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Dissolved Oxygen Concentration - a Remarkable Indicator of Ground Water Pollution in and around Tiptur town, Tumkur District, Karnataka, India

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ABSTRACT

In most non polluted waters, oxygen is usually maintained at the saturation level and does not either under saturate or super saturate because of factors responsible for its addition and removal and remains 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 the level that can be replenished. As a result, the oxygen 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 ground water and pollutes both ground water and surface water bodies by surface runoff. Changes in levels of dissolved oxygen in the aquatic system have a detrimental effect on aquatic biota in the system. Also, decreased level of oxygen is the indicator of pollution of the particular water body. Hence, analysis of dissolved oxygen plays an important role in water pollution control and waste water treatment process. Thus, estimation of dissolved oxygen concentration becomes essential; With this strong back ground this paper addresses the pollution effect on the basis of dissolved oxygen content in Tiptur and its surrounding areas. Further, study conducted during monsoon revealed that dissolved oxygen varied between 5mg/l to 9.4mg/l and free from maximum bacteriological contamination except few locations. The statistical analysis like Mean, standard deviation (SD), coefficient variance (%CV) and correlation(r) analysis of obtained data were carried out. It is also revealed that the water is fit for drinking, public supply, bathing and fish culture.

Key words *Dissolved oxygen, Bacteriological, aerobic degradation, Microorganisms, Biochemical oxygen demand.*

INTRODUCTION

Oxygen is the regulator of metabolic process of plant and animal communities and indicator of water condition [1]. The factor discussed in this paper provides the information about the over all quality of ground water used for drinking, bathing wild life ,agriculture and fish culture and in turn it becomes a base for Tiptur people to lead a healthy life as they purely depend on ground water resource for drinking purpose. The most important source of organic matter in water 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 mainly of human excreta and other organic matter [2] .Average raw sewage contains usually 1% solids which remain both suspended and dissolved. Out of these, 70% are of organic matter in nature and remainder are in inorganic forms; of the organic constituents 65% are nitrogenous (mainly proteins), 25% are carbo hydrates and 10% are fats .

India has presently the sewer facilities for about 2% of its population 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 pollution of different nature [3].

The BOD of urban runoff is highly variable, its value as high as 7700mg/l have been reported in certain areas. The excreta of aquatic animals also contains several refractory organic compounds. Though these trace organics cause mainly aesthetic problems, recently it has been found that some of them can produce chloroform or other halo methane's in water.

The degradation of organic matter in water is facilitated by different microorganisms that stabilize the organic matter by forming the end products usually immune to further degradation such as Co_2, H_2o,NH3, H_2S, etc. The decomposition of organic matter carried out under oxic conditions ,that is in presence of oxygen is called aerobic degradation , where as in the oxygen free environment it is called anaerobic degradation leading to fermentation[4]. 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

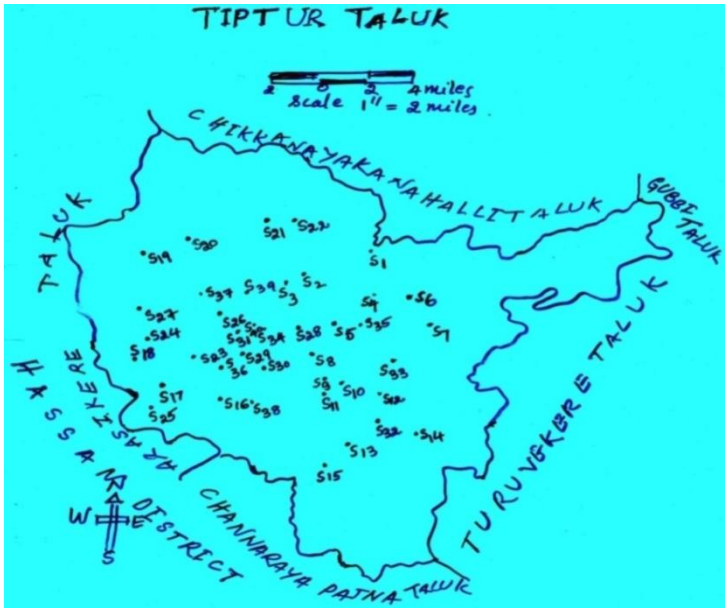
is the chemical oxygen demand and is the quantitative estimation of oxygen equivalent of organic matter that is vulnerable to oxidation in the presence of strong oxidizing agent like potassium dichromate [5].

Bacteriological test is the one of the measure of its pollution. A bacterial indicator of fecal pollution is any bacteria whose presence communicates contamination of water with fecal matter. This type of pollution is due to discharge through animal and human beings mainly *Escherichia coli*. The study mainly focuses on the parameters like DO, BOD, COD and E-coli, which are more important other than physico-chemical pollutants since they directly affect the human health [6]. The process of secondary sewage treatment is able to inactive several pathogenic organisms. Activated sludge can destroy the *Salmonella* spp. to the extent of 70-90% and protozoa and metazoa,0-90%.

Thus the study in Tiptur town and its surrounding areas becomes essential for people who mainly depend on ground water resources for drinking purpose.

STUDY AREA

Karnataka state is situated in the southern peninsular India. Tiptur town is about 75km from Tumkur district. It covers an area of 785 sq km having 13°,16' north latitude 76°, 29' east longitude and an altitude of 850.30 meter above the sea level. The average temperature ranges 11°in winter and 38° during summer. The average rain fall of Tiptur town is 503 mm.



MATERIAL AND METHODS

Water samples from 50 sampling locations were collected during monsoon season of 2011. The samples were collected in sterilized 1 liter bottles and dissolved oxygen was noted at the spot by water analyzer kit (global make). The sample were immediately taken to laboratory and analyzed to avoid impeditable changes .Biochemical oxygen demand analysis was carried out after 5 days incubation at $20^{0,}$ as the major portion of organic matter is oxidized during this period. Similarly, analysis of Chemical oxygen demand was carried out by acidifying sample at P^H <2 with sulphuric acid and carried out within 7 days. For E-coli, samples were collected in 200 ml sterilized containers and analyzed after incubation of the plates at 37^0c 0.5^0 for 24 hours by colonies examination using EMB Agar.

RESULTS AND DISCUSSIONS

Biological data collected during the study period are shown in table -1. The inter relationships between biochemical and chemical oxygen demand and dissolved oxygen are observed in Graph 1-8.

Temperature plays an important role in chemical and biological activities of the water body. In the present study, the water temperature ranges between 26^oC to30^o C.

The p^H plays an important role in the growth of biological process and also in biochemical process as they are p^H dependent. The p^H values in Tiptur ground water(In all 50 sampling location) ranges

between 7.03 to 7.69 .From the observed values it was clear that ground water in the town and its surrounding areas has a tendency of alkalinity.

Dissolved oxygen is a useful parameter (DO) to assess the quality of water. Temperature plays an important role in determining the dissolved oxygen in an aquatic system. During the study, the dissolved oxygen varied between 5 mg/l to 9.4 mg/l. Out of 50 sample ,26%of water samples collected were possessing dissolved oxygen less than 6mg/L. Around 74% of the samples were contained more than 6mg/L ,which represents that ground water was not contaminated by organic matter and non polluted with respect to biological parameters. Even than the ground water, not consumable it may be due to inorganic matter or due to some other factors. Hence whenever dissolved oxygen is more in the water bodies, biochemical oxygen demand will be less. In all other locations, DO values were more than 6 mg/l, representing less contamination due to domestic sewage, industrial effluents and other pollutants by percolation in the ground water.

Higher biochemical oxygen demand indicates a higher pollution in water and low levels of biochemical oxygen demand indicate low levels of biodegradable materials. In the study BOD ranged between 2.5 mg/l to 4.2 mg/l and is in accordance with BIS [7] and APHA [8] standards. In sample locations where BOD exceeds more than 3 mg/l ,the water becomes unfit for regular consumption and requires some treatment for microbiological bacteria (E coli) contamination [9].

Chemical oxygen demand is the oxygen required for chemical oxidation of organic matter. Chemical oxygen demand values convey the amount of dissolved oxidisable matter present in it. The values of COD ranged between 3.6 mg/l to 7.6 mg/l and were well within the BIS standards showing sampling locations free from organic matter .

In the present study *Escherichia coli* ranged between the maximum numbers of coliform 11/100 ml and minimum 1/100 ml. But as per BIS standards E .coli must be zero. The high values of total coli forms and fecal coliform are indicative of increasing pollution by discharge of sewage and domestic effluents in the ground water and discharge of excreta of human beings. Therefore this may cause risk due to presence of microbiological pathogens in water.

Statistical analysis shows the coefficient of variance of 2.8% for p^H .The p^H values were within WHO limits in the study area(table-2). Dissolved oxygen values were found within the BIS & WHO limits, with CV of 0.57%. Biochemical oxygen demand is the major parameter representing pollution. The value variance was CV= 15.8%.Similarly chemical oxygen demand showed variance of CV= 15.9%. E coli showed maximum value of CV =69.3% indicating that 44% of sampling locations are under the requirement of water treatment for drinking purpose [10].

From the collected data statistical correlation was developed between biological parameters as in table -3. p^H was in low correlation with all biological parameters showing least dependency. There was high correlation between dissolved oxygen and biochemical oxygen of r=0.9511showing inter dependency. Chemical oxygen demand showed poor negative correlation r= -0.1032 with biochemical oxygen demand, as always COD > BOD. Ecoli and BOD were low correlated with r=0.0161 ,showing contamination at minimum rate and also showing a negative correlation of r= -0.0475, with COD. Hence representing intensity of pollution depends more on biochemical oxygen demand than chemical oxygen demand [11].

Bureau of Indian standard (BIS) has laid down tolerance limits for ground water as follows,

Standard plate count colonies /cm3	Allowed -500
Total Coliform bacteria MPN/100m	2.2
E-Coliform	None
DO mg/l	>5mg/l
BOD	5mg/L
COD	10 mg/l

Table-1: Biological Parameters during Monsoon season 2011 in and around Tiptur town

	Smapling Stations	Do mg/L	BOD mg/L	COD mg/L	E-coli
S1	Eralagre	6.1	2.9	7.6	4
S2	Chikkmarppanahalli	7.9	3.8	5.2	0
S3	Doddamarppanahalli	6.7	3.2	5.4	0

S4	Ramenahalli	6.5	3.1	4.8	6
S5	Huchgondnahalli	5.4	2.6	5.6	0
S6	Karadi	5.8	2.8	4.9	0
S7	Kuppalu	8.2	3.9	5.1	0
S8	Gorgondanahalli	7.9	3.8	5.2	0
S9	Hedagarahalli	5.2	2.5	4.8	0
S10	Bedagarahalli	5.8	2.8	4.6	0
S11	Aldahalli	7.1	3.4	4.8	5
S12	Kannugatta	6.5	3.1	4.2	2
S13	Sugur	6.1	2.9	5.1	3
S14	Kodihalli	6.5	3.1	4.5	0
S15	Machegatta	7.3	3.5	4.2	5
S16	Tadasur	7	2.7	3.8	0
S17	Gurgadahalli	6.7	3.2	4.4	0
S18	Siddapura	7.5	3.6	4.1	0
S19	Honnavalli	6.3	3	4.6	0
S20	Potarihalli	5.8	2.8	5.1	0
S21	Byrapura	5.2	2.5	3.8	2
S22	Halenahalli	5	2.9	3.6	2
S23	Madenoor	7.9	2.4	4.2	0
S24	Bidaregudi	6.7	3.8	4.4	0
S25	Shivara	6.1	3.2	3.9	0
S26	Manakikere	7.9	2.9	5.4	3
S27	Nagatihalli	7.03	2.8	4.8	2
S28	Idenahalli	6.7	3.5	3.8	0
S29	Marangere	6.1	3.2	4.2	11
S30	Anagondanahalli	8.2	2.9	3.6	2
S31	Madihalli	9.4	3.9	3.8	3
S32	Nagaragatta	5.5	4.5	4.5	0
S33	Echoor	6.5	2.6	5.2	0
S34	Kanchegatta	8.6	3.1	5.6	0
S35	Kotanayakanahalli	8.8	4.1	3.8	0
S36	Lingadahalli	7.9	4.2	4.2	2
S37	Gudigondanahalli	6.7	3.8	4.8	0
S38	Rangapura	5.8	3.2	5.5	0
S39	Sarathavalli	7.3	2.8	4.9	0
S40	Kobredoddayyanna Palya	5.8	3.5	3.8	6
S41	Gandhi Nagar	8.8	2.8	4.2	7
S42	Chamundeshwari Badavane	5.5	4.2	4.5	3
S43	Sharada Nagar	5.8	2.8	5.2	2
S44	Vidya Nagar	6.7	3.2	6.1	3
S45	H.B.Colony	7.5	3.6	4.8	0
S46	Govina Pura	6.5	3.1	5.4	0
S47	Shankarappa Layout	5.8	2.8	3.9	0
S48	Manjunatha Nagar	6.7	3.2	5.5	2
S49	Vinayaka Nagar	6.7	3.2	5.8	2
S50	Kote	5.2	2.5	4.9	4

Table -2: Water Quality parameters of ground water of Tiptur town and its surrounding areas (Biological).

Water quality parameter	WHO standards Values	Experimental range	Mean value N=50	SD	%of CV
Temerature	-	26 -30 ^{0}	-	-	-
P^H	6.5-8.5	7.03-7.69	7.36	0.2079	2.8
Do	>5	5-9.4	3.19	0.0183	0.57

BOD	5	2.5-4.2	4.72	0.5043	15.8
COD	10	3.6	-7.6	0.7525	15.9
E-Coli	None	1-11	1.62	2.34	69.3

Values of all parameters are in mg/L ,except P^H

Table-3: Correlation values (r) between Biological parameters.

	P^H	**DO**	**BOD**	**COD**	**E-coli**
P^H	1	0.1936	0.0555	0.0314	0.1188
DO		1	0.9511	-0.0998	-0.0063
BOD			1	-0.1032	0.0161
COD				1	-0.0475
E coli					1

Values of all parameters are in mg/l, except p^H

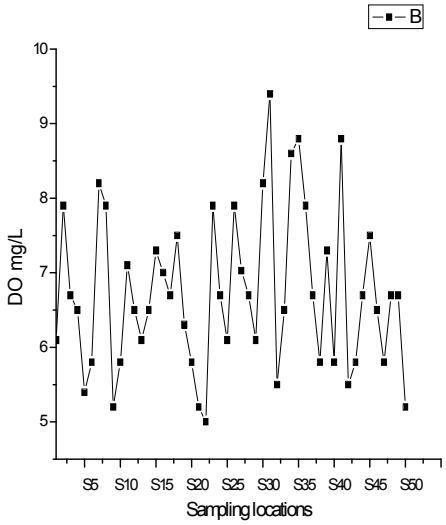


Figure-1

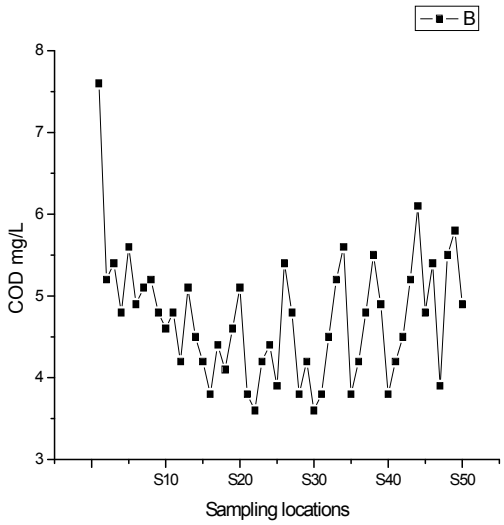
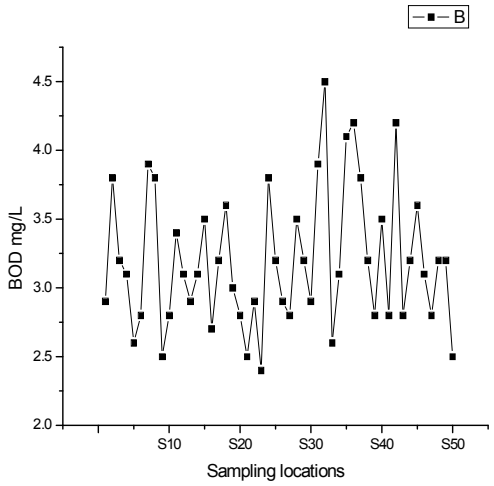


Figure-2



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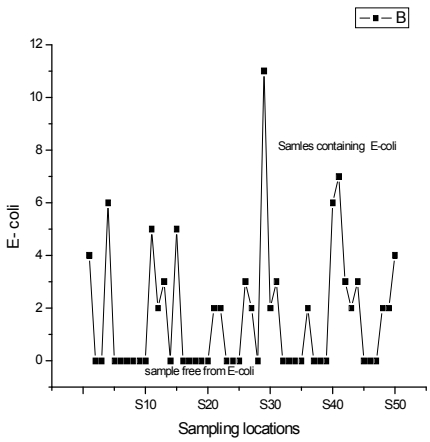

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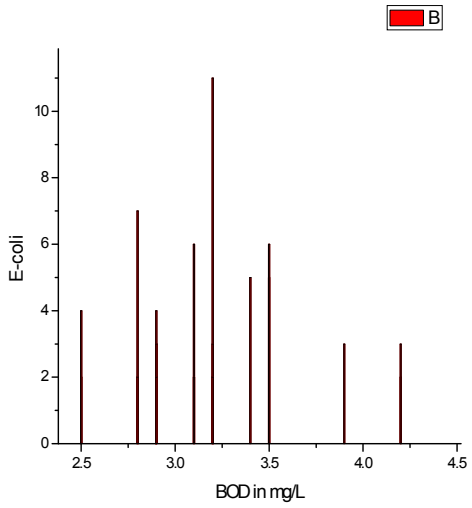

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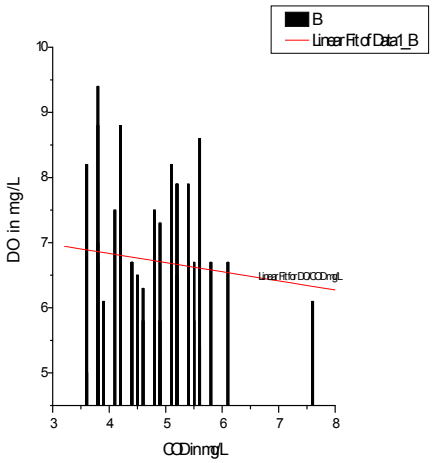


Figure-6

CONCLUSION

From above study it can be concluded that ground water in tiptur town has 44% contaminated samples in selected sampling locations by Escherichia coli ranged between 1/100ml to 11/100ml. but according to WHO, ISI and EPA. Escherichia coli should be zero per hundred milliliter. Hence in such a sampling locations it is necessary to treat water by municipal and water supply department for drinking suitability and lead healthy life. In this study it was also revealed that 56% of the sampling locations showed dissolved oxygen concentration more than 6mg/l , indicating that ground water in such sampling locations were free from organic matter or pollution ,as per WHO, BIS guidelines. Hence ground water was fit for drinking in such locations in tiptur town ,since the people of the town depend on ground water resources. Apart drinking, ground water can also be used for bathing wild life, irrigation and fish culture.

Figure-7

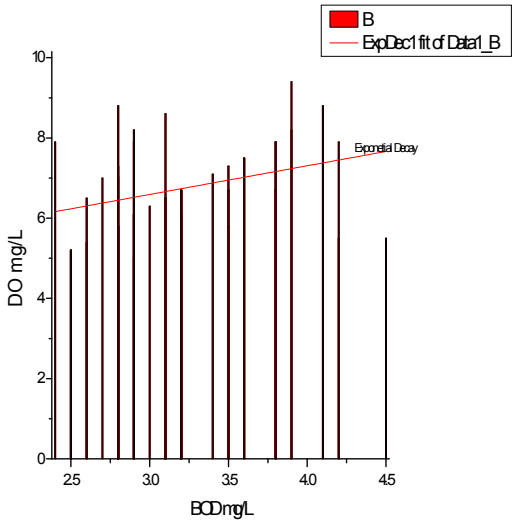
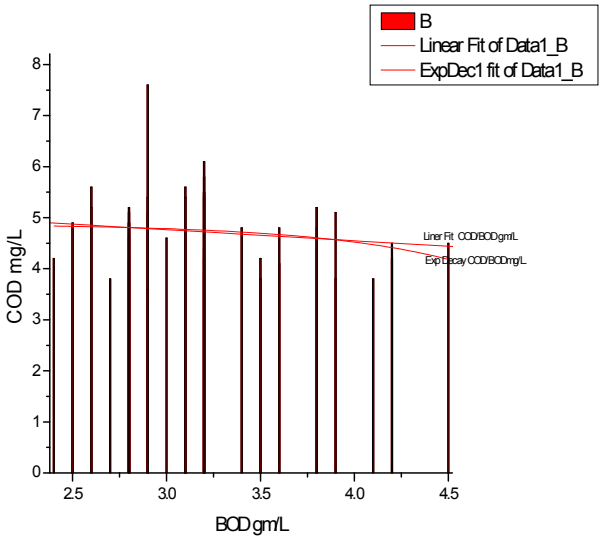


Figure-8



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