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Project Title: A STUDY ON BACTERIOLOGICAL ANALYSIS OF DRINKING WATER OF TUMKUR CITY

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ABSTRACT

Water is the most abundant chemical in the human body and plays a central role in the regulation of nutrient transport, toxic waste removal, thermal regulation and digestion, organ functioning and metabolic activities. Bacteria play important roles in the global ecosystems both on land and in the water by their ceaseless labor in cycling of nutrient. Bacteria have both beneficial and harmful effects. Some of the human pathogens easily transfer through by drinking water. The aim of this study is to analyze the microbiological quality of the available drinking water collected directly from various sources, supply outlets, as well as drinking water stored in various containers or storage pots in order to check the drinking water quality and evaluate the awareness of people for maintaining cleanness and hygiene conditions for storage of drinking water. Study area was under the stress of biological contamination which may lead to the water borne diseases. Bacteria like *Streptococcus, Staphylococcus, Bacillus, Pseudomonas, E. coli, Enterobacter, Salmonella* and *Shigella* were identified by conventional methods using standard Bergy's manual. Analysis was performed using culture and biochemical methods. Number of colonies and bacteria identified were subject to statistical work such as Pearson's correlation, Dendrogram and standard statistical methods by using SPSS software and Past program. Statistical work showed the high level of positive correlation between water samples of few places of Tumakuru city. Diversity indices of bacteria in different samples were tabulated. Results of bacteriological analysis recoded high density of bacteria and statistical work suggest that drinking water of different water samples of offices have correlation, with 0.005 level of significance.

Keywords: Drinking water, Bacteriological analysis, Statistical analysis, Tumakuru city

INTRODUCTION

Water being universal solvent essential for every bodily functions of living beings. Drinking water varies from place to place, depending on the condition of the source water from which it is drawn and the treatment it receives. Bacteriological test is the one of the measure of its pollution. The quality of water is direct impact on health issues of living beings (Akinbile and Yusoff, 2011). Many studies have been carried out worldwide for checking the quality and safety of drinking water. Kurup *et al* (2010) have carried out the microbial and physiochemical analysis of water samples by taking biofilm samples from residential areas in Georgetown, Guyana, discovering the most prevalent species to be *Lactobacillus* and the least prevalent species to be *Salmonella* sp. Zvidzai *et al* (2007) carried out a study on microbiological assessment of rural drinking water in Zimbabwe.

Smeets *et al* (2008) have found that absence of indicator organisms in drinking water does not guarantee microbial safety. So the water utilities are implementing water safety plans (WSP) to safeguard drinking water quality. Quantitative microbial risk assessment (QMRA) can provide objective quantitative input for Water Safety Plans. Nagpal *et al* (2011) have examined the drinking water for the presence or absence of *Salmonella*, *Citrobacter*, *E. coli* and *Vibrio* species in the Indira,Sagar/Omkeshwar project affected areas and rehabilitation/ resettlement colonies of Sardar project in Madhya Pradesh. Tambekar *et al* (2008) revalidated the testing methods for assessing microbial safety of drinking water in the villages of Amrawati district of Maharashtra for using bacteriological analysis with the help of Multiple Tube fermentation technique to determine most probable number (MPN), Membrane filter techniques, Eijekamn's test for thermotolerant coliform and Manja's Rapid hydrogen sulphide test for detection of fecal contaminations in drinking water.

Hence, it is essential to check the quality of the available drinking water from various sources. In view of this present study was designed to analyze the microbiological quality of the available drinking water from various sources like to facilitate the examination of level of contamination and finally hence the risk associated with their consumption. Hence the study has been designed to examine the microbiological quality of available drinking water. Report of the scientists at All

India Institute of Medical Sciences (AIIMS), New Delhi, finds an alarming prevalence of various diseases causing microbes in drinking water and recreational water. The use of this water may lead to several life threatening diseases. Potable water is the water that is free fromdisease producing microorganisms and chemicalsubstances that are dangerous to health (Lamikanra, 1999).

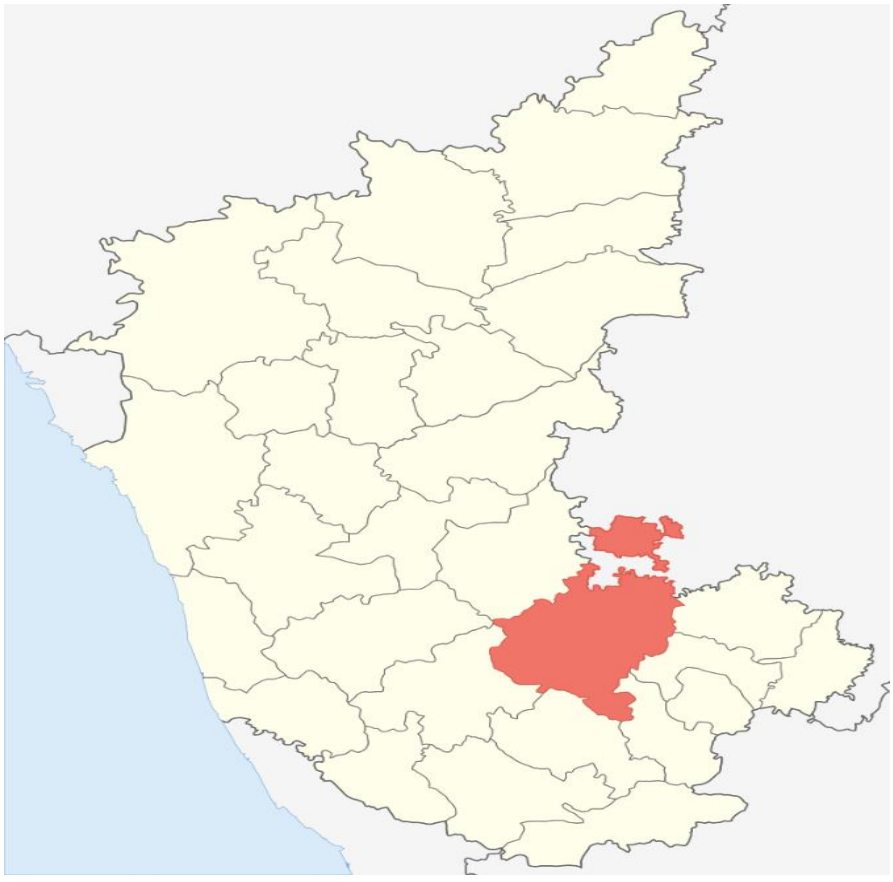
World health organization estimated in 2000 assessment that there are four billion cases of diarrhoea each year in addition to millions to other cases of illness associated with the lack of access of clean water (WHO, 2000). The human pathogens that present serious risk of disease whenever present in drinking water include *Salmonella species, Shigella species*, pathogenic *Escherichia coli* (Geldreich, 1992). Public and environmental health protection requires safe drinking water, which means that it must be free of pathogenic bacteria.

Biostatics is the application of statistics to a wide range of topics in biology, medicine and public health. The goal of biostatistics is to disentangle the data received and make valid inferences that can be used to solve problems in public health. In the view of public health, the present work drinking water from different offices of Tumakuru city was collected and bacteriological analysis and statistical work was carried out to check the quality of water.

MATERIALS AND METHODS

Collection of Drinking Water Samples: Drinking water samples were collected from different public sector offices of tumakuru city using sterile bottles as per the APHA (1992) standard protocol. The samples were collected from various sites like hospitals, schools, packaged mineral water, office vending machines and reverse osmosis treated water. Microbiological analysis of water samples was started as soon as possible after collection to avoid unpredictable changes in the microbial population (Gaudy, 1998). Inoculation, incubation, isolation (Plate No.1) and biochemical tests were carried out (Aneja, 2010). Identification of bacterial pure culture by Bergy's Manual. Bacterial Colonies were enumerated(table 2).

Study area



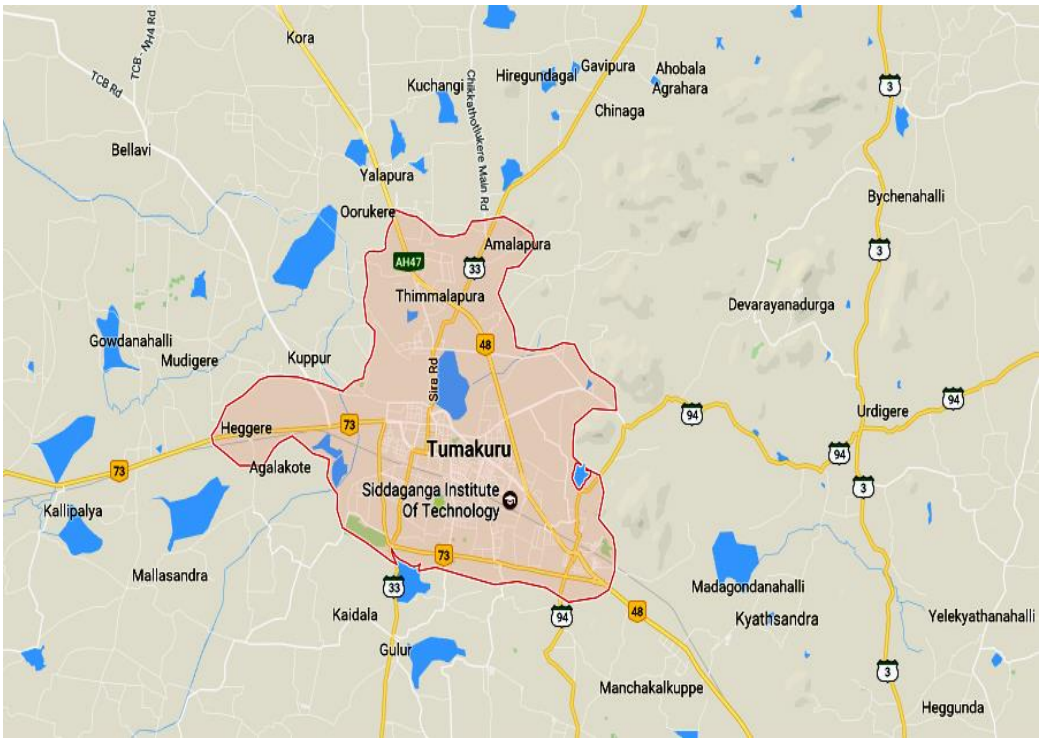


Fig No. 1: Map of Karnataka showing Tumakuru Distict and Tumkur City

Table 1: Sample Sites In Tumakuru City

SL No.	Sample sites
1.	District Armed reserve force
2.	S.P. Office
3.	D.C.C. Bank
4.	Siddaganga hospital
5.	Horticulture department
6.	Government junior college
7.	Railway station
8.	Government hospital
9.	Bus stand
10.	Government school, Krishnagar
11.	District court
12.	S.B.I.Bank,S.S Puram branch
13.	L.I.C.Office
14.	University college of science, Tumakuru
15.	Government polytechniqueTumakuru
16.	R.T.O. Office
17.	Head Post office
18.	D.C. Office
19.	Department of Women and Child welfare office
20.	Tumakuru Urban development authority office

RESULTS AND DISCUSSION

Water samples were tested and examined for bacteriological quality[table.2]. Bacteria like *Streptococcus, Staphylococcus, Bacillus, Pseudomonas, E. coli, Enterobacter, Salmonella* and *Shigella* were identified by conventional methods using standard Bergy's manual[table.5]. Control plate had zero colonies indicating no contamination. Number of colonies and bacteria identified were subject to statistical work such as Pearson's correlation, Dendrogram[fig.2] and standard statistical methods[table.3] by using SPSS software and Past program. In view of public health and hygiene bacteriological analysis of water is of prime importance in present scenario. Statistical work showed the high level of positive correlation[table.4] between water samples of few offices of Tumakuru city. Results of bacteriological analysis recoded high density of bacteria and statistical work suggest that drinking water of different water samples of offices have correlation, with 0.005 level of significance *Bacillus* was found to be the most diverse bacteria according to Simpson and Shannon diversity indices. Equitability being one shows complete eveness of the bacterial diversity among the samples[table6].

Table 2: Enumeration Of Bacterial Colonies From Water Samples.

SL No.	Sample sites	Number of colonies		
		1	2	3
1.	District Armed reserve force	89	93	91
2.	S.P. Office	152	150	150
3.	D.C.C. Bank	119	118	119
4.	Siddaganga hospital	52	54	50
5.	Horticulture department	58	55	58
6.	Government junior college	70	72	71
7.	Railway station	121	12	120

8.	Government hospital	152	152	150
9.	Bus stand	177	163	179
10.	Government school, Krishnagar	88	86	79
11.	District court	48	41	45
12.	S.B.I.Bank,S.S Puram branch	101	110	108
13.	L.I.C.Office	82	83	80
14.	University college of science, Tumakuru	92	89	91
15.	Government polytechniqueTumakuru	94	96	89
16.	R.T.O. Office	149	142	155
17.	Head Post office	76	78	72
18.	D.C. Office	88	80	84
19.	Department of Women and Child welfare office	58	54	50
20.	Tumakuru Urban development authority office	93	94	96

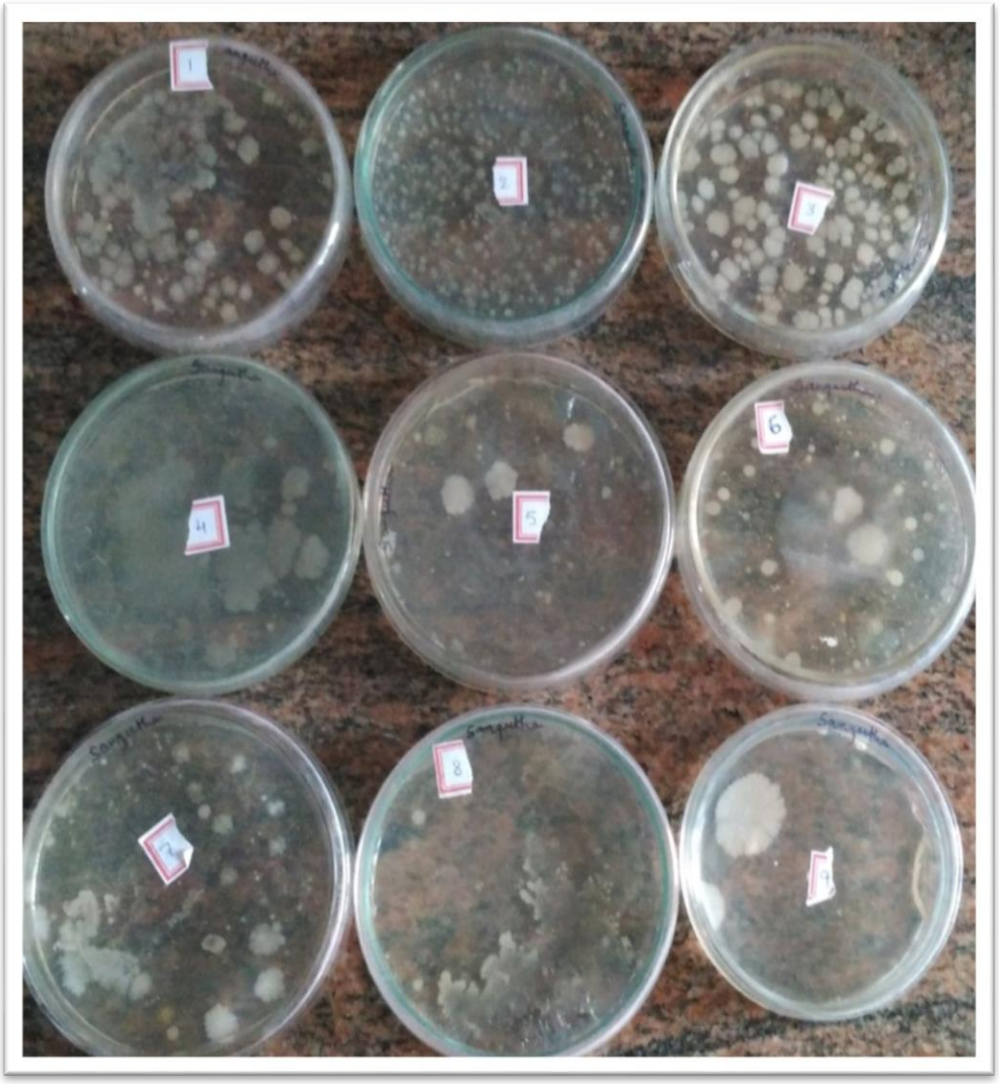


Plate No 01: NA Plates showing bacterial colonies

Table3: Statistics Of Drinking Water Of Tumkur Offices Of Tumkur City

Statistics																			
	District	S.P._Off	D.C.C._B	Siddagan	Horticul	Government	Railway	Government_A	Bus_stan	Government_B	District_A	S.B.I.Ba	L.I.C.Of	Universi	Government_C	R.T.O._O	Head_Pos	D.C._Off	Departme	Tumakuru
Mean	91.00	1.51	118.67	52.00	57.00	71.00	84.33	151.33	173.00	84.33	44.67	1.06	81.67	90.67	93.00	1.48	75.33	84.00	54.00	94.33
Std. Error of Mean	1.16	.66	.33	1.15	1.00	.57	3.61	.67	5.03	2.73	2.03	2.73	.88	.88	2.08	3.75	1.76	2.30	2.30	.88
Median	91.00	1.50	119.00	52.00	58.00	71.00	1.20	152.00	177.00	86.00	45.00	1.08	82.00	91.00	94.00	1.49	76.00	84.00	54.00	94.00
Mode	89.00[a]	150.00	119.00	50.00[a]	58.00	70.00[a]	12.00[a]	152.00	163.00[a]	79.00[a]	41.00[a]	101.00[a]	80.00[a]	89.00[a]	89.00[a]	142.00[a]	72.00[a]	80.00[a]	50.00[a]	93.00[a]
Std. Deviation	2.00	1.15	.57	2.00	1.73	1.00	6.26	1.15	8.71	4.72	3.51	4.72	1.52	1.52	3.60	6.50	3.05	4.00	4.00	1.52
Variance	4.000	1.333	.333	4.000	3.000	1.000	3.92	1.333	76.000	22.333	12.333	22.333	2.333	2.333	13.000	42.333	9.33	16.00	16.00	2.333
Range	4.00	2.00	1.00	4.00	3.00	2.00	109.00	2.00	16.00	9.00	7.00	9.00	3.00	3.00	7.00	13.00	6.00	8.00	8.00	3.00
Minimum	89.00	150.00	118.00	50.00	55.00	70.00	12.00	150.00	163.00	79.00	41.00	101.00	80.00	89.00	89.00	142.00	72.00	80.00	50.00	93.00
Maximum	93.00	152.00	119.00	54.00	58.00	72.00	121.00	152.00	179.00	88.00	48.00	110.00	83.00	92.00	96.00	155.00	78.00	88.00	58.00	96.00
Sum	273.00	452.00	356.00	156.00	171.00	213.00	253.00	454.00	519.00	253.00	134.00	319.00	245.00	272.00	279.00	446.00	226.00	252.00	162.00	283.00

a. Multiple modes exist. The smallest value is shown

* H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * * * * * * * *

Dendrogram using Single Linkage

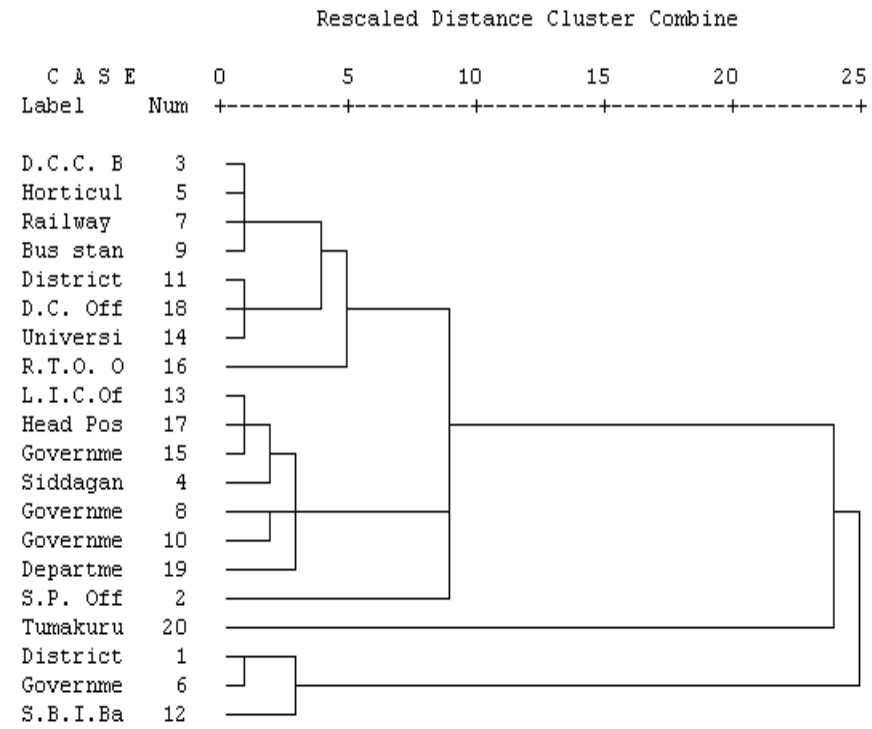


Fig 2: Dendrogram Of Bacterial Colonies In Drinking Water Of Different Offices Of Tumkur City

Table.4: Organisms Identified At Each Sample Site

Sample site		Bacteria identified							
		Streptococcus	*Staphylococcus*	*Bacillus*	*Pseudomonas*	*E.coli*	*Enterobacters*	*Salmonella*	*Shigella*
1	District Armed reserve force	1	0	1	1	0	0	0	0
2	S.P. Office	1	0	1	0	0	1	0	0
3	D.C.C. Bank	1	0	1	0	0	1	0	0
4	Siddaganga hospital	0	1	1	0	0	0	0	0
5	Horticulture department	0	1	0	0	1	0	1	0
6	Government junior college	0	1	0	1	0	0	0	0
7	Railway station	0	1	0	0	1	1	0	1
8	Government hospital	1	0	0	1	1	0	1	1
9	Bus stand	0	1	0	1	0	1	1	0
10	Government school, Krishnagar	1	0	1	0	0	0	0	0
11	District court	1	0	1	1	0	1	0	0
12	S.B.I.Bank,S.S Puram branch	1	0	1	0	0	1	0	0
13	L.I.C.Office	0	1	0	1	0	1	0	0
14	University college of	1	1	1	0	0	0	0	0

	science, Tumakuru								
15	Government polytechniqueTumakuru	1	1	1	0	0	0	0	0
16	R.T.O. Office	1	0	1	0	1	1	0	0
17	Head Post office	1	0	1	1	0	1	0	0
18	D.C. Office	1	1	1	0	0	0	0	0
19	Department of Women and Child welfare office	0	1	0	1	0	0	1	0
20	Tumakuru Urban development authority office	0	1	1	0	0	0	0	1

Table 6: Diversity Indices Of Bacteria Of Water Samples In Tumakuru City.

0	B	C	D	E	F	G	H	I
Taxa_S	12	11	13	8	4	9	4	3
Individuals	12	11	13	8	4	9	4	3
Dominance_D	0.08	0.09	0.08	0.13	0.25	0.11	0.25	0.33
Simpson_1-D	0.9167	0.9091	0.9231	0.875	0.75	0.8889	0.75	0.6667
Shannon_H	2.485	2.398	2.565	2.079	1.386	2.197	1.386	1.099
Evenness_e^H/S	1	1	1	1	1	1	1	1
Brillouin	1.666	1.591	1.735	1.326	0.7945	1.422	0.7945	0.5973
Menhinick	3.464	3.317	3.606	2.828	2	3	2	1.732
Margalef	4.427	4.17	4.678	3.366	2.164	3.641	2.164	1.82
Equitability_J	1	1	1	1	1	1	1	1
Fisher_alpha	0	0	0	0	0	0	0	0
Berger-Parker	0.083	0.091	0.077	0.125	0.25	0.111	0.25	0.333
Chao-1	78	66	91	36	10	45	10	6

CONCLUSION

Water being the inseparable part of life is a reservoir of most of the bacteria. From the present it concluded that the water quality of most of the offices in Tumakuru city is contaminated due to lack of maintenance and people are at risk of more infections. It is recommended to have proper sanitary survey, design and implementation of water and sanitation projects; regular disinfections, maintenances and supervisions of water sources and regular bacteriological assessment of all water sources for drinking should be planned and conducted.

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