Biolife
AN INTERNATIONAL QUARTERLY JOURNAL OF BIOLOGY & LIFE SCIENCES
3(3):608-613
ISSN (online): 2320-4257
www.biolifejournals.com
BIOLIFE RESEARCH ARTICLE

Drinking water quality analysis of some villages from Gadhinglaj Tahsil, Maharashtra

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ABSTRACT

The present research work deals with assessment of drinking water quality of 30 villages from Gadhinglaj tahsil; carried out during the year 2013-2014. The physico-chemical and Microbial parameters were assessed to check either the water is suitable or not for drinking purpose. The physico-chemical parameters such as Total hardness, Ca, Mg, Chloride, Total alkalinity, pH and EC were analyzed as per standard methods. The microbial parameters like MPN, SPC, Total and Fecal coliforms were carried out. The investigation has confirmed a significant number of fecal coliform in all the samples and it found significantly higher than the WHO limit (0) for drinking water. So all the water samples may raise concern on the safety of the water for human health may cause the various water borne and gastro-intestinal diseases so, proper hygiene and purification techniques should be recommended.

Keywords: Water, Physico-chemical and Microbial parameters.

INTRODUCTION

Water is the prime and essential thing of life as is a basic and primary need of all vital processes and it is well established that the life first arose in aquatic environment (Patil, *et al.*, 2013). Human uses it for the domestic and agricultural purposes and for this he is depend on the various water sources like river, reservoirs, small water bodies, dug wells and bore wells. According to Solanki, (2013) ground water is the source of 90 % country's drinking water and in rural areas most of the water supply comes from the ground water. Ground water and other water sources become contaminated by various ways and sources making the water unfit for human use.

How to cite this article:
Shobha D. Jadhav, Rajaram S. Sawant, Rahul Shivaji Patil and Ashvin G. Godghate (2015). Drinking water quality analysis of some villages from Gadhinglaj Tahsil, Maharashtra. Biolife, 3(3), pp 608-613.

Fecal coliforms (like *Escherichia coli*) are the indicator microorganisms used in measuring the sanitary condition and quality of water for drinking (Michigan water science center, 2007; EPA, 2007). As per Oram (2011), presence of heterotrophic bacteria and fecal coliform in water may raise concern on its safety for human. As the Gadhinglaj tahsil is dependent on various water sources for drinking purpose it is necessary to assess the water quality and determine either it is fit for consumption or not.

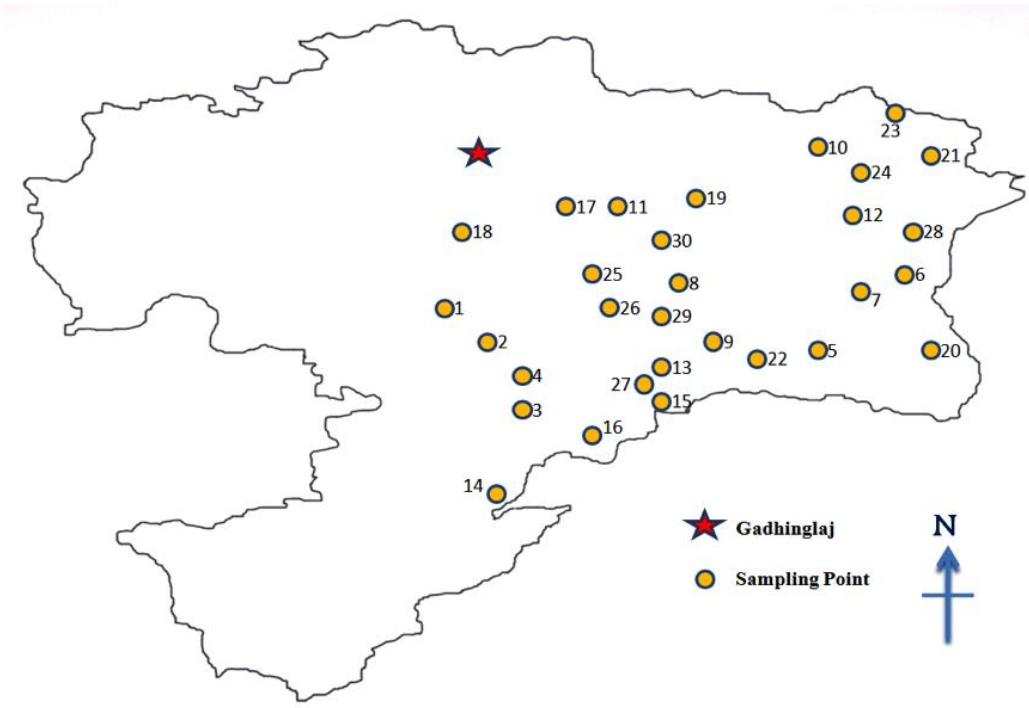
The present investigation was undertaken to estimate the various water quality parameters and to check it either it is suitable for human health or not.

MATERIALS AND METHODS

Study area:

Gadhinglaj is one of the Tahsil of Kolhapur district from Maharashtra located at 16° 13' 26" N and 74° 26' 9" E having a population about 216257. It is distributed in to 90 small as well as large villages which occupy about 48094 ha of area. Throughout the Tahsil, there are number of sources of water for drinking purpose like small and large water bodies along with an important river Hiranyakeshi, which is lifeline of the Tahsil, Dug wells and also bore wells.

Figure-1. Study area: Sampling sites



The people, who are living away from river, are very dependent on the other water sources.

Collection of samples:

The samples of 30 villages from Gadhinglaj tahsil (Fig. 1) were collected in the month of July 2013. Samples were collected in an ice packed plastic container. The Physico-chemical parameters were analyzed within 12 hrs. at the laboratory and the Microbial parameters were analyzed immediately at the Microbiology laboratory.

Analysis of physico-chemical parameters:

The standard methods were used for analyzing physico-chemical parameters. The analyses of parameters were made by the standard methods recommended by APHA, AWWA and WPCF (2005) and Trivedi and Goel (1984).

Analysis of Microbial Parameters:

Standard Plate Count (SPC) and Most Probable Number (MPN) were estimated as per the methods of Greenberg *et al*. (1992). The bacterial colony count was enumerated by using the colony counter. The fecal coliform in the samples was enumerated by using Membrane filtration technique using MacConkeys agar in sterile petri plates. Total coliform were enumerated by using pour plate technique and serial dilution technique, on a Nutrient Molten agar as a medium.

RESULTS AND DISCUSSION

The variations in Physico-chemical and microbial parameters are presented in Table 1 and 2.

Total hardness:

The total hardness is the sum of concentration of alkaline earth metal cations present in the water. It is due to presence of Ca and Mg ions in ground water (Jadhav *et al.,* 2012). In the present study, the content of total hardness for bore well ranges from 240 mg L^{-1} (Hitani) to 580 mg L^{-1} (Basarge), for river 80 mg L^{-1} (Nool) to 100 mg L^{-1} (Jarali), for reservoir 236 mg L^{-1} (Tupurwadi) to 300 mg L^{-1} (Narewadi) and for dug well 180 mg L^{-1} (Chandankud) to 300 mg L^{-1} (Nangnur).

Calcium hardness:

Calcium hardness is an important component of the carbonic buffer system. It is also cycles through biotic and a-biotic components of the ecosystems. Calcium is a main factor responsible for water hardness in natural water. Calcium hardness is originates from natural processes is a dissolvent of minerals which contains calcium and other sources such as industrial wastes and agricultural wastes but this is non-toxic. The level of calcium for bore well ranges from 14.43 mg L^{-1} (Kumbhanhal) to 96.24 mg L^{-1} (Mugali), for river 32.08 mg L^{-1} (Nool) to 70.73 mg L^{-1} (Hebbal Jaldyal), for reservoir 24.06 mg L^{-1} (Tupurwadi) to 29.67 mg L^{-1} (Narewadi) and for dug well 12.03 mg L^{-1} (Terani) to 58.76 mg L^{-1} (Shindewadi).

Table-1. Physico-chemical analysis

Sr. No.	Villages	Sources	Chloride	Total Alkalinity	Mg Hardness	Ca Hardness	Total Hardness	EC	pH
1	Chinchewadi	Bore well	071.00	086	057.32	44.11	280	0.64	6.67
2	Hasursasgiri	Bore well	107.92	070	055.18	48.92	276	0.76	7.81
3	Kadal	Bore well	068.16	070	062.00	20.85	276	0.59	6.93
4	Hidduggi	Bore well	051.12	068	064.02	46.51	310	0.58	6.83
5	Bugadikatti	Bore well	056.80	088	120.52	08.02	504	0.71	7.96
6	Halkarni	Bore well	059.64	070	061.90	15.23	270	0.53	7.80
7	Kumbhanhal	Bore well	053.96	072	057.24	14.43	250	0.54	7.67
8	Yenchavandi	Bore well	045.44	054	088.83	14.43	380	0.36	8.49
9	Manwad	Bore well	028.40	080	073.66	16.84	320	0.56	7.26
10	Hitani	Bore well	071.00	042	043.70	60.15	240	0.59	6.92
11	Mugali	Bore well	099.40	084	056.80	96.24	330	0.87	7.39
12	Basarge	Bore well	221.52	092	127.29	56.14	580	1.31	7.81
13	Narewadi	Reservoir	028.40	086	065.69	29.67	300	0.55	7.23
14	Tupurwadi	Reservoir	034.08	076	051.50	24.06	236	0.45	7.37
15	Tenginhal	River	056.80	110	024.06	60.73	274	0.55	7.64
16	Jaldyal Hebbal	River	052.80	101	034.06	70.73	304	0.45	7.40
17	Jarali	River	061.30	108	024.16	66.73	234	0.53	7.44
18	Hunginhal	River	060.50	120	026.36	67.93	224	0.51	7.65
19	Nool	River	204.48	040	011.64	32.08	080	0.96	7.60
20	Terani	Dug well	071.00	076	055.39	12.03	240	0.52	8.06
21	Aralgundi	Dug well	113.60	074	053.73	48.66	254	0.83	7.87
22	Nandanwad	Dug well	028.40	074	062.10	18.44	274	0.40	7.26
23	Nangnur	Dug well	213.00	106	085.01	52.54	300	1.44	8.24
24	Khandal	Dug well	085.20	068	045.71	51.58	258	0.69	8.32
25	Channekupi	Dug well	042.60	060	072.18	37.37	226	0.44	8.44
26	Khamletti	Dug well	042.60	044	038.49	39.24	200	0.37	8.47
27	Tanawadi	Dug well	085.20	100	032.08	40.80	200	1.02	8.19
28	Chandankud	Dug well	091.20	130	022.08	30.80	180	1.04	7.19
29	Hanmantwadi	Dug well	081.32	140	033.03	50.80	190	1.32	7.90
30	Shindewadi	Dug well	111.60	084	063.73	58.76	234	0.73	7.67

Note: All values are in mg L^{-1}, except pH and E.C. (mhos cm^{-1})

Magnesium:

Monthly variations in magnesium values for bore well ranges from 43.70 mg L^{-1} (Hitani) to 121.29 mg L^{-1} (Basarge), for river 11.64 mg L^{-1} (Nool) to 34.06 mg L^{-1} (Hebbal Jaldyal), for reservoir 51.50 mg L^{-1} (Tupurwadi) to 65.69 mg L^{-1} (Narewadi) and for dug well 22.08 mg L^{-1} (Chandankud) to 85.01 mg L^{-1} (Nangnur).

Chloride:

Chloride occurs in lower concentration in natural water and the soil and rocks, atmospheric precipitation and various environmental factors are responsible for the presence of chloride in dug well water (Patil *et al.*, 2015). Generally fresh water contains 8.2 mg/l of chloride per liter in general (Swarnlata and Rao, 1998). The chloride values for bore well ranges from 28.40 mg L^{-1} (Manwad) to 221.52 mg L^{-1} (Basarge), for river 52.80 mg L^{-1} (Hebbal Jaldyal) to 204.48 mg L^{-1} (Nool), for reservoir 28.40 mg L^{-1} (Narewadi) to 34.08 mg L^{-1} (Tupurwadi) and for dug well 28.40 mg L^{-1} (Nandanwad) to 213.00 mg L^{-1} (Nangnur). High chloride concentration is an excellent indicator of large amount of organic matter present in water. The desirable limit of chloride concentration in drinking water is 250 mg/l (WHO, 1984) (Table-3).

Total alkalinity:

It is usually imparted by the salts of weak acids. As per Jingram (1982), the natural water bodies show a wide range of fluctuations in total alkalinity values depending upon the location and season. The total alkalinity value for bore well fluctuates from 42.00 mg L^{-1} (Hitani) to 88 mg L^{-1} (Bugadikatti), for river 40.00 mg L^{-1} (Nool) to 120 mg L^{-1} (Hunginhal), for reservoir 76.00 mg L^{-1} (Tupurwadi) to 86.00 mg L^{-1} (Narewadi) and for dug well 44.00 mg L^{-1} (Khamletti) to 140.00 mg L^{-1} (Hanmantwadi).

Table-2. Microbial analysis

Sr. No	Villages	Sources	SPC CFU/ml	Total Coliform by MFT cfu/100ml	Fecal Coliform/100ml	MPN/100ml
1	Chinchewadi	Bore well	52,200 X10^5	009	06	022
2	Hasursasgiri	Bore well	57,200 X10^5	012	08	024
3	Kadal	Bore well	53,900 X10^5	011	06	033
4	Hidduggi	Bore well	58,900 X10^5	012	07	019
5	Bugadikatti	Bore well	64,400 X10^5	018	08	024
6	Halkarni	Bore well	37,000 X10^5	034	15	045
7	Kumbhanhal	Bore well	54,800 X10^5	015	07	022
8	Yenchavandi	Bore well	67,500 X10^5	013	06	022
9	Manwad	Bore well	43,800 X10^5	024	10	021
10	Hitani	Bore well	53,200 X10^5	012	08	026
11	Mugali	Bore well	37,500 X10^5	039	18	048
12	Basarge	Bore well	44,300 X10^5	036	14	032
13	Narewadi	Reservoir	1,00,000 X10^5	063	27	074
14	Tupurwadi	Reservoir	1,54,000 X10^5	069	26	087
15	Tenginhal	River	67,900 X10^5	102	36	130
16	Jaldyal Hebbal	River	72,300 X10^5	118	34	126
17	Jarali	River	2,30,000 X10^5	122	38	140
18	Hunginhal	River	6,25,700 X10^5	116	41	130
19	Nool	River	59,800 X10^5	018	07	023
20	Terani	Dug well	33,600 X10^5	032	12	043
21	Aralgundi	Dug well	31,700 X10^5	031	13	049
22	Nandanwad	Dug well	39,200 X10^5	031	12	041
23	Nangnur	Dug well	35,100 X10^5	041	14	052
24	Khandal	Dug well	36,300 X10^5	038	12	048
25	Channekupi	Dug well	31,300 X10^5	030	10	036
26	Khamletti	Dug well	38,700 X10^5	046	23	063
27	Tanawadi	Dug well	33,300 X10^5	032	18	045
28	Chandankud	Dug well	34,400 X10^5	035	14	041
29	Hanmantwadi	Dug well	35,300 X10^5	040	27	031
30	Shindewadi	Dug well	36,100 X10^5	034	12	023

Note: SPC = Standard plate count, cfu = Colony forming unit,
MFT = Membrane filtration technique, MPN = Most probable number

pH:

pH of water is measurably governed by CO_2, carbonates and bicarbonates equilibrium (Chapman, 1996) and water with high or low pH is not suitable for drinking as well as irrigation. The pH value for bore well fluctuates from 6.67 (Chinchewadi) to 8.49 (Yenechavandi), for river 7.40 (Hebbal Jaldyal) to 7.65 (Hunginhal), for reservoir 7.23 (Narewadi) to 7.37 (Tupurwadi) and for dug well 7.19 (Chandankud) to 8.47 (Khamletti).

Electric conductivity:

It is a measure of the ability of a solution to conduct an electric current. Conductivity of water is depends upon the presence of ions, mobility, nutrient status, variations in dissolved solid contents and temperature of water. The variation in electrical conductance, ranges for bore well from 0.36 mho cm^{-1} (Yenechavandi) to 1.31 mho cm^{-1} (Basarge), for river 0.45 mho cm^{-1} (Hebbal Jaldyal) to 0.96 mho cm^{-1} (Nool), for reservoir 0.45 mho cm^{-1} (Tupurwadi) to 0.55 mho cm^{-1} (Narewadi) and for dug well 0.37 mho cm^{-1} (Khamletti) to 1.44 mho cm^{-1} (Nangnur).

SPC; MPN; Total coliform and Fecal coliform:

The standard Plate count, Total coliform, fecal coliform and Most Probable Number were analyzed for water samples are presented in Table 2. The SPC ranged from 31,300 to 6,25,700 (x 10^5) cfu/ml. Total coliforms count ranged from 9 to 22 cfu/100 ml of water sample. The fecal coliforms ranged from 6 to 41 /100 ml while MPN ranged from 19 to 140 /100 ml of water sample.

The present investigation has confirmed a significant number of fecal coliform in all the samples and it found significantly higher than the WHO limit (0) for drinking water. So the all water samples may raise concern on the safety of the water for human.

Table-3. Drinking water standards of WHO (1963), BIS (1991) and ISI (1991)

Parameters	WHO		BIS		ISI	
	General Allowable Acceptability	Limit	Requirement Permissible limit Desirable limit the absence of alternate source	Limit	Permissible Allowable Acceptability	Excessive Limit
Total Hardness	500	-	500	-	200	600
Calcium	75	200	75	200	75	200
Magnesium	50	150	50	150	50	150
Chloride	200	600	200	600	200	600
Alkalinity	75	200	-	-	200	600
pH	7.0 to 8.0	6.5 to 9.2	7.0 to 8.0	6.5 to 9.2	8.5 to 9.0	6.5 to 9.2
E.C.	300	-	300	-	-	-

Note: All values are in mg L^{-1}, except pH and E.C. (mmhos cm^{-1})

CONCLUSION

On the basis of Physico-chemical parameters water of the all sampling points found to be suitable for drinking and domestic purposes while, a significant presence of fecal coliform in all the samples found significantly. So all the water samples may raise concern on the safety of the water for human health and its consumption may lead to the various diseases like dysentery, typhoid, hepatitis, kidney diseases, cholera, etc. so proper purification technique should be recommended before drinking.

Acknowledgement:

Authors are very thankful to UGC (WRO), Pune for funding the minor research project. Authors are also thankful to Principal, Dr. Ghali College, Gadhinglaj, 416502 for providing research laboratory.

Conflict of interests:

The authors declare that there is no conflict of interests regarding the publication of this paper.

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DOI: https://dx.doi.org/10.5281/zenodo.7272994
Received: 4 July 2015;
Accepted; 21 August 2015;
Available online : 5 September 2015