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Assessment of drinking water quality in hand pump water of Tonk city, Rajasthan, India

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Abstract– water is essential for growth and maintenance of life for all living organism at the earth. To study the drinking water pollution in Tonk city of Rajasthan(India), a total of 5 water samples were collected from hand pump of various sites of tonk city. The eleven physical chemical parameters such as pH, Chloride, Total alkalinity, Total dissolved solid(TDS), Total hardness, Iron, Calcium, Sulphate and nitrate and Fluoride were analysed in hand pump water to characterise the ground water quality and suitability for drinking and domestic uses. All the analysed data of hand pump water were compared with Indian standard of drinking water recommended by bureau of Indian standard BIS 10500:2012. The physical chemical analysis of hand pump water samples of Tonk city show that pH value ranged from 7.20 to 8.28 and chloride ranged from 86.85mg/l to 960.70 mg/l. The total alkalinity between 396.98 mg/l to 562.80 mg/l. The total dissolved solid ranged from 778mg/l to 3970 mg/l and total hardness from 88.98mg/l to 1156 .76 mg/l. The iron value ranged from 0.0mg/l to 28.79 mg/l, Calcium ranged from 28.62mg/l to 367.81 mg/l and magnesium from 4.09 to 55.74 mg/l . Sulphate ranged from 30.86mg/l to 104.33 mg/l, nitrate from 3.38mg/l to10.13 mg/l and Fluoride varied from 0.1mg/l to 0.3 mg/l. The result of physical chemical analysis of hand pump water samples of Tonk city indicated that hand pump water of sampling site S6 was unsuitable for drinking on the basis of TDS and hand pump water of sampling site S7 was unsuitable for drinking on the basis of TDS, Total hardness and Calcium. Hand pump water of sampling sites S8, S9 and S10 were unsuitable for drinking of the basis of concentration of iron .This study recommended to carry out a strong and continuous water quality program and development of effective practices for utilization of water resources in Tonk city.

Keyword: Drinking water, Hand pump water, TDS, Physical-Chemical Parameters.

1. Introduction

Water is a valuable resource of nature. Fresh, pure and clean water is a basic need for all human beings for healthy living on the earth. Maximum population of world used the ground water as a drinking water. Last few decades, the industrialisation, urbanisation, modern civilization, human activities and population growth have lead to fast degradation of our ground water quality and quantity. The development of industries and human activities in developing countries created a number of environment problem like water pollution and air pollution with their serious effects on human health (wang et al. 2010, Patrick L 2003). The drinking water pollution is the biggest problem in present time. Over 90 percent population of rural and urban of Rajasthan used the ground water as the drinking water which is contaminated. In the world around 80 percent of the diseases and 1/3 percent of deaths in developing countries are caused by drinking of contaminated water (WHO 2004). The joint monitoring programme of WHO and UNICEF, water supply and sanitation reports that 783 million people in the world have no access to safe water. In india about 85 percent of all diseases are directly concerned to low drinking water quality and polluted conditions (olajire and imeo kparia 2001).

Rajasthan is a dry and developing state of India which has an area of 342239 lakh square kilo meter. It has 32 districts. Many research showed that all the 32 district of Rajasthan suffer from drinking water pollution. Many researchers and government of Rajasthan gave emphasis on drinking water quality parameters in Rajasthan. Drinking water in 160 villages of Ramgarh tehsil and 6 sites of alwar district were observed not suitable for human consumption. (Anil yadav 2004). In ground water of Dudu town, alkalinity and total hardness were found to be increases after rainfall (

Ranjana agarwal 2009).High concentration of fluoride were reported in ground water of malpura and tonk (G S Tailor et al 2010 and A K yadav).Ground water quality and their effect on human health reported in jhunjhunu.(Taruna Juneja 2013). Review of literature showed that a large number of research have been done on ground water quality parameter to access the suitability of ground water in various district of Rajasthan but no study have been undertaken in tonk city of Rajasthan on drinking water pollution yet. So the objectives of this study were to analyse the drinking water pollution in Tonk city and to acess the suitability of hand pump water of tonk city for drinking purpose.

2 .Material and methods

2.1 Study area

Tonk is a district of Rajasthan which is located in eastern part of Rajasthan at 25 ^{o} 41' to 26^{o} 34' north latitude and 75^{o} 07' to 76^{o} 19' east longitude with geographical area of 7194 square kilo meter. Tonk district is comprises of seven sub division and seven tehsils viz. Tonk, Peeplu, Todaraisingh, Deoli, Niwai, Uniyara and Malpura. The nick name of tonk is city of Nawab. It is situated 100 kilo meter away from jaipur by road, near the right bank of Banas river. The climate of district is semiarid type and average mean annual rainfall of district is 531mm during 2001 to 2010. In present study 5sampling sites of Tonk city is selected to analyse the drinking water pollution in hand pump water of Tonk city. All the 5 sampling sites of Tonk city are described as follows .(table-1)Figure 1

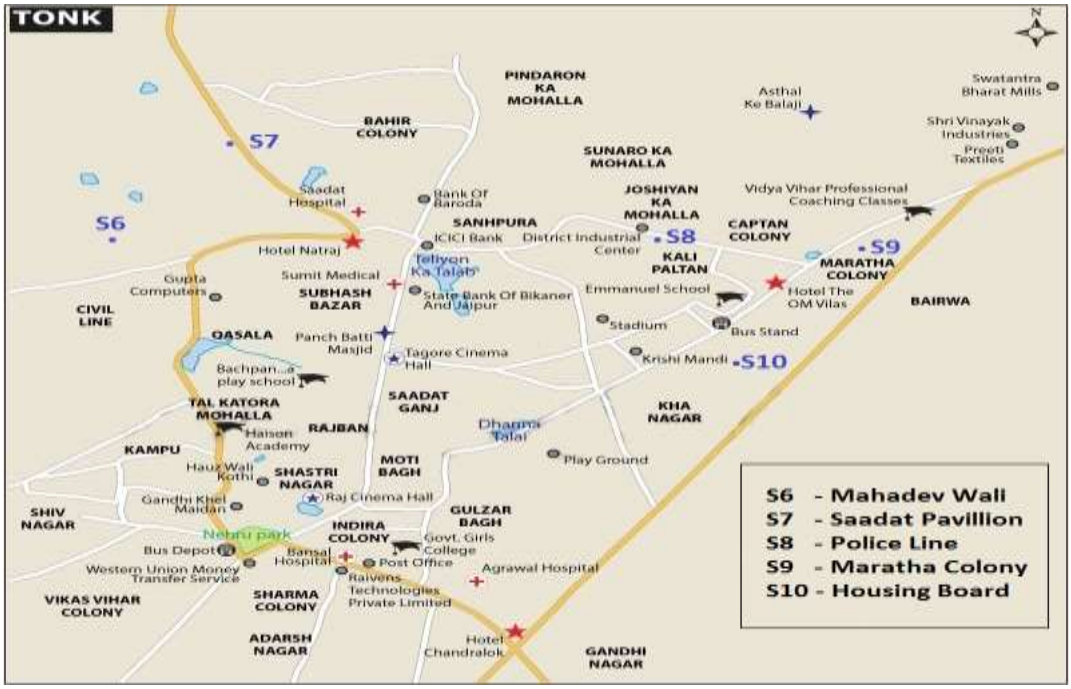

Figure 1. Hand pump water sample in Tonk City

Table 1-sampling sites of Tonk city, Rajasthan, India

Serial No.	Source of water sample	sampling site of Tonk city	Sample/site code
1	Hand pump Water	Mahadev wali Tonk	S_6
2	Hand pump Water	Saadat pavilion ground Tonk	S_7
3	Hand pump Water	Police lineTonk	S_8
4	Hand pump Water	Maratha colony Tonk	S_9
5	Hand pump Water	Housing board Tonk	S_{10}

- Mahadev wali Tonk (S_6) :

  This sampling is located in Mahadev wali nearer to district elementary education office, Tonk.

- Saadat pavilion ground Tonk (S_7) :

  This sampling is located in pavilion ground opposite to government post graduate college, Tonk.

- Police line Tonk (S_8) :

  This sampling is located in police line outside the fire brigade office, Tonk

- Maratha colony Tonk (S_9) :

  This sampling is located in Maratha colony tonk nearer to chawani, Tonk.

- Housing board (S_{10}) :

  This sampling is located in housing board nearer to community hall, Tonk.

2.2 water sampling

Ground water samples of hand pump water of five sampling sites of Tonk city were collected after 10 minute pumping in pre-cleaned and rinsed high density polythene bottles of two litres capacities. During sampling standards methods were followed with precaution. Each bottle was properly labelled with sticker to furnish the information regarding sampling code and sampling site.

2.3 Physical-chemical Analysis of water samples

All the five hand pump water samples were analysed for eleven physical and chemical parameters –pH, chloride, Total Alkalinity, TDS, Total Hardness, Iron, Calcium, Magnesium, Sulphate, Nitrate and Fluoride. The analysis of water samples were done as soon as in accordance to standard methods for the examination of water and waste water American public health association (APHA 1985) and Bureau of Indian standards (BIS 1983).

3. Results and discussion

The analysed data for hand pump water of various sites of Tonk city are illustrated in table 2. The standard of drinking water prescribed by bureau of Indian standard (BIS) depicted in table 3. All the results are compared with desirable and permissible limit recommended by bureau of Indian standard BIS10500.2012. Statistical parameters of hand pump water of Tonk city were summarized in table 4.

3.1 pH

pH has no direct adverse affect on human health, however a low value, below 4.0 will produce sour taste in water. pH value in the water sample in the ranged from 7.20 to 8.28 gm/l. The mean and standard deviation of pH was obtained7.66 and 0.49 respectively. The minimum pH value was observed for sample water of sampling site S6. The maximum pH value was observed for sample water of sampling sites S10. The pH value of all hand water samples were in the desirable range prescribed by BIS. The graphical representation of pH in hand pump water sample of Tonk city is depicted in figure-2.

3.2 Chloride

Chloride concentration in water is the best indicator of pollution .It is present in the water in the form of sodium chloride, calcium chloride and magnesium chloride. Chloride value in the water samples in the ranged from 86.85 to 960.70 mg/l. The mean and standard deviation of chloride was obtained 445.96 and 335.69 respectively .The minimum chloride value was observed for sample water of sampling sites S8. The maximum chloride value was observed for sample water of sampling sites S7. The chloride concentration in sampling site S8 and S9 were below the desirable limit prescribed by BIS. The chloride concentration in sampling site S6, S7 and S10 were above the desirable limit prescribed by BIS. The graphical representation of chloride in hand pump water sample of Tonk city is depicted in figure-3.

3.3 Total alkalinity

The main alkalinity of water is due to presence of carbonate ion and bicarbonate ion. Total alkalinity value in the water samples in the ranged from 396.98 to 562.80 mg/l. The mean and standard deviation of total hardness was obtained469.33 and 69.49respectively. The minimum total alkalinity value was observed for sample water of sampling site S6. The maximum total alkalinity value was observed for sample water of sampling sites S9. The total alkalinity value in sampling sites S6, S7, S8, S9 and S10 were above the desirable limit prescribed by BIS. The graphical representation of total alkalinity in hand pump water sample of Tonk city is depicted in figure-4.

3.4 Total dissolved solid

High concentration of TDS in drinking water may result as incidence of cancer, arteriosclerotic heart diseases and cardiovascular diseases. The total dissolved solid in the water samples in the ranged from 778 to 3970mg/l .The mean and standard deviation of total dissolved solid was obtained 1855.60 and 1282.87 respectively. The minimum total dissolved solid value was observed for sample water of sampling site S8. The maximum total dissolved solid value was observed for sample water of sampling site S7. The total dissolved solid concentration in sampling sites S8, S9 and S10 were above the desirable limit of BIS. The TDS in sampling sites S6 and S7 was above the permissible limit of BIS. The graphical representation of total dissolved solid in hand pump water sample of Tonk city is depicted in figure-5.

3.5 Total hardness

Various diseases like nervous system defect and prenatal mortality are correlated with hardness of water. The total hardness in the water samples in the ranged from 88.98 to 1156.76 mg/l. The mean and standard deviation of total hardness was obtained 445.67 and 449.32 respectively. The minimum total hardness value was observed for sample water of sampling sites S10. The maximum total hardness value was observed for sample water of sampling site S7. The total hardness in sampling sites S9 and S10 were below the desirable limit prescribed by BIS. The total hardness in sampling site S6 andS8 was above the desirable limit of BIS. The total hardness in sampling site S7 was above permissible limit of BIS .The graphical representation of total hardness in hand pump water sample of Tonk city is depicted in figure-6.

3.6 Iron

Lake of iron in human body causes anaemia disease. Iron concentration in water samples varied from 0.0 to 28.79 mg/l. The mean and standard deviation of iron was obtained 7.46 and 12.11 respectively. The minimum iron value was observed in sample water of sampling site S7.the maximum iron value was observed in sample water of sampling site S10. The iron concentration in sampling sites S6, and S7 were observed below desirable limit of BIS. Iron concentration in sampling sites S8, S9 and S10 were observed above permissible limit of BIS. The graphical representation of iron concentration in hand pump water sample of Tonk city is depicted in figure-7.

3.7 Calcium

Calcium is non toxic and may not produce any hazardous effect on human health. Calcium concentration in water samples varied from 28.62 to 367.81 mg/l. The mean and standard deviation of calcium was obtained 148.16 and 136.71 respectively The minimum calcium value was observed in sample water of sampling site S10. The maximum calcium value was observed in sample water of sampling siteS7.the calcium concentration in sampling sites S9 and S10 were observed below desirable limit of BIS. Calcium concentration in sampling site S6 and S8 was observed above desirable limit of BIS. Calcium concentration in sampling sites S7 was observed above permissible limit of BIS. The graphical representation of calcium concentration in hand pump water sample of Tonk city is depicted in figure-8.

3.8 Magnesium

Magnesium concentration in water samples varied from 4.09 to 55.74 mg/l. The minimum magnesium value was observed in sample water of sampling site S10. The mean and standard deviation of magnesium was obtained 22.29 and 20.80 respectively. The maximum magnesium value was observed in sample water of sampling site S7.The magnesium concentration in sampling sites S6, S7, S8, S9 and S10 were observed below desirable limit of BIS. The graphical representation of magnesium concentration in hand pump water sample of Tonk city is depicted in figure-9.

3.9 Sulphate

Sulphate concentration higher than 800 mg/l in drinking water causes cathartic effect Sulphate concentration in water samples varied from 30.86 to 104.33 mg/l. The mean and standard deviation of sulphate was obtained 60.04 and 31.56 respectively. The minimum sulphate value was observed in sample water of sampling site S8.the maximum sulphate value was observed in sample water of sampling site S7. Sulphate concentration in sampling sites S6, S7, S8, S9 and S10 were observed below desirable limit of BIS. The graphical representation sulphate concentration in hand pump water sample of Tonk city is depicted in figure-10.

3.10 Nitrate

High concentration of nitrate in drinking water give bad effect to bottle fed babies. Nitrate concentration in water samples varied from 3.38 to 10.13 mg/l. The mean and standard deviation of total hardness was obtained 5.29 and 2.85 respectively. The minimum nitrate value was observed in sample water of sampling sites S8 and S10.The maximum nitrate value was observed in sample water of sampling site S7. Nitrate concentration in sampling sites S6, S7, S8, S9, and S10 were observed below desirable limit of BIS. The graphical representation of nitrate concentration in hand pump water sample of Tonk city is depicted in figure-11.

3.11 Fluoride

Dental fluoridise is observed when fluorides exceed the level of 1.5 mg/l in drinking water. Fluoride concentration in the water samples in the ranged from 0.1 to 0.3 mg/l. The mean and standard deviation of total hardness was obtained 0.2 and 0.1 respectively. The minimum fluoride values were observed for sample water of sampling sites S8and S10. The maximum total fluoride value was observed for sample water of sampling sites S6 and S7.the fluoride concentration in all sampling sites S6, S7, S8, S9 and S10 were below the desirable limit prescribed by BIS. The graphical representation of fluoride in hand pump water sample of Tonk city is depicted in figure-12.

Table-2 Analysed data of sampling sites of Tonk city, Rajasthan, India.

Serial No.	Parameters	Unit	Sampling Sites				
			S_6	S_7	S_8	S_9	S_{10}
1	pH		7.20	7.35	7.57	8.13	8.28
2	Chloride	mg/l	574.29	960.70	86.85	297.78	310.19
3	Total alkalinity	mg/l	396.98	472.35	407.03	562.80	507.53
4	TDS	mg/l	2130	3970	778	1290	1110

5	Total Hardness	mg/l	588.97	1156.76	319.91	173.73	88.98
6	Iron	mg/l	0.1	0.0	5.15	3.29	28.79
7	Calcium	mg/l	187.69	367.81	101.84	55.55	28.62
8	Magnesium	mg/l	28.12	55.74	15.34	8.18	4.09
9	Sulphate	mg/l	81.89	104.33	30.86	44.03	39.09
10	Nitrate	mg/l	5.63	10.13	3.38	3.94	3.38
11	Fluoride	mg/l	0.3	0.3	0.1	0.2	0.1

Table-3 Drinking water standard of BIS-10500:2012

Serial No.	Parameters	Desirable limit	Permissible Limit	Unit
1	pH	6.5-8.5	----------	-------
2	Chloride	250	1000	mg/l
3	Total alkalinity	200	600	mg/l
4	Total Dissolved solid	500	200	mg/l
5	Total Hardness	200	600	mg/l
6	Iron	0.3	No relaxation	mg/l
7	Calcium	75	200	mg/l
8	Magnesium	30	100	mg/l
9	Sulphate	200	400	mg/l
10	Nitrate	45	No relaxation	mg/l
11	Fluoride	1.0	1.5	mg/l

Table 4 Statistical analysis of hand pump waters of Tonk city, Rajasthan, India.

S.N.	Parameters	Unit	Minimum	Maximum	average	Standard deviation
1	pH		7.20	8.28	7.66	0.499
2	Chloride	mg/l	86.85	960.70	445.96	335.69
3	Total Alkalinity	mg/l	396.98	562.80	469.33	64.49
4	TDS	mg/l	778	3970	1855.60	1282.87
5	Total hardness	mg/l	88.98	1156.76	445.67	449.32
6	Iron	mg/l	0.0	28.79	7.46	12.11
7	Calcium	mg/l	28.62	367.81	148.16	136.71
8	Magnesium	mg/l	4.09	55.74	22.29	20.80
9	Sulphate	mg/l	30.86	104.33	60.04	31.56
10	Nitrate	mg/l	3.38	10.13	5.29	2.85
11	Fluoride	mg/l	0.1	0.3	0.2	0.1

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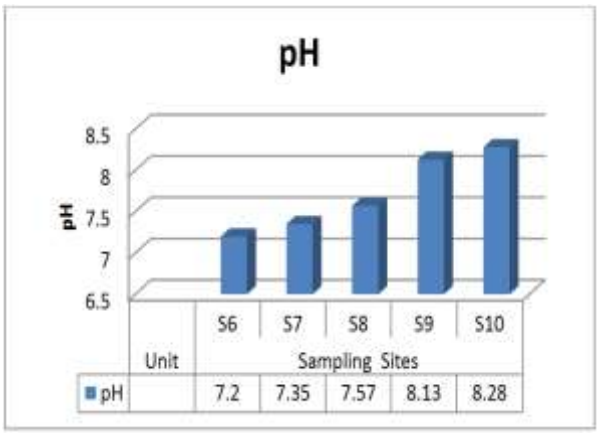

Figure.2.Variation in pH with sampling sites of Tonk City

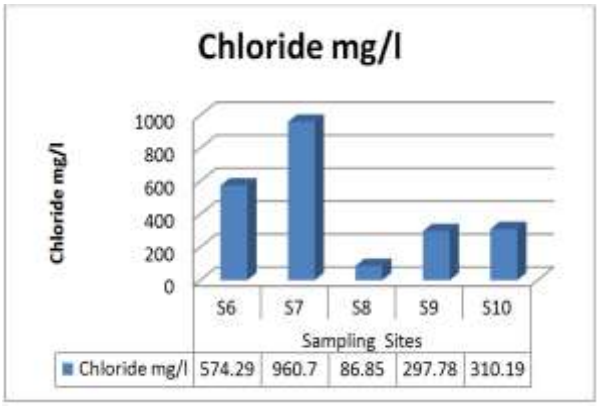

Figure.3.Variation in Chloride with sampling sites of Tonk City

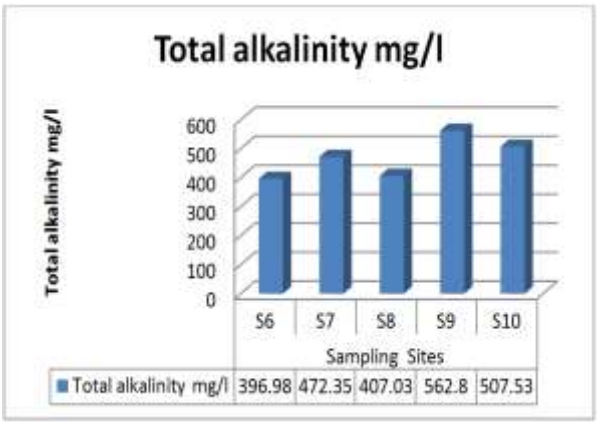

Figure.4.Variation in Total alkalinity with sampling sites of Tonk City

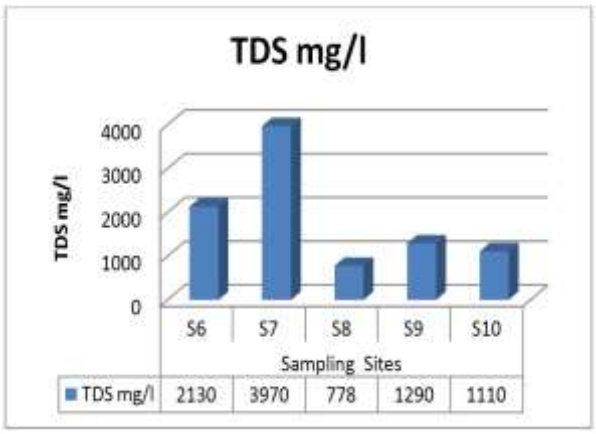

Figure.5.Variation in TDS with sampling sites of Tonk City

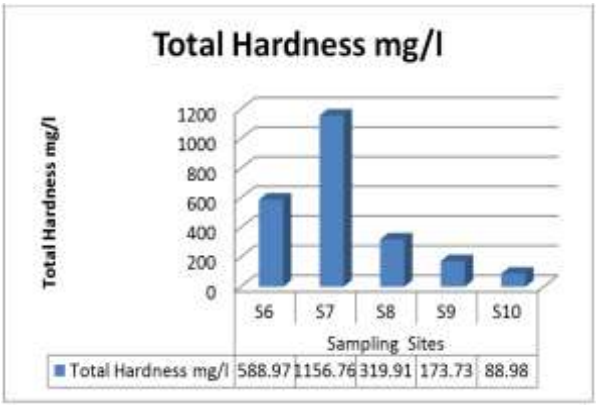

Figure.6.Variation in Total Hardness with sampling sites of Tonk City

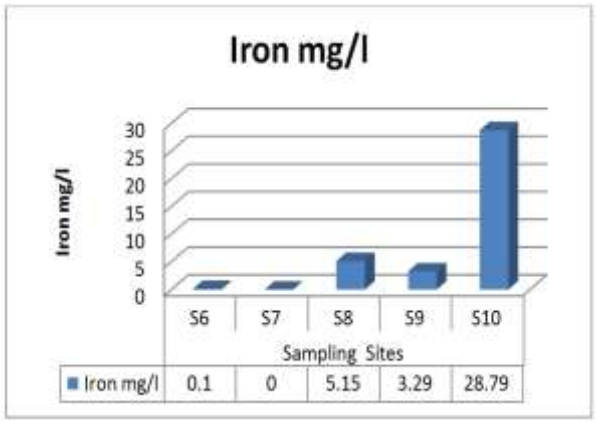

Figure.7.Variation in Iron with sampling sites of Tonk City

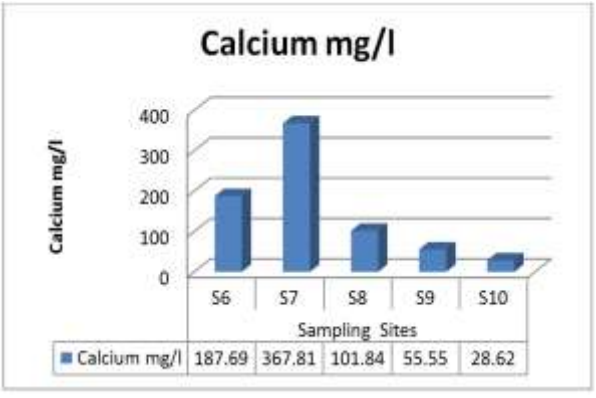

Figure.8.Variation in Calcium with sampling sites of Tonk City

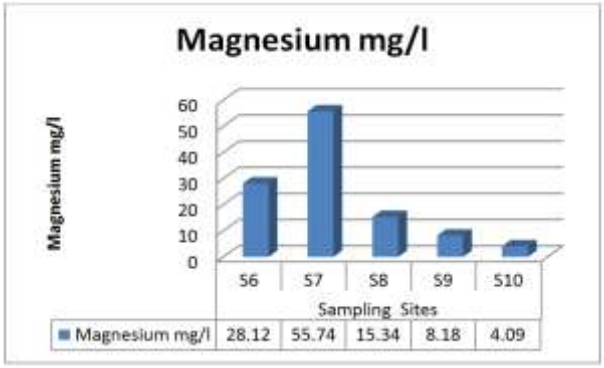

Figure.9.Variation in Magnesium with sampling sites of Tonk City

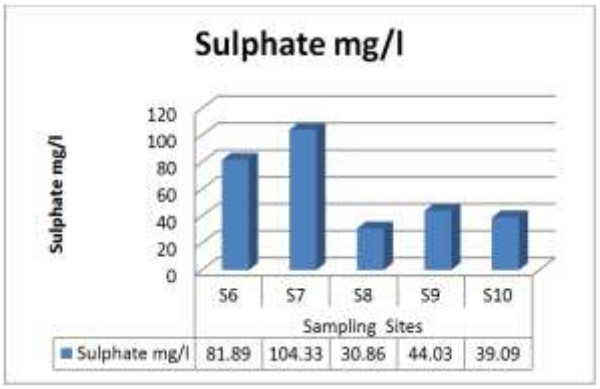

Figure.10Variation in Sulphate with sampling sites of Tonk City

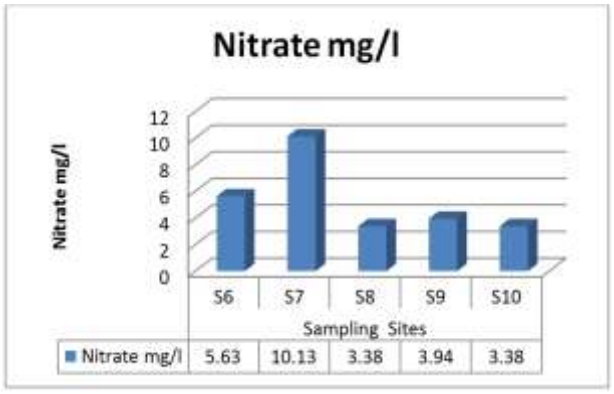

Figure.11.Variation in Nitrate with sampling sites of Tonk City

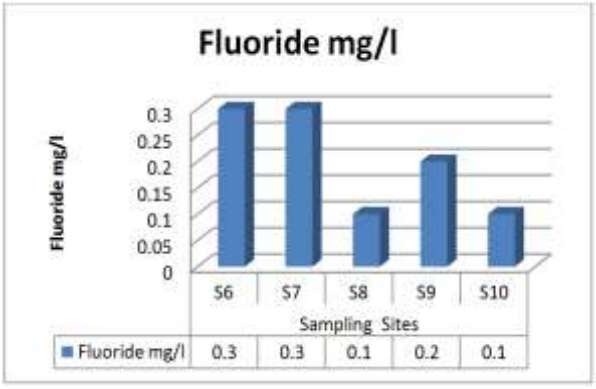

Figure.12.Variation in Fiuoride with sampling sites of Tonk City

4. Conclusion

The analysis of hand pump water samples collected from different sites of Tonk city revealed that hand pump water of Mahadev wali (S6) was found to be unsuitable for drinking purpose on the basis of TDS and hand pump water of Saadat pavilion ground (S7) was also found to be unsuitable for drinking on the basis of TDS, total hardness and calcium. The hand pump water of Police line (S8), Maratha colony (S9) and Housing board (S10) were found to be unsuitable for drinking purpose on the basis of iron concentration prescribed by bureau of Indian standard BIS10500:2012. Such hand pump water requires proper treatment before used by local community. This study recommended to carry out a strong and continuous water quality program and development of effective practices for utilization of water resources in Tonk city.

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