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Water Quality of Dug Wells from Samangad Fort and Adjoining Area, Western Maharashtra, India

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Abstract:

The present investigation deals with the dug well water quality of an important historical place, the Samangad fort and its adjoining region from Kolhapur district of Western Maharashtra. The water quality was determined by assessing various physico-chemical parameters. The samples were collected from various 10 dug wells during May 2013 and physico-chemical parameters like temperature, pH, E.C., free CO_2, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, dissolved oxygen and biological dissolved oxygen were estimated. The values were compared with water standards given by WHO, ICMR and BIS. On the basis of total hardness out of 10 samples 3 water samples were above the permissible limit and not suitable for drinking purpose while suitable for domestic purposes.

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Key words: Dug well, Water quality, Physico-chemical parameters, Potability, Samangad fort.

Introduction

Samangad is a hill fort in Kolhapur district situated at western part of Maharashtra which was built by King Bhoj II. In 1667 Chhatrapati Shivaji Maharaj captured this fort from Adilshah. During the rule of Maratha Empire, the fort was used as base to keep arms, gun-powder, Rasad, etc. However, the fort is situated at hill top, to fulfill the scarcity of water few dug-wells were dug during that period to domestic and drinking purpose. When the British Empire took hold on Kolhapur district, the Samangad garrison was firstly made an attempt to rebel against the British army and he succeeded in it. However, finally in 1844 British army captured and destroyed this fort. Later on, Samangad fort was developed by the government of Maharashtra as a tourist place. Devotees use to visit Chaloba and Hanuman temple oftenly, situated near to the fort. The Bhimshappa Math is a prominent destination which is the shrine of local saint Bhimshappa, who went to state of trance here. The villages near this fort are Hasursasgiri, Naukud and Chinchewadi which are rural and hilly areas.

Since long time the dug-wells present over hilly part of fort are not in use. However, dug-wells at base region are using for domestic as well as drinking purpose. The source of water at hill top is from the base of hill. Since regular water is supplied to hill top from hill base. The present attempt was made to access the water quality status of dug-wells of both hill top and hill base region and make feasible alternative source of water from dug-wells of hill top, instead of hill base.

Materials and Methods

Study Area

Gadhinglaj is located at 16° 13' 26" N and 74° 26' 9" E, Tahsil of Kolhapur District from Maharashtra. This Tahsil is one of the important Tahsils of the Maharashtra state. The population is about 2,16,257, distributed in 90 small as well as large villages occupying about 48,094 ha of area. The Tahsil receives 85 to 90 % of the annual rainfall during south west monsoon season. The average rainfall during study period was 1200 mm.

Samangad fort is located 2,600 feet i.e. 790 meters high from sea level. The fort is situated on the oval shaped top of the hilly region and surrounded by trees.

Collection of samples

The dug well water samples were collected in plastic container during morning hours and brought to the laboratory for further analysis during May 2013.

Analysis of Physico-Chemical Parameters

Standard methods were used for the analysis of physico-chemical properties. Some parameters like temperature and pH were done at the study sites. The sample for DO was fixed in the BOD bottle at the site and then brought to the laboratory for further analysis. Winkler's method was followed for this analysis, while remaining analysis was made as per the standard methods of APHA (2005) and Trivedy and Goel (1984).

Result & Discussion

The results obtained during analysis of Dug well water samples of 10 sites are given in Table 2. A comparison of the physico-chemical data of dug well water samples has been made with WHO (1961) BIS (1991) and ICMR (1975) drinking water standards (Table 3). Figure 1 shows the map of Samangad fort

and location of sampling sites. Out of 10 drinking water samples, 7 samples were clear, colorless & odorless.

Temperature:

The atmospheric temperature ranges from 31 ºC to 34 ºC and water temperature ranges from 16 ºC to 21 ºC.

Total Hardness:

The total hardness of water is due to the presence of Ca and Mg ions in ground water (Jadhav *et al.* 2012). The total hardness of dug well water ranged from 130 mg L^{-1} to 500 mg L^{-1}. The lower values were recorded from Bhimshappa dug-well and higher value was recorded from Chaloba-I dug-well. According to the criteria of Hen (1985), the dug well water of the present investigation was classified as hard to very hard. Out of 10 samples, 3 samples (Chaloba-I, II and III) fall under very hard category with more than above 300 mg L^{-1} total hardness. The desirable limit of total hardness for drinking purpose is below 300 mg L^{-1} (WHO, 1993) and the present study revealed that out of 10 samples 3 samples (Chaloba-I, II and III) were not safe for drinking purpose as it may cause gastrointestinal irritation (ICMR, 1975).

Calcium Hardness:

The calcium values lies between 24.06 mg L^{-1} to 88.22 mg L^{-1}. Lower value was noted from Hanuman temple dug-well and higher value was from Chaloba-I. According to WHO (1993) the desirable limit of Calcium in drinking water is 75 mg L^{-1} and maximum permissible limit is 200 mg L^{-1}. All values are within the limit therefore, all dug water samples are suitable for drinking and domestic purpose as these are within permissible limit.

Magnesium Hardness:

The value of Mg lies between 24.76 mg L^{-1} to 100.06 mg L^{-1}. Minimum values were recorded from Bhimshappa dug well while Maximum values from Chaloba-I. The permissible limit of Mg in water for drinking purpose is 50 mg L^{-1} and maximum limit is 150 mg L^{-1} (WHO 1993, BIS 1991). According to these criteria, all samples are safe for domestic use.

Chloride:

Generally chloride occurs in lower concentration in natural water. The soil and rocks, atmospheric precipitation and other environmental factors are responsible for the presence of chloride in dug well water. As per the Swarnalatha and Rao (1998), the freshwater contains 8.2 mg L^{-1} chlorides. Commonly higher values of chlorides observed during summer months may be associated with reduction in water level (Patil *et al.* 2013). The present values of chlorides fluctuated from 28.40 mg L^{-1} to 53.96 mg L^{-1}. The dug well water from Chaloba-II shows lower content of chloride while the dug well water from Chinchewadi-II contains higher value of chloride. The desirable limit of chloride concentration in drinking water is 250 mg L^{-1} (Raghvendran 1992, BIS 1991). All dug well water samples from present study were found safe for drinking purpose. The lower concentration of chloride is not harmful to the Human being. Higher values shows salty taste to water and become unsuitable for drinking purpose.

pH:

The pH of water is highly governed by carbon dioxide, carbonates and bicarbonates equilibrium (Chapman 1996). It is the important indicator which shows acidic and alkaline nature of water. The pH values varied from 7.27 to 8.28. All samples of dug well water were slightly alkaline in nature. Maximum permissible limit of pH is 6.5 to 8.5 (Table 2), therefore water samples shown all dug-wells are suitable for drinking purpose.

E.C.

It is an excellent indicator of total dissolved solids which is measure of solubility that affects taste of the drinking water (WHO, 1984). It is the important parameter to measure the nutrients and useful to determine the water pollution. The level of E.C. ranges between 0.157 mhos cm^{-1} to 0.564 mhos cm^{-1}. The minimum values were noted from Bhimshappa dug well while maximum from Chinchewadi-I and II. According to standards, desirable limit of E.C. is 0.300 mhos cm^{-1} and present investigation shown 4 dug-well samples (Chinchewadi-I and II, Chaloba-I and II) were above desire limit, hence not safe for drinking purpose.

Alkalinity:

The major source of total alkalinity in freshwater are salts of phosphates, silicates, borates and nitrates. Alkalinity also depends upon location and nature of bottom deposits. The total alkalinity lies between 20 mg L^{-1} to 68 mg L^{-1} which found within the permissible limit. As per G. Sandhya Kiran *et al.* (2012) the total alkalinity in itself is not harmful to human being and as yet the water with less than 100 mg L^{-1} are desirable for the domestic purpose.

Free CO_2:

The concentration of Free CO_2 is generally maintained by breathing through animals and photosynthesis in plants. The value of free CO_2 varied from 4.4 mg L^{-1} to 8.8 mg L^{-1}.

Dissolved Oxygen:

It is very important parameter which gives bad odor to water when present in lower levels due to decomposition of organic matter through anaerobic bacteria. The value of D.O. fluctuates from 5.2 mg L^{-1} to 12.4 mg L^{-1}.

Biological Oxygen Demand:

According to Adoni *et al.* (1985) B.O.D. is the amount of D.O. required in mg L^{-1} for stabilization of organic matter by microorganisms of the sample under anaerobic condition in a stated time. B.O.D. was ranges from 2.8 mg L^{-1} to 5.6 mg L^{-1}.

Conclusion

On the basis of present investigation, it can be concluded that all samples are within permissible limit except Chaloba-I, II and III. The total hardness values of these three sites can exceed normal range and it may cause gastrointestinal irritation. Water from these sites can be used after proper treatment.

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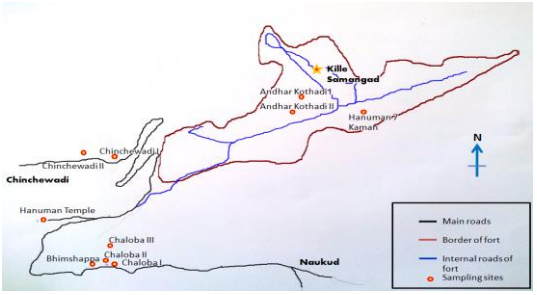

Fig 1: Map showing location of sampling sites

Fig 2: Google map of Samangad fort

Table 1: Geographic location of the dug-wells

Site / Parameter	Latitude	Longitude
Hanuman 7 kaman	16⁰ 17' 553"	74⁰ 40' 560"
Andhar kothadi-I	16⁰ 17' 564"	74⁰ 40' 452"
Andhar kothadi-II	16⁰ 17' 549"	74⁰ 40' 445"
Chaloba-I	16⁰ 16' 622"	74⁰ 39' 721"
Chaloba-II	16⁰ 16' 655"	74⁰ 39' 702"
Chaloba-III	16⁰ 16' 665"	74⁰ 39' 684"
Bhimshappa	16⁰ 16' 578"	74⁰ 39' 400"
Hanuman temple	16⁰ 16' 922"	74⁰ 39' 237"
Chinchewadi-I	16⁰ 17' 433"	74⁰ 39' 410"
Chinchewadi-II	16⁰ 17' 384"	74⁰ 39' 497"

Table 2: Physico-chemical parameters of water from dug-wells

Site / Parameter	Air Temp.	Water Temp.	Free CO_2	pH	E.C.	Alkalinity	Hardness	Calcium	Magnesium	Chloride	D.O.	B.O.D.
Hanuman 7 kaman	33	16	4.4	7.31	0.237	32	210	40.10	041.28	39.76	05.20	3.2
Andhar kothadi-I	34	16	4.4	7.27	0.260	32	250	48.12	049.05	36.92	06.40	4.8
Andhar kothadi-II	33	18	8.8	7.35	0.245	22	200	40.10	038.85	34.08	08.80	5.6
Chaloba-I	34	19	4.4	7.45	0.448	50	500	88.22	100.06	36.92	07.20	4.8
Chaloba-II	34	20	4.4	8.28	0.378	42	420	72.18	084.52	28.40	11.20	5.6
Chaloba-III	34	19	4.4	7.53	0.300	30	330	56.14	066.54	42.60	11.60	3.6
Bhimshappa	32	20	8.8	7.40	0.157	20	130	28.07	024.76	39.76	11.20	3.2
Hanuman temple	31	20	8.8	7.98	0.199	26	170	24.06	035.46	36.92	10.80	4.4
Chinchewadi-I	34	20	4.4	8.23	0.564	66	190	64.16	030.57	36.92	12.40	2.8
Chinchewadi-II	31	21	4.4	8.19	0.564	68	280	64.16	052.44	53.96	12.00	3.6

Note: All values are in mg L^{-1}, except temperature (^0C), pH and E.C. (mhos cm^{-1})

Table 3: Drinking water standards of WHO (1963), ICMR (1975) & BIS (1991)

Parameters	WHO	ICMR	BIS
Total Hardness	500	300	500
Calcium	75	75	75
Magnesium	50	50	50
Chloride	200	250-1000	200
Alkalinity	75	-----	-----
pH	6.5-8.5	7-8.5	7 to 8
E.C.	0.300	0.300	0.300
D.O.	4 to 6(ppm)	4 to 6(ppm)	4 to 6(ppm)

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