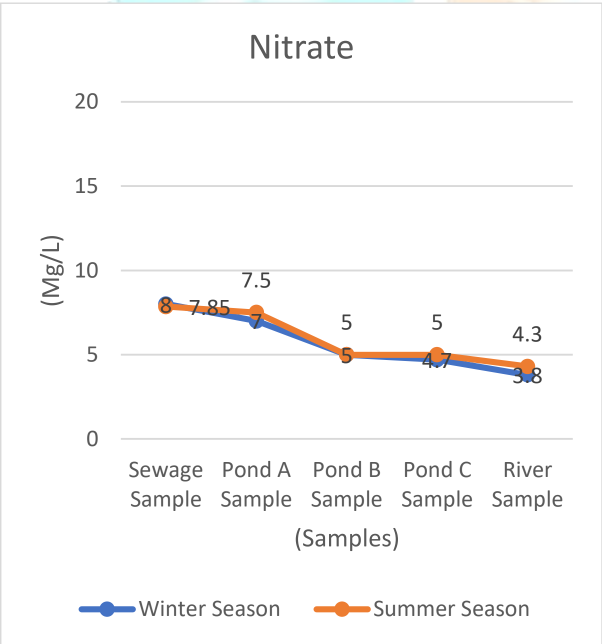
FIG (8) – MAGNESIUM

6.9 NITRATE CONTENT

Nitrate is a mineral contains in water. Consuming too much nitrate can be harmful—especially for babies. Consuming too much nitrate can affect how blood carries oxygen and can cause methemoglobinemia Its desirable limit is 45mg/lit and the permissible limit is 45mg/lit.

NITRATE VALUE			
SL.NO	**SAMPLE**	**WINTER SEASON in (Mg/L)**	**SUMMER SEASON in (Mg/L)**
1.	SEWAGE WATER	8	7.85
2.	POND A	7	7.5
3.	POND B	5	5
4.	POND C	4.7	5
5.	RIVER WATER	3.8	4.3
*Note; Acceptable value = 45 Mg/L, Permissible value = 45 Mg/L			

TABLE (9) – NITRATE



GRAPH (9) – NITRATE

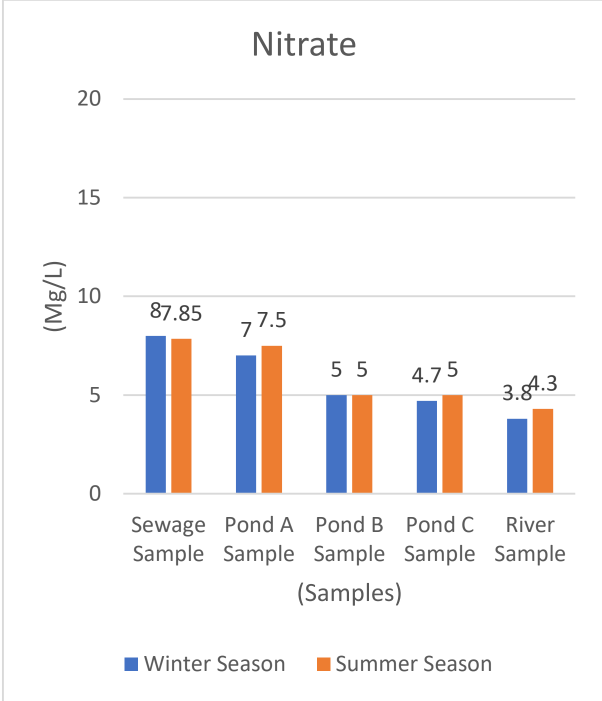


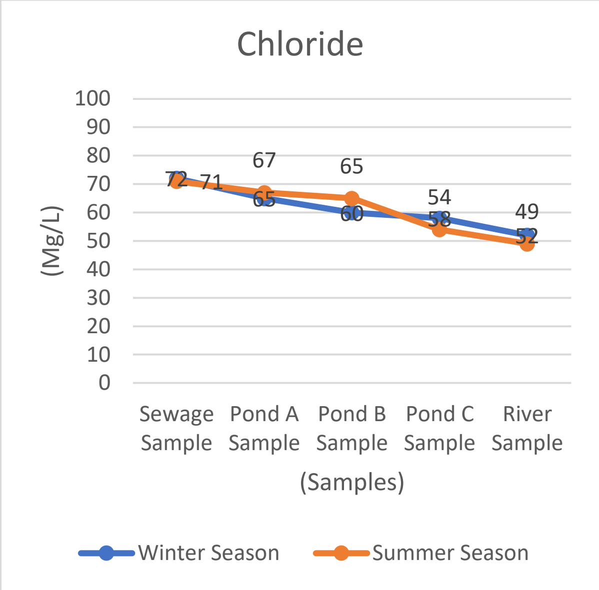
FIG (9) – NITRATE

6.10 TOTAL CHLORIDE

Chloride is a mineral which present naturally in the form of sodium Chloride. It is determined by the titration method which colour may changes. From yellow to milk white and then brick red. The desirable limit is 250mg/lit and the permissible limit is 1000 mg/lit.

CHLORIDE VALUE			
SL.NO	**SAMPLE**	**WINTER SEASON in (Mg/L)**	**SUMMER SEASON in (Mg/L)**
1.	SEWAGE WATER	72	71
2.	POND A	65	67
3.	POND B	60	65
4.	POND C	58	54
5.	RIVER WATER	52	49
*Note; Acceptable value = 250 Mg/L, Permissible value = 1000 Mg/L			

TABLE (10) – CHLORIDE



GRAPH (10) – CHLORIDE

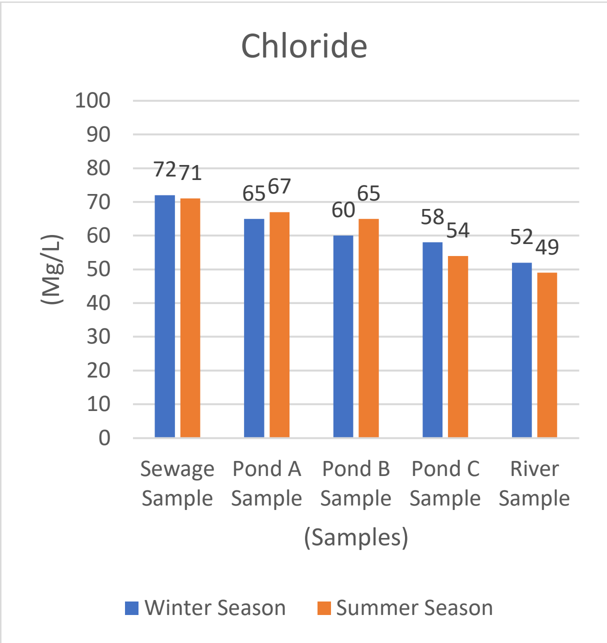


FIG (10) – CHLORIDE

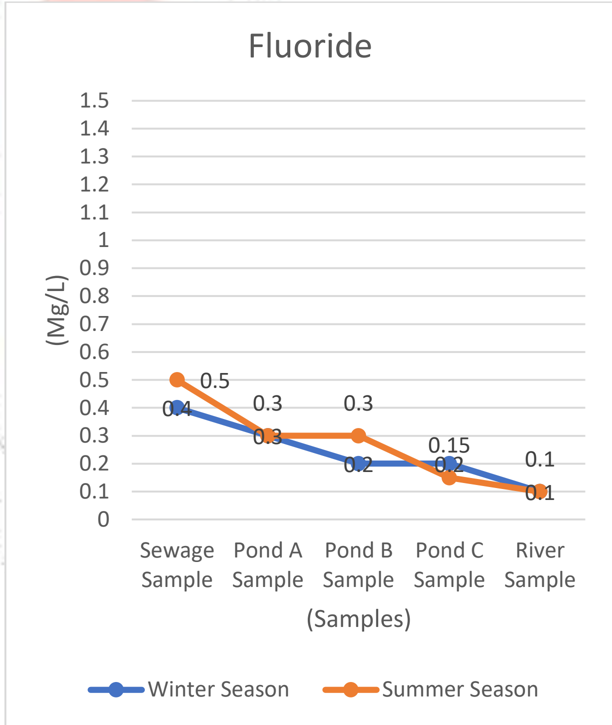
6.11 FLUORIDE CONTENT

Fluoride is a mineral contains in water. Consuming too much fluoride can be harmful Dental fluorosis, Skeletal fluorosis, Thyroid problems, Neurological problems and Other health problems. The desirable limit is 1mg/lit and the permissible limit is 1.5 mg/lit.

FLUORIDE VALUE

SL.NO	SAMPLE	WINTER SEASON in (Mg/L)	SUMMER SEASON in (Mg/L)
1.	SEWAGE WATER	0.40	0.50
2.	POND A	0.30	0.30
3.	POND B	0.20	0.30
4.	POND C	0.20	0.15
5.	RIVER WATER	0.10	0.10
*Note; Acceptable value = 1 Mg/L, Permissible value = 1.5 Mg/L			

TABLE (11) – FLUORIDE



GRAPH (11) – FLUORIDE

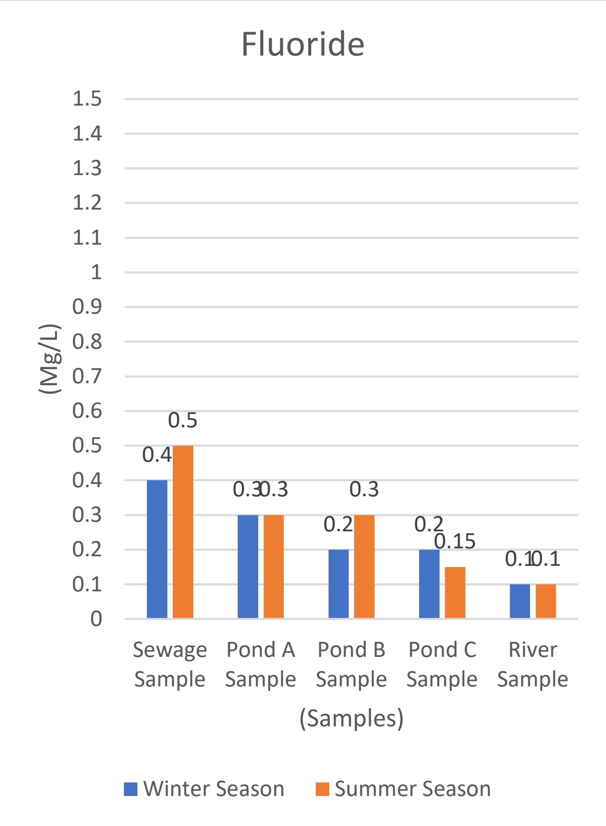


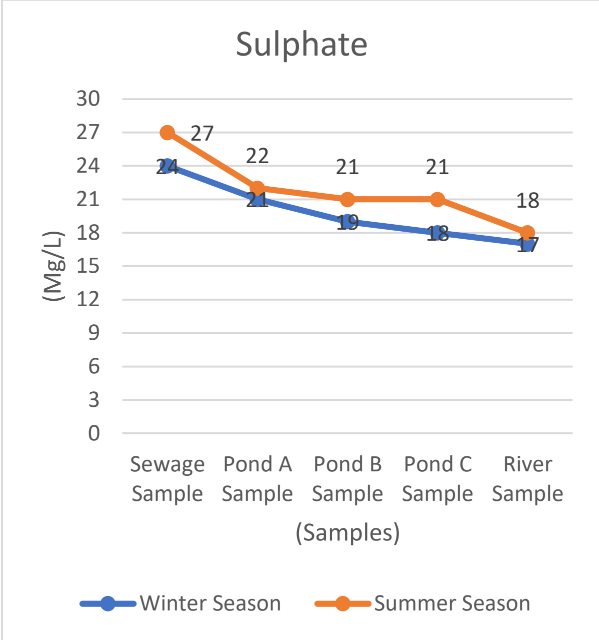
FIG (11) – FLUORIDE

6.12 SULPHATE CONTENT

Sulphate is a mineral contains in water. Consuming too much sulphate can be harmful Diarrhea and dehydration with a high sulfate content can have a laxative effect and lead to diarrhea which can then cause dehydration. The desirable limit is 200mg/lit and the permissible limit is 400 mg/lit.

SULPHATE VALUE			
SL.NO	SAMPLE	WINTER SEASON in (Mg/L)	SUMMER SEASON in (Mg/L)
1.	SEWAGE WATER	24	27
2.	POND A	21	22
3.	POND B	19	21
4.	POND C	18	21
5.	RIVER WATER	17	18
*Note; Acceptable value = 200 Mg/L, Permissible value = 400 Mg/L			

TABLE (12) – SULPHATE



GRAPH (12) – SULPHATE

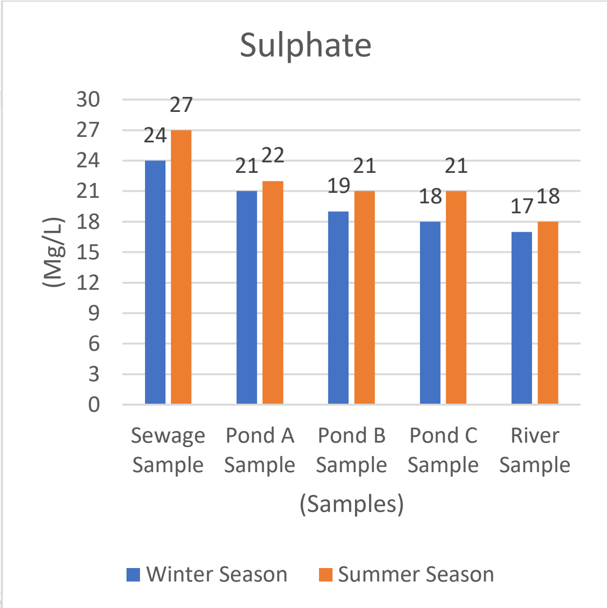
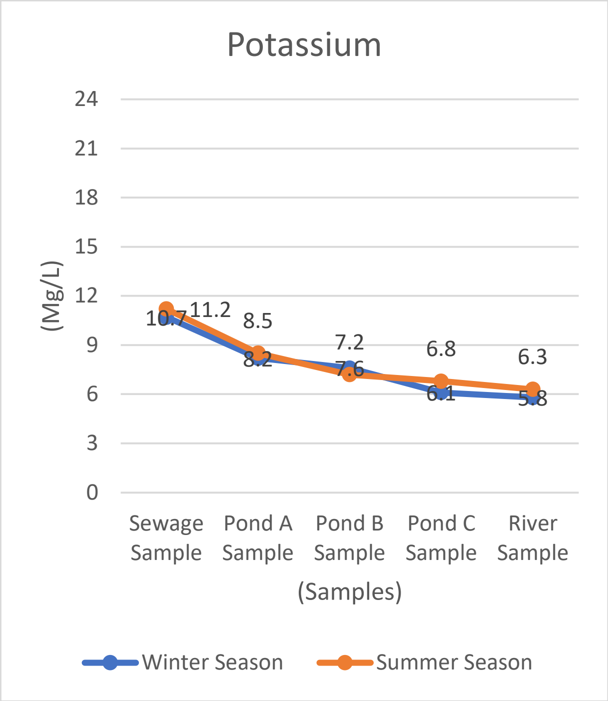


FIG (12) – SULPHATE

6.13 POTTASIUM CONTENT

Potassium is a mineral which is more evenly distributed than the sodium. It is measured by flame photometer. Its desirable limit is 30mg/lit and the permissible limit is 100mg/lit.



GRAPH (13) – POTASSIUM

POTASSIUM VALUE			
SL.NO	**SAMPLE**	**WINTER SEASON in (Mg/L)**	**SUMMER SEASON in (Mg/L)**
1.	SEWAGE WATER	10.7	11.2
2.	POND A	8.2	8.5
3.	POND B	7.6	7.2
4.	POND C	6.1	6.8
5.	RIVER WATER	5.8	6.3
*Note; Acceptable value = 30 Mg/L, Permissible value = 100 Mg/L			

TABLE (13) – POTASSIUM

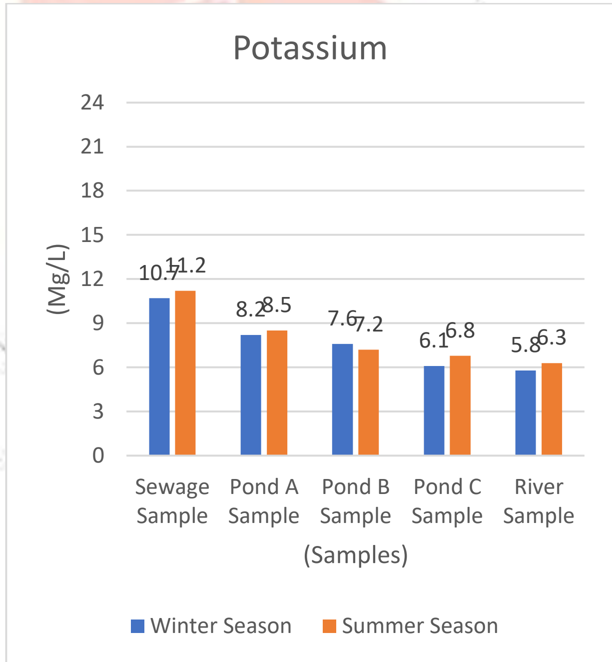


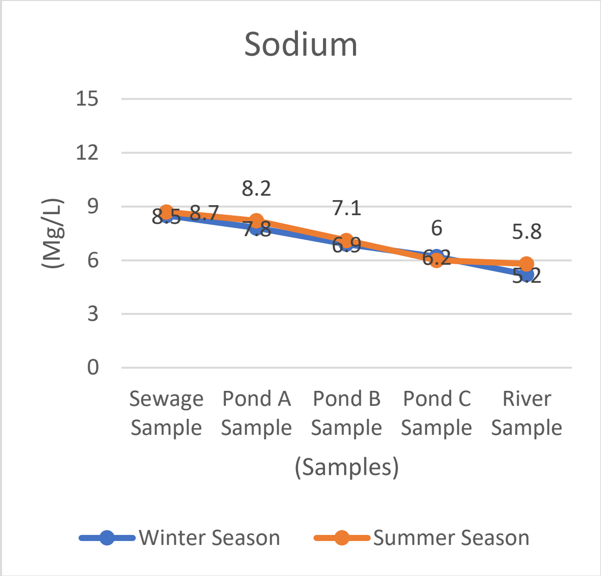
FIG (13) – POTASSIUM

6.14 SODIUM CONTENT

Sodium is essential mineral for water. It is has no smell but it can be tasted when its concentration is high. Its desirable limit is 30mg/lit and permissible limit is 60mg/lit.

SODIUM VALUE			
SL.NO	**SAMPLE**	**WINTER SEASON in (Mg/L)**	**SUMMER SEASON in (Mg/L)**
1.	SEWAGE WATER	8.5	8.7
2.	POND A	7.8	8.2
3.	POND B	6.9	7.1
4.	POND C	6.2	6.0
5.	RIVER WATER	5.2	5.8
*Note; Acceptable value = 30 Mg/L, Permissible value = 60 Mg/L			

TABLE (14) – SODIUM



GRAPH (14) – SODIUM

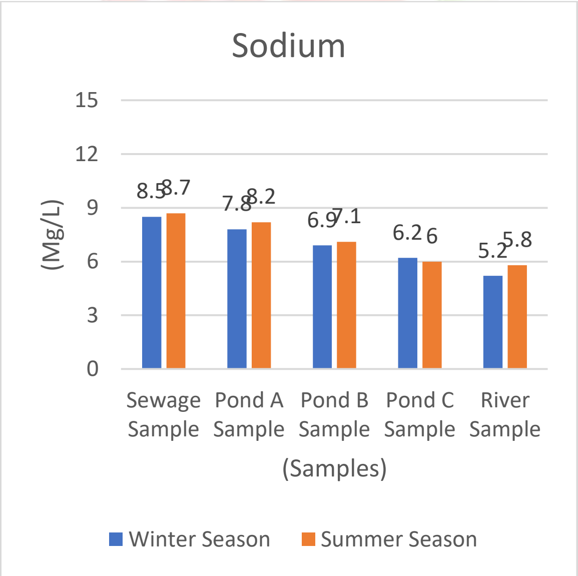


FIG (14) – SODIUM

6.15 Microbiological characteristics

Bacteria in sewage remain viable for several weeks and microbial contamination will increase in the environment consequently2. Bacterial count in raw sewage attains maximum (77x 106 CFU ml-1) in the pre-monsoon compared to post monsoon season (68 x 106CFU ml-1). This shows that increasing temperature aids in the multiplication of microorganisms9. The same trend follows in fungi population (7x 106 CFU ml-1 to 45x 106 CFU ml-1) and actinomycetes (5x 106 CFU ml-1 to 62x 106 CFU ml-1).

Coliforms in sewage are the major indicator of fecal matter contamination. Coliforms ranges from 2400 MPN per 100 ml to 160 MPN per 100 ml in raw sewage in the pre-monsoon season. High number of coliforms is mostly contributed by the organic materials from the human sewerage i.e. municipality sewage plant has more number of coliforms (Figure 1) than the other sewage treatment plants. The high total coliform loads recorded is mostly attributed to organic deposits predominantly from human and animal sewerage as well as high suspended solid matter. Coliforms were observed to be more in number in both winter and summer seasons.

7. CONCLUSION

Wastewater characteristics play an important role in the designating of wastewater treatment facilities. The selection of wastewater treatment processes depends on waste-water composition, e.g. BOD, COD, pH, suspended solids, nitrogen, phosphorous, presence of toxic materials and bacterial population. In pre-monsoon , the undesirable characteristics of sewage water are higher than in the monsoon except the TSS. Treatment was highly beneficial in reducing the undesirable characteristics of sewage water and it requires some modifications based on the time period and the waste generation of the particular locality. The result says that the raw sewage from the municipality treatment plant receives more contaminants from both households as well as industries. The experimental data suggests a need to implement separate channels to collect industrial wastewater originates from various points that reach municipality treatment plant. This could make the better treatment options for the industry wastewater and more useful in proper management wastewater generates in the city. And also the household water that does not contain much toxicant could be effectively irrigated to the agricultural land

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