International Journal of Research Studies in Biosciences (IJRSB)
Volume 2, Issue 11, December 2014, PP 107-115
ISSN 2349-0357 (Print) & ISSN 2349-0365 (Online)
www.arcjournals.org

Bacteriological Contamination and Remedies of Ground Water of Tiptur Town and Surrounding Areas, Tumkur District. Karnataka

Dr. S.B. Basavaraddi

Department of Environmental Science, Kuvempu University
Associate Professor of Physics Kalpataru First Grade Science College Tiptur
ronsubhasbasavaraddi@rediffmail.com

***Dr. Hina Kousar**

Department of Environmental Science, Kuvempu University
Shankargatta, Karnataka India.

****Dr. E.T. Puttaiah**

Professor of Environmental Science. Vice Chancellor
Gulbarga University. Karnataka

Abstract: *Ground water is one of the most pure water resources on this planet earth. Surface water resources are more accessible to contamination compared ground water. Now days in the most part of our country and worldwide, the ground water is under stress and deterioration due to contamination. Over exploitation, anthropogenic activities, untreated domestic and sewage waste disposal in to the water resources has been increased. Insanitation and disposal of septic tank effluents in to the land forms intern cause ground water contamination. Study area was under the stress of biological contamination which may lead to the water borne diseases due to coli forms and pathogenic bacteria, if the proper treatment to the water is not given through municipal water supplies. The study revealed that 45-50% of the sampling locations were contaminated during the period of investigation 2009-2011. Since Tipturians depend on ground water for their domestic and drinking purpose, immediate attention is required in the area of Tiptur taluk , Tumkur district.*

Keywords: *Ground water, Biological contamination, septic tank effluents, pathogenic bacteria's, sewage waste disposal, coliforms*

1. Introduction

Oxygen is the regulator of metabolic process of plant and animals communities and indicator of water condition (Gautham and Sharma; 2011). The factor discussed in this paper provides the information about the overall quality of ground water used for drinking, bathing wild life, Agriculture and fish culture and in turn it becomes base for Tiptur people to lead healthy life; as they purely depend on ground water resource mainly for drinking purpose. The most important source organic matter in waters are disposals of municipal sewage, industrial waste waters, urban and rural run off and detritus formed by indigenous primary and secondary products. The municipal sewage consists of mainly of human excreta and other organic matter (Rout et al 2001) ,average raw sewage contains usually 1% solids which remains both suspended and dissolved ,out of these 70% are of organic matter in nature and remainder are in organic forms, of the organic constituents 65% are nitrogenous (mainly proteins) 25% are carbo hydrates and 10% are fats (Tebbut, 1977).

India has presently the sewer facilities for about 2% of its population (Rao, 1981) and the sewage generated in class I –cities gets some kind of treatment for only 25% of the total volume. Industrial waste waters are important sources of organic pollutions of different in nature (Sharma *et al.*, 2002).

The biochemical oxygen demand of urban' runoff is highly variable its reduces as high as 7700mg/l have been reported in certain areas (Mason; 1981) the excreta of aquatic animals also contains several refractory organic compounds, though there trace causes mainly aesthetic problems; recently it has been found that some of them can produces chloroform or other halo methane's in water (sawyer and McCarthy, 1978).

The degradation of organic matter in water is facilitated by different microorganism that stabilize the organic matter by forming the end products usually immune to further degradation such as CO_2, H_2o,NH_3 and H_2S, etc. The decomposition of organic matter carried out under oxic conditions presence of oxygen is called aerobic degradation, where as in the oxygenious free environment it is called an aerobic degradation leading to fermentations. (P.K.Goel,2001) increase in the BOD is the amount of oxygen consumed by living organisms (mainly bacteria) and is the measure of pollution of water, Similarly COD is chemical oxygen demand is the quantitative estimation of oxygen equivalent of organic matter that is vulnerable to oxidation in the presence of strong oxidizing agent like potassium dichromate (Chattopadyaya *et al.*, 2001).

Bacteriological test is the one of the measure of its pollution. A bacteria indicator of fecal pollution and bacteria whose presence communicates contamination of water with fecal matter. This type of pollution is due to discharge through animal and human being mainly *Escherichia coli*. The study mainly focuses on the DO, BOD, COD and E-coli for contamination which are more important other than physicochemical pollutants as they directly affect the human health (Sinha A.K *et al.*, 1985)

2. STUDY AREA

Karnataka state is situated in the southern peninsular India. Tiptur taluk is about 75 Kms from Tumkur district and covers an area of about 758.5 Sq.Km. The average temperature ranges from 11°C in winter and 38°C during summer. Average rainfall of Tiptur town is 503 mm and its geographical area is 76,510 ha.

Map of Sampling Locations in and Around Tiptur

3. MATERIALS AND METHODS

In the present study, 50 bore well water samples from Tiptur and its surrounding villages were collected during summer (February - May), rainy (June - September) and winter (October - January) seasons for the period of two years (February 2009 - January 2011), for the analysis of physico-chemical and bacteriological parameters.

Allen *et al.,* (1978) have suggested a sampling design of the bore well water in order to pursue the quality control and making forecasts to determine the extent of damage due to pollution.

For bacteriological examination, the tip of the hand pumps was cleaned by sterilization material to avoid external contamination during sampling and samples were carried in sterile glass bottles labeled and stoppered to prevent contamination.

To prevent the increase in the bacterial count due to high temperature, the samples were preserved, cooled and protected from breakages during transportation to the laboratory. Immediately after arrival, samples were refrigerated approximately at 4°C.

For *E. coli* examination, collected sample was filtered through a membrane which retains the bacteria. After filtration, the membrane containing bacterial cells was placed on a selective medium like EMB Agar in petridish and incubated at 37°C for 24 hrs.

Biochemical oxygen demand analysis was carried out after 5 days incubation at 20^{o}C as the major portion of organic matter is oxidized during this period. Similarly, analysis of chemical oxygen demand was carried out within 7 days by strong oxidizing agent of potassium dichromate with 50% H_2SO_4 (Table-3).

4. RESULTS AND DISCUSSION

4.1. Sources of Ground Water Pollution

Ground water is usually of excellent quality. This is primarily because of natural infiltration that occurs in the layer of the soil through which water flows. Rain water flows over the surface of the earth to form lakes and ponds and a good amount of water slowly percolates into the ground layer. Ground water collects more minerals and salts. Pesticides and fertilizes from the agriculture fields, domestic and industrial waste water may join any water course. All these may pollute both surface and ground water.

4.2. Water Borne Diseases

Majority of diseases are directly related to poor quality of drinking water and insanitary conditions. Water borne diseases are due to the presence of pathogens and some chemical substances in water.

The first group called as the water related infections include some of the greatest cause of diseases and death in developing countries including India. The spread of major infections and parasitic diseases such as cholera, typhoid, dysentery, hepatitis, giardiasis and guinea worm infections are due to poor drinking water quality. The second category includes diseases such as gastro intestinal irritation as a result of TDS, methaemoglobinemia i.e., blue born baby disease as a result of high nitrate, bone fluorosis ,mottle teeth due to high fluoride, decrease in hemoglobin due to high arsenic and bacteria causing odor, bad taste and undesirable color in water due to excess of iron.

Table1. *Biological parameters of study sites during the year 2009-2011*

Sample	DO	BOD	COD	*E. coli*	DO	BOD	COD	*E. col*	DO	BOD	COD	*E. coli*
	Summer Season				***Rainy Season***				***WinterSeason***			
S1	6.5	3.13	4.84	2.5	5.8	2.74	4.6	2.5	5.95	2.85	4.75	0
S2	5.95	2.8	4.95	0	7	3.33	4.825	0.5	5.95	2.85	4.75	1.5
S3	6.75	3.2	5.48	0	7.45	3.05	4.95	0	6.95	3.305	5.56	0
S4	7.05	3.35	5.2	4.5	6.5	3.05	4.77	3	6.75	3.2	5.1	0
S5	6.8	3.205	5.05	0	5.7	2.71	4.99	0.5	6.1	2.95	5.7	4.5

S6	6.9	3.25	5.46	0	5.9	2.8	4.64	0	6.35	3	5.2	0
S7	7	3.33	5.52	0	6.1	2.89	4.01	0.5	6.1	2.85	5.35	1.5
S8	6.25	2.96	5.25	0	7.15	3.4	4.935	0	6.45	3.05	5.25	0
S9	6.75	3.23	4.76	0	5.7	2.705	4.66	0	3.1	2.95	4.85	0
S10	6.65	3.135	5.24	0	5.4	2.575	4.125	0	5.8	2.55	5.1	1.5
S11	6	2.835	5.18	2	6.95	3.295	4.88	3.5	5.75	2.7	4.9	0.5
S12	7.25	3.45	5.3	2	6	2.84	4.105	1.5	6.05	2.95	5.2	0
S13	6.6	3.1	5.33	1.5	6.3	2.95	4.92	2.5	6.2	2.95	5.4	0
S14	6.55	3.115	5.09	0.5	6.25	2.96	4.44	0	6.3	3.05	5.65	0
S15	6	2.85	5.25	2	7.05	3.345	4.58	2.5	6.6	3.15	5.4	0
S16	7.05	3.35	4.75	1.5	6.5	2.76	4.08	0.5	6.5	3.05	5.25	0
S17	7.25	3.45	5.28	0	6.45	3.055	4.46	0.5	6.1	2.8	5	0
S18	6.65	3.18	5.65	0	6.85	3.255	4.31	0	6.35	3.05	5.65	0
S19	6.3	3	5.6	0	5.75	2.72	4.195	0	6.3	2.95	5	0
S20	6.05	2.885	5.29	0	5.9	2.855	4.74	0	6.75	3.2	5.65	0
S21	6.55	3.13	5.11	0.5	5.6	2.705	4.075	1.5	6.7	3.25	5.55	0
S22	6.3	3	5.26	0.5	6	2.89	4.425	1	7.2	3.4	5.75	0
S23	7.95	3.77	5.85	0.5	7.8	3.78	5.02	0	6.3	3.05	5.05	0
S24	6	2.835	5.3	0	5.85	2.82	4.095	0	6.4	2.85	5.5	0
S25	5.15	2.46	4.29	0	5.55	2.74	3.95	0	5.5	2.6	5.1	1.5
S26	6.9	3.25	4.15	1	6.95	3.495	5.18	2	5.9	2.8	4.45	1.5
S27	6.6	3	5.73	2	6.615	3.205	4.66	1	6.95	3.15	5.4	0
S28	6.15	2.945	4.7	0.5	6.1	2.89	3.9	0.5	6.2	2.95	4.95	1.5
S29	6.8	3.225	4.9	6	6.05	2.86	4.29	5.5	6.35	3	5.35	0
S30	6.5	3.09	4.96	4	7.5	3.545	4.28	1	6.1	2.9	4.9	0
S31	5.7	2.715	4.92	2.5	7.3	3.495	5.3	1.5	5.65	2.65	4.4	1
S32	6.05	2.905	5.2	1.5	5.5	2.59	4.25	1	5.05	2.3	3.82	2.5
S33	7.15	3.4	5.06	0	5.85	2.77	4.495	0	5.35	2.45	4.15	0
S34	6.4	3.04	5.29	0	6.9	3.505	5.06	0	6.65	3.15	5.55	0
S35	6.55	3.115	5.33	0	7.9	3.745	4.455	0	7	3.3	5.5	0
S36	5.95	2.845	5.3	0.5	6.7	3.19	4.36	1.5	5.6	2.65	5.15	1
S37	5.55	2.635	5.28	0.5	6.55	3.1	4.735	1	6	2.65	4.55	0
S38	7.3	3.45	4.79	0	6	2.855	5.01	0.5	5.7	3.1	5.35	0
S39	6.1	2.885	4.8	0	7.15	3.391	5	0	6.3	3.1	5.55	0
S40	7.25	3.45	5.35	0	6.5	3.09	4.525	4	7.1	3.05	5	1
S41	6.5	3.09	5.28	6	7.7	3.695	4.58	3.5	6.95	2.85	5.4	0
S42	6.4	3.04	5.5	3	5.85	2.755	4.51	3	5.9	2.8	4.7	1
S43	5.65	2.685	5.05	1.5	5.35	2.55	4.385	1.5	5.4	2.4	4.2	3.5
S44	6.95	3.305	5.6	1.5	6.8	3.2	5.55	2.5	5.9	2.7	4.9	1.5
S45	7.35	3.55	5.54	0	6.85	3.255	4.66	0	6.6	2.6	4.85	0
S46	6.95	3.3	5.46	0	6.6	3.125	5.145	0	6.9	3.25	5.35	0
S47	7.45	3.555	5.8	0	6.5	3.09	4.575	0	6.85	3.2	5.3	0
S48	6.955	3.065	5.8	1.5	6.75	3.195	5.23	1.5	6.05	2.9	5.3	1.5
S49	6.35	3.01	2.95	0.5	6.75	3.195	5.38	1	6.9	3.25	5.45	1.5
S50	7.4	2.56	2.9	2.5	6.1	2.895	5.005	2	6.5	3.05	5.45	1.5

Note: *All parameters are expressed in mg/l except E. coli (Number/100ml)*

Table2. *Correlation matrix of Biological parameters*

	DO	**BOD**	**COD**	***E. coli***	**DO**	**BOD**	**COD**	***E. coli***	**DO**	**BOD**	**COD**	***E. coli***
	Summer Season				***Rainy Season***				***Winter Season***			
DO	1	**0.987**	0.129	0.035	1	**0.949**	**0.510**	0.057	1	**0.481**	0.691	**-0.452**
BOD		1	-- 0.093	-0.186		1	**0.465**	0.057		1	**0.553**	0.285
COD			1	0.087			1	0.097			1	0.298
E.Coli				1				1				1

Table3. *Minimum, maximum, mean and standard deviation of biological parameters during season, 2009-11, Note: All parameters are expressed in mg/l except E. coli in Number/100ml.*

Parameters	Minimum	Maximum	Mean	±SD
Summer Season				
DO	5.15	7.95	6.58	±0.55
BOD	2.46	3.77	3.12	±0.264
COD	2.9	5.85	5.08	±0.56
E. coli	0	6	1.16	±1.44
Rainy Season				
DO	5.35	7.8	6.46	0.689
BOD	2.55	3.78	3.06	±0.314
COD	3.9	5.55	4.63	±0.397
E. coli	0	5.5	1.16±	±1.28
Winter Season				
DO	5.35	7.2	5.05	±0.495
BOD	2.3	3.4	2.9	±0.248
COD	3.82	5.75	5.1	±0.426
E. coli	0	4.5	0.66	±0.976

4.3. Dissolved Oxygen

In most natural waters, oxygen is usually maintained at the saturation level and does not either under saturate or supersaturate because the factors responsible for its addition and removal remain at equilibrium. However, the addition of organic matter disturbs this equilibrium, because of the excessive supply of readily available food which increases the respiratory demand for oxygen by aerobic bacteria beyond a level that can be replenished. As a result, oxygen concentration goes down and water becomes totally anoxic. The dissolved oxygen decreases due to biological oxidation of organic matter. The discharge of domestic and industrial wastes and agriculture runoff percolates in the ground water and pollutes both ground water and surface water bodies. Changes in the level of dissolved oxygen in the aquatic system have a detrimental effect on aquatic biota. Also, decreased level of oxygen is the indicator of pollution of a particular water body. Hence, analysis of dissolved oxygen plays an important role in water pollution control and waste water treatment process.

In the present study, the concentration of dissolved oxygen varied from a minimum of 5.15 mg/l to a maximum of 7.95 mg/l in summer, in rainy season it varied from a minimum of 5.35 mg/l to 7.8 mg/l and in winter it fluctuated from a minimum of 5.35 mg/l to a maximum of 7.2 mg/l. Mean values are 6.58, 6.46 and 5.05 mg/l respectively (Table-1, 3\)

The data generated reveals that dissolved oxygen increased in the summer season compared to winter season. This may be attributed to lowering of ground water table in pre monsoon. The dissolved oxygen decreases due to precipitation and surface water runoff that raises the water table through percolation.

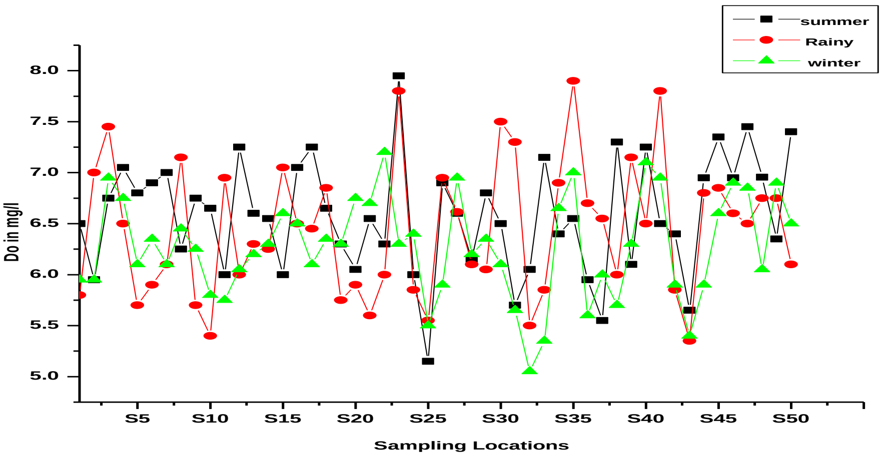

Fig1. *Seasonal variation of dissolved oxygen at different sampling locations*

Studies have been made on bacteriological counts by Venkata Ramanaiah Solanki *et al.*, (2007) and Tambekar *et al.*, (2008) in some other areas infer positive results.

In the present study, dissolved oxygen was well within the permissible limits of WHO / BIS standards

In the above graph, dissolved oxygen concentration showed an increasing trend in summer season compared to rainy and winter season due to more aeration by lowering of ground water table. It was less comparatively in rainy and winter season due to dissolution of more inorganic minerals and organic matter thereby declining the concentration of dissolved oxygen.

4.4. Biochemical Oxygen Demand

Bacteria and other microorganisms use organic substances for food. The organics are broken into simpler compounds, such as CO_2 and H_2O and the microbes use the energy released for growth and reproduction. When this process occurs in water the oxygen consumed is said as biochemical oxygen demand. If the oxygen is not replaced in the water by natural means, the oxygen level in water will decrease as the organic matter is decomposed by the microbes. This need for oxygen is called biochemical oxygen demand (BOD) which is a commonly used term in water quality and pollution technology. BOD is used as a measure of the strength of sewage. A strong sewage has a high concentration of organic matter and a corresponding high BOD. Biochemical oxygen demand is a function of time.

BOD test is also useful in stream pollution control management and evaluating self purification capacities of streams while it serves as a measure to assess the magnitude of the pollution.

p^H, types of microorganisms, presence of toxins, some reduced mineral matters and nitrification process are important factors influencing the BOD test. Commonly, BOD test has been developed for 5 days at 20°C.

In general, BOD gives a quantitative index of organic substances which are degraded quickly in a short period of time. BOD values should not be used as an equivalent to the organic load.

In the present study, the bio chemical oxygen demand varied from a minimum of 2.46 mg/l to a maximum of 3.77 mg/l in summer. In rainy season, it varied from a minimum of 2.55 to a maximum of 3.78 mg/l. In winter, it varied from a minimum of 2.3 mg/l to a maximum of 3.4 mg/l . The mean values were 3.12, 3.06 and 2.9 mg/l respectively. The study revealed that BOD was well within the permissible limits of 5 mg/l of drinking water standards (Table-1, 3).

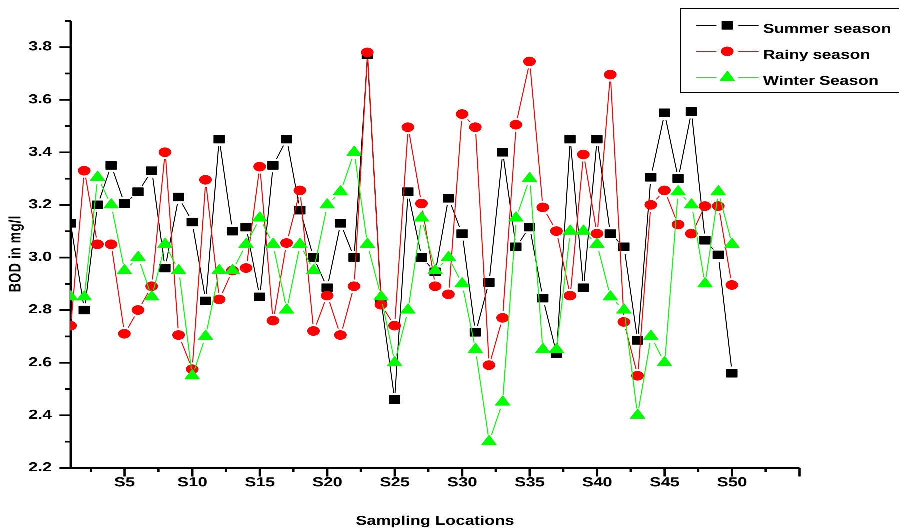

Fig2. *Seasonal variation of BOD at different sampling locations*

The graph represents an increase in BOD concentration during rainy season due to percolation of organic matter. The concentration of BOD was less in summer and winter season.

4.5. Chemical Oxygen Demand

Chemical oxygen demand or COD is another parameter of water quality which measures all organics including the non degradable substances. COD test can be performed within 2 hrs which is definitely an advantage over 5 day's standard BOD test. It is defined as the amount of oxygen required to oxidize the organic matter by a strong oxidizing agent under acidic condition.

This test is widely used as a means of measuring the organic strength of domestic and industrial waste. During determination of COD, organic matter is converted to carbon dioxide and water regardless of assimilating biological substances. COD values are always higher than BOD values for a sample but there is no generally consistent correlation between the two tests for different waste waters.

Bureau of Indian standards (BIS) has laid down tolerance limits for COD of ground water as 10 mg/l. In general, COD test gives no indication of whether or not the waste is degradable biologically nor does it indicate the rate at which biochemical oxidation would proceed and what amount of oxygen is required.

In the present study, COD fluctuated between a minimum of 2.9 mg/l to a maximum of 5.85 mg/l in summer, in rainy season, it varied from a minimum of 3.9 mg/l to a maximum of 5.55mg/l . In winter season, it varied between a minimum of 3.82 mg/l to a maximum of 5.75 mg/l . Mean values are 5.08, 4.63 and 5.1 mg/l (Table-1,3) respectively. The BIS standard permissible limit for COD is 10 mg/l. In the present observation, COD values were well within the permissible limit of BIS (1998).

Mahananda *et al.*, (2010) analyzed surface and ground water of Bargarh district, Orissa and found variation of COD of dug well and bore well water. COD concentration of bore well water varied between a minimum of 1.27±0.16 mg/l to a maximum of 2.21 ±0.52 mg/l.

Jayashankara *et al.*, (2010) studied microbiological diversity and water quality index in temple ponds of Udupi district and found COD concentration ranging between a minimum of 0.01 mg/l to a maximum of 0.08 mg/l.

Pavithra Reddy *et al.*, (2011) assessed leachate characteristics and ground water pollution near Mavallipura, Yelhanka, North Bangalore and found COD ranging between 243- 436 mg/l

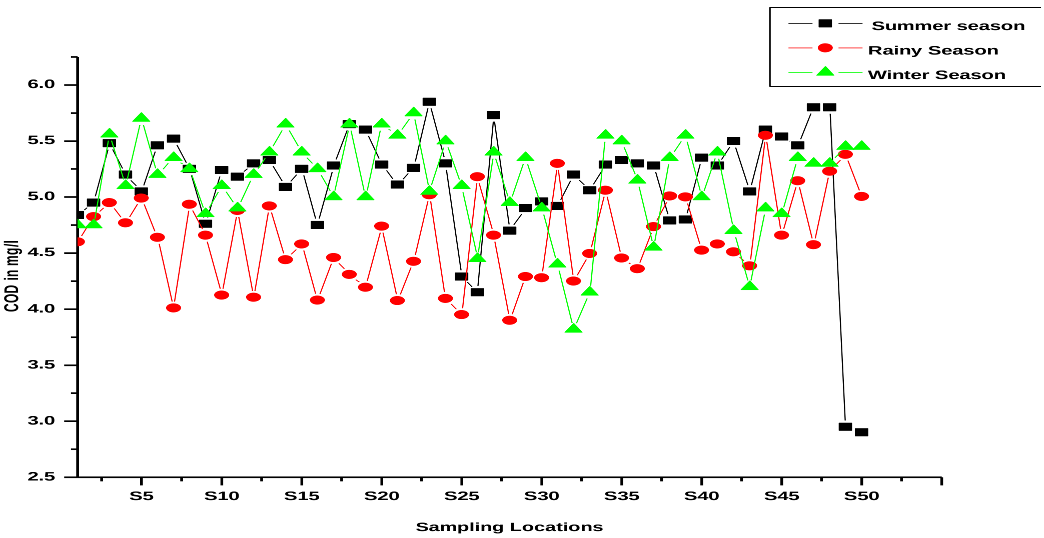

Fig3. *Seasonal variation of COD at different sampling locations*

The graph indicates an increase in concentration of COD during winter season compared to rainy and summer season due to more dissolution of inorganic nutrients in ground water.

4.6. Escherichia coli (E. coli)

An important biological indicator of water quality and pollution used in environmental technology is the group of bacteria called coliforms. Non pathogenic *coliforms* are always present in the intestinal tract of humans and millions are excreted with the body waste. Consequently, fresh water bodies contaminated with sewage will always contain *coliforms*.

Some *coliform* are harmless and some are disease causing. Public water supplies use chlorine as a disinfectant to kill the bacteria before the water leaves the treatment plant. The presence of *E. coli* in water indicates the infiltration of sewage from the drainage. Usually, membrane filter method is used to test *E. coli* after incubation at 35°C for 24 hrs by colony count.

The test for *E. coli* presence is an index of the degree of pollution. The microbiological processes may influence the ground water quality. Many cities discharge their sewage into water courses without treatment (Ramesh *et al.*, 1995).

Escherichia coli fluctuated between a minimum of 0 *coliform* /100 ml to a maximum of 6 *coliform* /100ml in summer, in rainy season, it varied from a minimum of 0 *coliform*/100ml to a maximum of 5.5 *coliform* /100ml. In winter season, *E. coli* ranged between a minimum of 0 *coliform*/100ml to 4.5 *coliform* /100ml. The examined water samples showed 44-58% contamination during summer and rainy season and 20% during winter season. This may be due to contamination with the *faecal* matter, animal bathing near sampling sites, percolation of untreated domestic sewage and solid waste leachate into the ground water. The examination also showed that 40% of the samples were free from *E. coli* contamination (Table-1,3)

Prajapathi *et al.*, (2008) tested the ground water of Patna city, North Gujarat and found *coliforms* varying from 10 *coliform*/100ml to 23 *coliform*/100ml and opined that the samples were bacteriologically unsafe for drinking due to faecal pollution.

Wavde *et al.*, (2008) studied the potability of ground water in Malgaon village of Nanded district, Maharastra and found seasonal variation averaging 127.7, 109.6 and 70.4 MPN/100ml during summer, rainy and winter season respectively.

Binoj Kumar *et al.*, (2012) assessed the likely contamination of ground water in the shallow aquifer, owing to the gratuitous invasion of micro organisms in Thrissur, Kerala. The outcome denotes that the water was habitually contaminated and the degree of contamination was elevated in the vicinity of temporary shelters of migrant workers. The estimated *coliform* count was 93-240. BIS (1998) standard for *E. coliform* is None/ 100 ml.

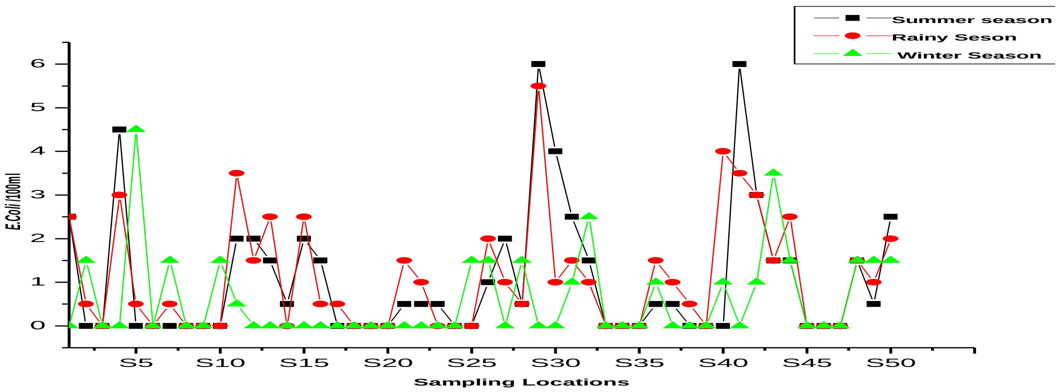

Fig4. *Seasonal variation of E. coli at different sampling locations*

In the above graph, it is observed that *E. coli* bacterial density increased in summer and rainy season compared to winter. This may be due to percolation of untreated sewage, septic tank water and solid waste leachate into the well water.

5. CONCLUSION

1. Contamination of water was observed in all seasons during the period of study.
2. Bacteriological examination (*E. coli*) revealed that 45 to 50% of the samples in the study area were slightly contaminated (*0 coliforms* /100 to *6 coliforms*/100ml).
3. Disinfection is necessary to protect the citizens from health hazards and to assure a healthy atmosphere to all by following discussed methods.
4. Municipality water supply system in and around Tiptur Town must supply treated water to citizens for healthy atmosphere.

REFERENCES

APHA ,1995.American Public Health Association , Washington D C.

BIS ,2006 .Tolerance limits for Inland surface water IS: 2296-1982 and BIS standard

Binoj Kumar, R.B. and Anet Panakkal. 2012. Assessment of ground water pollution based on bacteriological study in Thrissur city, Kerala, India. NEPT, 11(1): 157-158.

Chattopadyaya, S N et al., a short term study of river ganga in Kanpur region Indian J,ENV, HEALTH 26:244-257

Ingole, S.B., Pawale, R.G. and Suresh, T. 2009. Studies on water quality of Majalgoan, Dam Beed Dist., Maharastra, J. Aqua. Biol,, 24(1): 71-76.

Jayashankara, M., Vijaya, R., Girish and Shankar P. Hosmani. 2010. Microbial diversity and water quality index in temple ponds of Udupi District, Karnataka India. NEPT, 9(1): 197-209.

Khulab, . R.D. Prospective in aquatic biology" payarus pub House , New Delhi 1989

Mahananda, M.R., Mohanty, B.P. and Behera, N.R. 2010. Physico chemical analysis of surface and ground water of Bargarh district, Orissa, India. IJRRAS, 2(3).

Mayur C. Shah, Prateek G. Shipakar and Pradip B. Acharya. 2008. Ground water quality of Gandhinagar Taluk, Gujarat, India. E. Journal of Chemistry. 5(3): 435-446

Prajapati and Rao, B.V. 2007. Studies on the ground water quality of Kalol city, Gujarat India. NEPT, 6(2): 197-201. Pavithra Reddy and Nandini, N. 2011. Leachate characterization and assessment of water pollution near Municipal solid waste landfill. NEPT, 10(3): 415-418

Tambekar, D.H., Waghode, S.M., Ingole, S.G. and Gulhane, S.R. 2008. Water quality index analysis of the salinity affected villages from Purna river basin of Vidarha region, Amaravathi Maharastra. NEPT, 7(4): 707-711.

Venkataramaiah, Solanki, Sambmurthy, S., Amajit Kaur and Sabita Raju, S. 2007. Variation in dissolved, oxygen and biochemical oxygen demand in two fresh water lakes of Bodhan, A.P. India. NEPT, 6(4): 623-628.

Ramesh, R.K., Shivakumar, S., Eshwaramoorthi and Pururaja. 1995. Migration and contamination of major and trace elements in the ground water of Madras City, India. Environmental Geology, 25: 126-136.

Rout, jayashree and Bula Das, 2001. Impact of municipal sewage ion river bank (S,Assan) bulletin national institute of Ecology.

Sharma, Moti ram ,J.K Bassin and A.B Gupta (2002). water quality modeling and management of Hathali stream in lower Himalaya.

Sinha A.K el al 1985, water quality of river Gai in rae Bareloi – preliminary report .J. Planet .res. env 2 : 87-90 .

Trivedy R.K and Goel P.K (1986) chemical and biological methods for water pollution studies, Environmental Publication.

Wavde, P.N. and Parveen R. Sheikh. 2008. Potability status of ground water in Malegaon village of Nanded district, Maharashtra. NEPT, 1: 56-6. 1. DK. Gautham, M R Sharma; (2011) India journal of env. Protection 31(6) 464-466