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Chemical analysis of drinking water of villages of Sanganer Tehsil, Jaipur District

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ABSTRACT: Due to pressure of human activity, urbanization and industrialization, the groundwater sources are degraded gradually; therefore pure, safe, healthy and odorless drinking water is a matter of deep concern. There are many pollutants in groundwater due to seepage viz. organic and inorganic pollutants, heavy metals, pesticides, fluorides etc. In Rajasthan state, all 32 districts are affected with high fluoride concentration in groundwater and among these Jaipur ranks second. The drinking water samples were collected in clean polyethylene plastic containers from villages (Code No. 51-100) of Sanganer Tehsil of Jaipur District. The water samples were analysed for pH, Fluoride (F^-), Electrical Conductivity (EC), Total Dissolved Solid (TDS), Calcium (Ca), Magnesium (Mg), Total Hardness (TH), Chloride (Cl^-), Carbonate (CO_3^{-2}), Bicarbonate (HCO_3^-), Alkalinity, Sodium (Na^+), Potassium (K^+) and Nitrate (NO_3^-using standard techniques in laboratory (APHA, 1985). The results revealed that most of the water samples were below or out of limited; according to the WHO standards (1996). The fluoride concentration ranged from 0.4 to 5.4 ppm, where 42% samples showed fluoride less than permissible limit and 48% water samples were within optimum limit i.e. 1-1.5 ppm while 10% samples contained Fluoride higher than permissible limit. pH of all the samples were within limit (6 to 9.2), while EC of all the water samples were out of limit i.e. 300 µmhos/cm. The alkalinity was greater than permissible limit (200 mg/l) in 98% villages and only 2% villages had below than optimum limit. The NO_3^- concentration was less than permissible limit (45 mg/l) in 64% villages whereas 26% samples showed higher concentration of NO_3^-. However only 10% samples contain optimum level of nitrate. Moreover Na concentration was greater than permissible (50 to 60 mg/l) limit in 98% water samples whereas K^+ concentration was below the optimum (20 mg/l) level in all the samples studied. The results revealed that the quality of drinking water of Sanganer is very poor, which can be used for drinking and cooking only after prior treatment.

Key words: *Drinking water, Sanganer Tehsil, fluoride, electrical conductivity, total dissolved solids, nitrate*

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INTRODUCTION

Groundwater is a valuable natural resource for various human activities (Prasad and Narayana, 2004). Natural water always contains dissolved and suspended substances of organic and mineral origin. The pollution of groundwater is of major concern, firstly because of increasing utilization for human needs and secondly because of the ill effects of the increased industrial activity. High concentration of fluoride in groundwater is a considerable health problem in several regions of the world. Considerable part of India has fairly good distribution of fluoride contaminated groundwater (Sinha, 1991). As per report of UNICEF, 20% of the fluoride affected villages in the world are in India and out of these, 10% are in Rajasthan. High fluoride in groundwater is present especially in peninsula and in arid to semi-arid regions of north-western India (Jack *et al.*, 1999). The groundwater of Jaipur district is contaminated with various pollutants including fluoride. So the present study was undertaken to assess the quality of drinking water of villages of Sanganer Tehsil (Code no. 51-100). The sampling of water analysis was done in month of October and November 2003 at various location viz. hand pumps, open wells, tube wells and PHED supply from villages of Sanganer Tehsil of India.

MATERIALS AND METHODS

Sanganer Tehsil is attached with the main city. It lies between 26° 49' to 26° 51' N latitude and 75° 46' to 75° 51' E longitude. It covers an area of 635.5 sq. km. Water samples were collected in clean polyethylene bottles from

different sources viz. tube wells, hand pumps, open wells and other sources. The samples were analysed for different parameters as pH, F^-, EC, TDS, Ca, Mg, TH, Cl^-, CO_3^{-2}, HCO_3^-, Alkalinity, Na^+, K^+ and NO_3^- by using standard techniques (Anonymous, 1976).

RESULTS

The results revealed that pH ranged from 8 to 9. Minimum pH (8.0 ± 0.11) was observed from Ramsinghpura village and Maximum (9.0 ± 0.14) was observed from Sukhiya village (Table 1 and Fig. 1). pH is expressed as a number ranging from 0-14. The number is an expression of the concentration of H^+ ion in the solution. All water samples were found to be within limit but alkaline in nature (Table 2). pH showed positive correlation with fluoride and negative correlation with other parameters (Table 3).

Trivedi (1988) also reported fluoride concentration associated with alkalinity. According to WHO (1996), the permissible limit for pH is 6.9 to 9.2. Fluoride (F^-) varied from 0.2 to 5.4 ppm. Minimum (0.2 ± 0.08 ppm) and maximum (5.4 ± 0.11 ppm) concentration of F^- was observed from Ramsinghpura and Sukhiya villages respectively (Table 1, Fig. 2). Permissible limit for F^- concentration is 1-1.5 ppm according to WHO (1996). The data revealed that 10% villages of Sanganer Tehsil are affected with high concentration of F^-, whereas 42% villages had lower F^- content. However, 48% villages contained optimum limit of fluoride concentration (Table 2). A positive correlation (r=+0.893) was observed between F and pH (Fig. 3) as earlier reported by Teotia and Singh (1981) and Trivedi (1988).

Table 1: Showing values of various parameters of villages of Sanganer Tehsil (Code No. 51-100)

Code No.	Name of villages	pH	F^- (ppm)	EC (µmhos/cm)	TDS (mg/l)	Ca-H (mg/l)	Mg-H (mg/l)	TH (mg/l)	Cl^- (mg/l)	TA (mg/l)	Na^+ (mg/l)	K^+ (mg/l)	NO_3^- (mg/l)
51	Mohanpura	8.3	1.2	1700	905	28	33	210	120	633	380	2.346	34
52	Lyalya ka bas	8.6	1.6	930	480	12	12	105	57	49	97	1.56	10
53	Jhanyee	8.3	1.2	1620	855	27	30	205	113	609	380	1.96	32
54	Khatwara	8.3	1	1600	849	26	30	190	108	548	359	1.96	30
55	Peepla Bharat singh	8.4	1.2	1540	775	24	24	170	106	524	329	1.955	26
56	Mandau	8.9	3.8	734	367	6	5	90	43	292	62	0.782	Tr
57	Chak Harbanshpura	8.5	1.4	1260	630	18	20	140	71	438	168	1.955	18
58	Harbanshpura	8.2	0.6	6240	3435	144	97	650	1099	1387	899	10.557	182
59	Jaichandpura	8.2	0.4	4800	2700	144	124	670	824	1121	880	7.04	182
60	Shri Rampura	8.4	1.2	1425	765	24	27	170	99	524	329	1.955	24
61	Chimanpura	8.25	0.8	2000	1120	36	42	246	142	742	526	3.13	46
62	Hasampura bas bhakarota	8.2	0.4	4700	2604	128	90	540	767	1193	876	7.04	132
63	Shri Ramgopalpura	8.2	0.4	3030	1665	80	75	435	625	1059	860	6.256	124
64	Keshopura	8.3	0.6	3000	1580	80	78	540	461	1071	699	5.871	114
65	Bhankrota Kalan	8.2	0.4	2700	1530	76	66	410	404	950	699	5.474	102
66	Asarpura	8.4	1.2	1420	705	24	27	180	99	1112	320	1.955	24
67	Ganpatpura chak no.2	8.2	0.6	2680	1510	60	65	400	319	815	690	5.08	100
68	Manyawas/Nandkishorepura	8.2	0.4	2655	1500	52	59	370	200	815	690	5.08	94
69	Sukhalpura	8.4	1.2	1350	675	24	29	180	85	487	306	1.955	22
70	Mangyawas	8.2	0.4	2640	1490	50	56	345	199	901	596	5.08	94
71	Singarpura	8.2	0.6	2600	1455	50	46	320	199	937	595	3.52	70
72	Narrotampura	8.7	1.6	810	465	8	7	100	48	293	89	1.173	6
73	Ramsinghpura/Rampura	8	0.2	9570	4650	172	132	700	2173	1460	1000	10.557	202
74	Ganpatpura	8.75	2	850	436	6	5	90	43	270	69	1.173	4
75	Ganpatpura chak no.1	8.2	0.4	2600	1455	48	44	262	199	937	584	3.519	66

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Table 1: Showing values of various parameters of villages of Sanganer Tehsil (Code No. 51-100)

Code No.	Name of villages	pH	F^- (ppm)	EC (µmhos/cm)	TDS (mg/l)	Ca-H (mg/l)	Mg-H (mg/l)	TH (mg/l)	Cl^- (mg/l)	TA (mg/l)	Na^+ (mg/l)	K^+ (mg/l)	NO_3^- (mg/l)
76	Manpura deori/Golyawas	8.5	1.4	1230	630	16	18	130	71	438	168	1.955	16
77	Ramsinghpura/Dhaulai	8.4	1.2	1350	675	20	21	145	85	487	264	1.955	21
78	Balrampura/Khejra ka bas	8.4	1.2	1320	660	20	21	145	71	511	216	1.955	20
79	Kalyanpura	8.2	0.4	2370	1305	48	46	288	185	754	570	3.13	56
80	Jaitpura/Hajyawala	8.5	1.4	1215	615	16	18	130	57	463	140	1.88	16
81	Barh Mohanpura	8.25	0.6	2000	1009	36	36	230	142	657	510	3.13	42
82	Sukhiya	9	5.4	483	242	4	2	90	42	268	39	0.782	Tr
83	Mohanpura	8.3	1.1	1574	810	24	22	165	107	548	330	1.955	28
84	Jagat Shiromanipura	8.25	0.8	1815	1005	36	38	230	142	681	455	3.128	40
85	Chak no. 12/Muhana	8.25	0.8	1815	1000	32	34	215	135	681	425	3.128	40
86	Muhana	8.4	1.2	1275	660	20	22	150	71	426	216	1.955	20
87	Neota with Girdharipura	8.4	1.2	1275	645	20	22	160	71	426	184	1.955	18
88	Hasampura Neota	8.25	0.8	1790	915	32	34	220	128	718	400	2.74	38
89	Chak Basri	8.4	1.2	1260	645	18	20	140	71	438	175	1.95	18
90	Barh meena/Balkhandi	8.25	0.8	1710	915	32	34	220	121	633	400	2.737	36
91	Girdharipura chak no.6	8.5	1.2	1170	615	14	17	125	57	378	140	1.63	14
92	Ramjipura	8.5	1.4	1110	595	14	17	130	57	378	140	1.564	12
93	Sawai Jaisinghpura	8.3	1	1545	780	24	24	170	106	573	330	1.955	28
94	Prempura	8.25	0.8	1710	910	32	34	220	121	633	400	2.346	34
95	Daulatpura	8.5	0.6	1070	585	12	15	110	57	402	420	1.564	36
96	Bhapura	8.5	1.4	960	530	12	16	120	57	317	124	1.564	12
97	Chatarpura	8.6	1.4	869	470	12	12	100	57	268	97	1.173	8
98	Chak no.1,2,3,4,5,8,14 Girdharipura	8.5	1.2	930	530	12	17	120	57	341	111	1.564	10
99	Chak sherwali	8.2	0.4	2025	1120	44	44	262	156	779	540	3.13	50
100	Khatipura	8.5	1.2	930	510	12	7	100	57	354	97	1.564	10

EC is a numerical expression of ability of an aqueous solution to carry electric current. USPH recommended permissible limit for electrical conductivity (EC) is 300 µmhos/cm. The values of EC ranged from 483-9570 µmhos/cm. Minimum (483 ± 36.68 µmhos/cm) and maximum (9570 ± 161.65 µmhos/cm) EC was reported from Sukhiya and Ramsinghpura villages respectively (Table 1and Fig. 4). By analyzing the results, all water samples showed EC higher than permissible limit (Table 2). EC signifies the amount of TDS in water. Findings of the present study were in agreement with the results of the survey conducted by Gupta *et al.* (1994). The total dissolved solids (TDS) in drinking water reveal the saline behaviour of water, which indicates the organic pollution level of water. TDS ranged from 242 to 4650 mg/l. Minimum (242 ± 39.26 mg/l) and maximum

Table 2: Showing permissible limit and percentage of villages of Sanganer Tehsil (Code No. 51-100)

Parameters	Permissible limit	Villages (%)		
		Below	Optimum	Higher
pH	6.9-9.2	-	100%	-
F^-	1-1.5 ppm	42%	48%	10%
EC	300 µmhos/cm	-	-	100%
TDS	500-1500 mg/l	12%	72%	16%
Ca H	75-200 mg/l	86%	14%	-
Mg H	30-150 mg/l	50%	50%	-
TH	100-500 mg/l	6%	88%	6%
Cl^-	200-600 mg/l	82%	8%	10%
Alkalinity	200 mg/l	2%	-	98%
Na^+	50-60 mg/l	2%	-	98%
K^+	20 mg/l	100%	-	-
NO_3^-	40-50 mg/l	64%	10%	26%

Table 3: Showing correlation among various parameters of water samples of villages of Sanganer Tehsil (Code No. 51-100)

Parameters	pH	EC	TDS	Ca-H	Mg-H	TH	Cl^-	TA	F^-	NO_3^-	Na^+	K^+
pH	1	-0.64	-0.66	-0.65	-0.73	-0.70	-0.50	-0.80	+0.89	-0.69	-0.83	-0.67
EC		1	+0.99	+0.95	+0.92	+0.91	+0.97	+0.99	-0.49	+0.92	+0.84	+0.94
TDS			1	+0.97	+0.94	+0.93	+0.95	+0.99	-0.51	+0.95	+0.87	+0.96
Ca-H				1	+0.97	+0.97	+0.91	+0.92	-0.51	+0.97	+0.90	+0.96
Mg-H					1	+0.98	+0.86	+0.93	-0.58	+0.98	+0.94	+0.95
TH						1	+0.85	+0.94	-0.54	+0.99	+0.94	+0.96
Cl^-							1	+0.79	-0.36	+0.87	+0.74	+0.89
TA								1	-0.61	+0.93	+0.99	+0.93
F^-									1	-0.54	-0.65	-0.54
NO_3^-										1	+0.93	+0.98
Na^+											1	+0.91
K^+												1

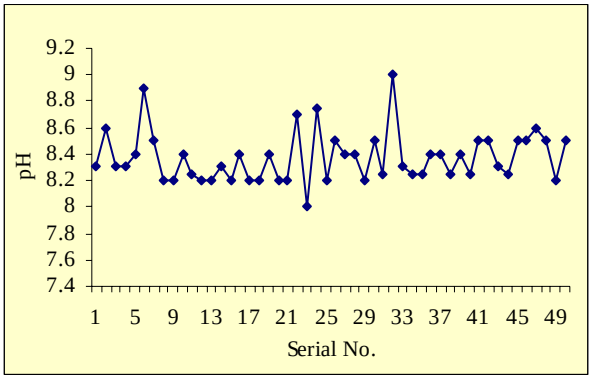

Fig. 1: pH of villages of Sanganer Tehsil (Code No. 51-100)

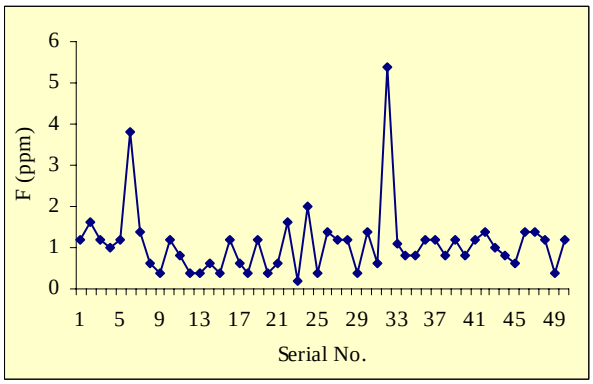

Fig. 2: F of villages of Sanganer Tehsil (Code No. 51-100)

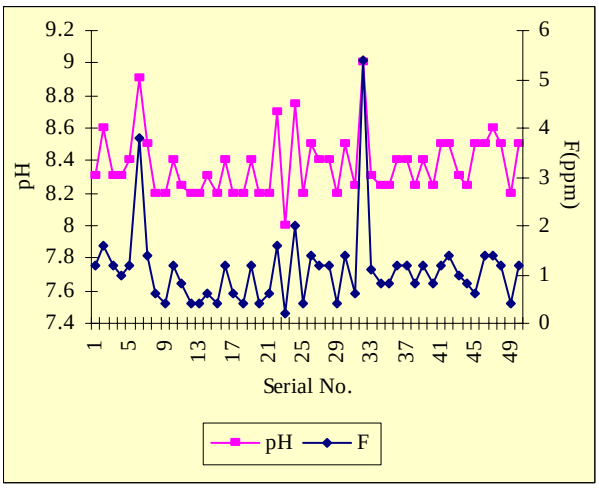

Fig. 3: Correlation between pH and F of villages of Sanganer Tehsil (Code No. 51-100)

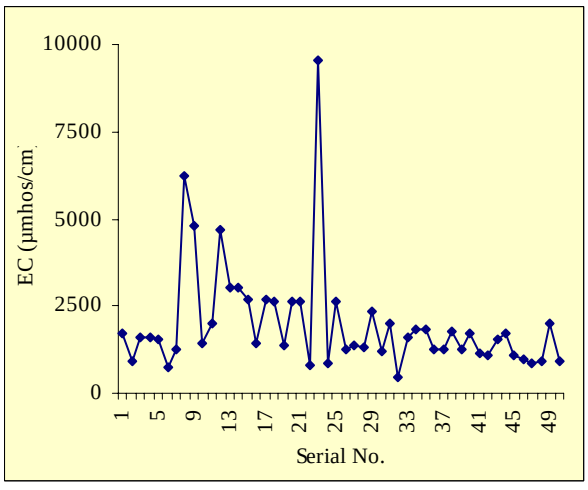

Fig. 4: EC of villages of Sanganer Tehsil (Code No. 51-100)

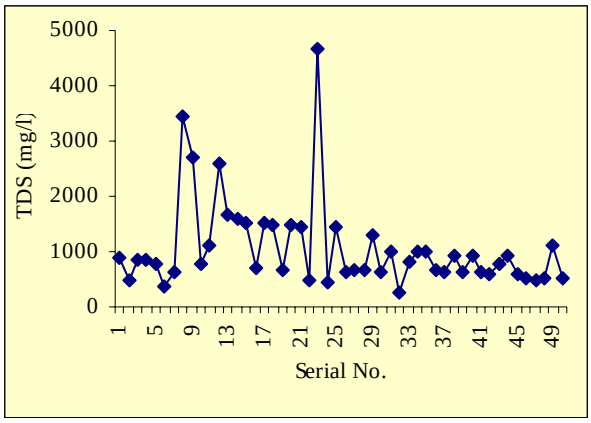

Fig. 5: TDS of villages of Sanganer Tehsil (Code No. 51-100)

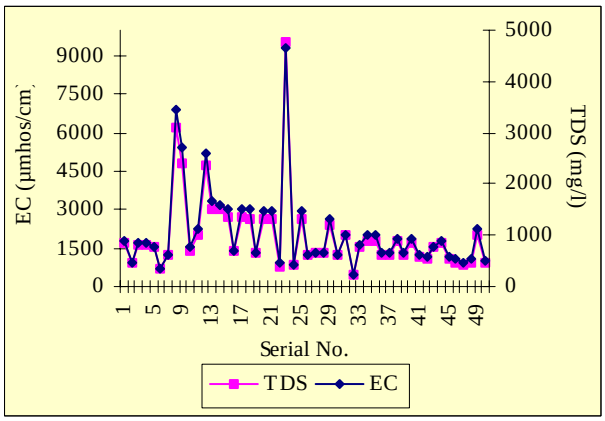

Fig. 6: Correlation between EC and TDS of villages of Sanganer Tehsil (Code No. 51-100)

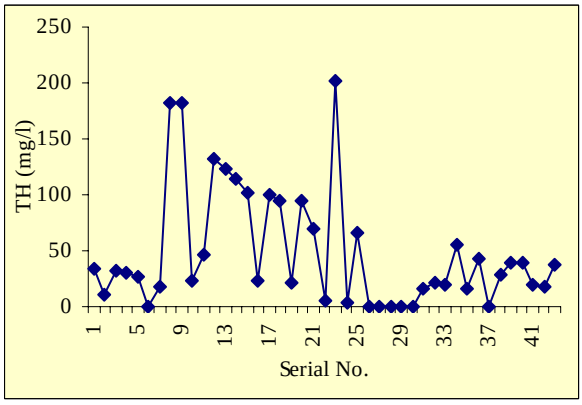

Fig. 7: TH of villages of Sanganer Tehsil (Code No. 51-100)

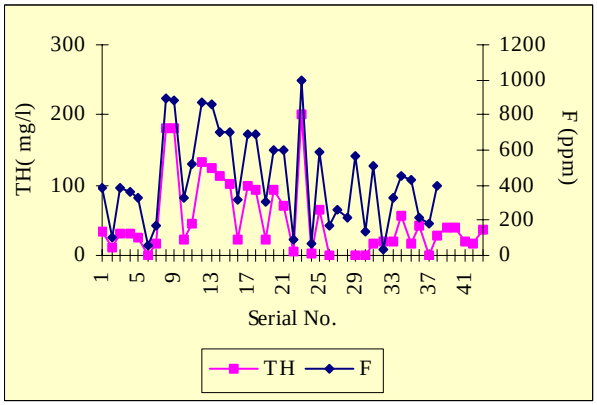

Fig. 8: Correlation between F and TH of villages of Sanganer Tehsil (Code No. 51-100)

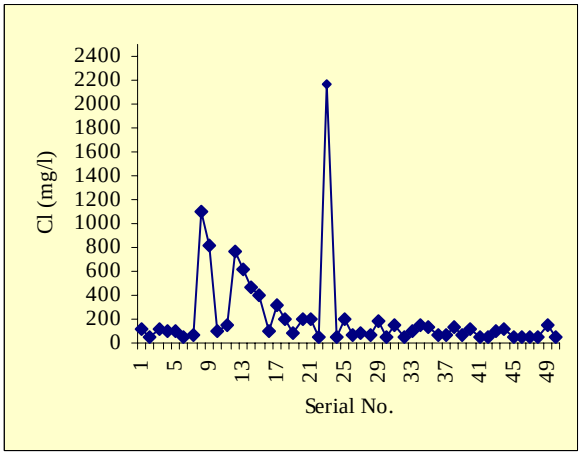

Fig. 9: Cl of villages of Sanganer Tehsil (Code No. 51-100)

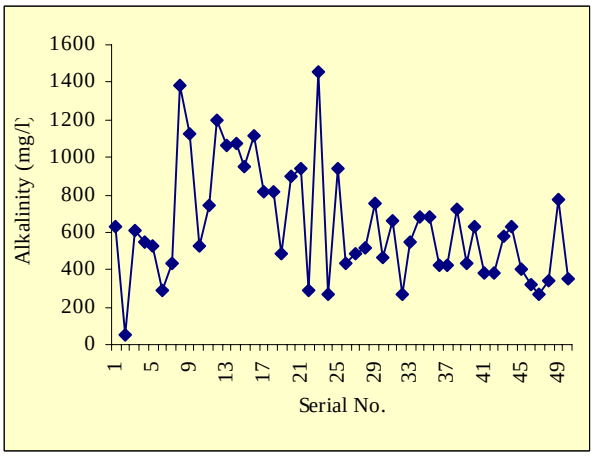

Fig. 10: Alkalinity of villages of Sanganer Tehsil (Code No.51-100)

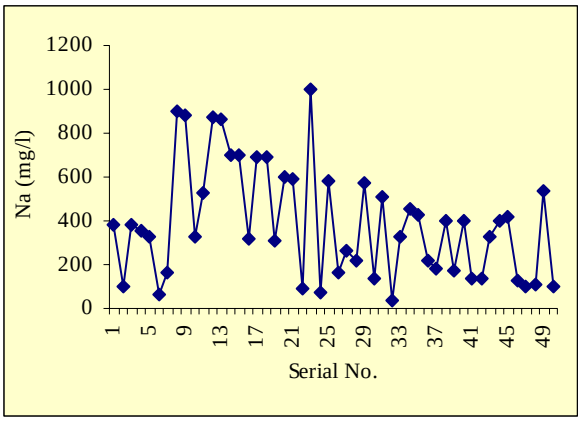

Fig. 11: Na of villages of Sanganer Tehsil (Code No. 51-100)

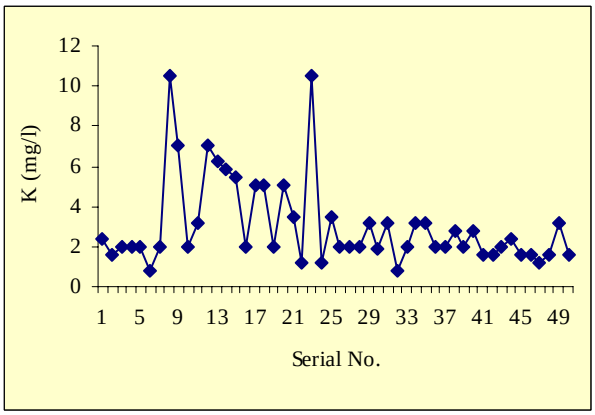

Fig. 12: K of villages of Sanganer Tehsil (Code No. 51-100)

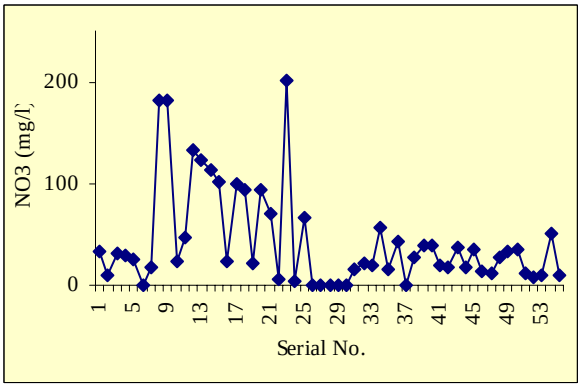

Fig. 13: NO3 of villages of Sanganer Tehsil (Cod No. 51-100)

(4650 ± 254.03 mg/l) concentration of TDS was observed from Sukhiya and Ramsinghpura villages respectively (Table 1 and Fig. 5). According to WHO (1996), TDS should be between 500-1500 mg/l. TDS was found to be within limit in 72% villages, lower in 12% villages, whereas 16% villages showed TDS higher than limit (Table 2). In this study, significant positive correlation (r=+0.995) was observed between EC and TDS (Table 3, Fig. 6). Calcium hardness (Ca-H) ranged from 4 to 172 mg/l. Minimum Ca-H (4 ± 1.15 mg/l) was observed from Sukhiya village whereas maximum Ca-H (172 ± 6.92 mg/l) was reported from Ramsinghpura Village. Magnesium hardness (Mg-H) ranged from 2 to 132 mg/l. Minimum (2 ± 1.15 mg/l) and maximum (132 ± 6.92 mg/l) values were reported from Sukhiya and Ramsinghpura villages respectively. Ca-H and Mg-H combined to form total hardness. TH varied from 90 to 700 mg/l. Minimum (90 ± 24.24 mg/l) and maximum (700 ± 57.74 mg/l) was reported from Sukhiya and Ramsinghpura villages respectively (Table 1 and Fig.7). WHO recommended safe permissible limit for hardness i.e. 100-500 mg/l (Table 2). In groundwater, hardness is mainly due to carbonates, bicarbonates, sulphates and chlorides of Ca and Mg. Ca H was within permissible limit in 14% villages whereas 86% villages contained Ca H below than limit (Table 2). Mg-H was below than limit in 50% villages and 50% villages showed Mg-H within optimum limit. Total hardness was higher in 6% villages; below than limit in 6% villages whereas 88% samples contained TH within optimum limit (Table 2). In this study, hardness showed negative correlation with F^- and pH (r= -0.544; r= -0.702) (Table 3 and Fig. 8). The results are in agreement with the findings of Trivedi (1988) and Sharma (2003). Chloride (Cl) varied from 42 to 2173 mg/l. Minimum (42 ± 6.92 mg/l) was reported from Sukhiya village and maximum (2173 ± 99.88 mg/l) was observed from Ramsinghpura village (Table 1 and Fig. 9). The chloride content was higher than permissible limit (200-600 mg/l) in 10% villages whereas lower in 82% villages. Only 8% villages were within optimum limit (Table 2). High content of chloride gives salty taste to water. Carbonate (CO_3^{-2}) ranged from 24 to 216 mg/l. At some villages CO_3^{-2} concentration is negligible. Minimum (24 ± 6.92 mg/l) and maximum (216 ± 11.55 mg/l) content of CO_3^{-2} was observed from Bhapura, Girdharipura Chak Nos. 1,2,3,4,5,8,14, Khatipura and Ramsinghpura respectively. Minimum bicarbonate (HCO_3^-) (49 ± 6.35 mg/l) observed from Lalya ka bas village and maximum (1244 ± 87.18 mg/l) was reported from Ramsinghpura village. CO_3^{-2} and HCO_3^- together make total alkalinity.

It ranged from minimum (49 ± 6.35 mg/l) Lalya ka bas to maximum (1460 ± 98.72 mg/l) from Ramsinghpura villages (Table 1 and Fig 10). Alkalinity was higher than permissible limit i.e. (200 mg/l) in 98% villages, only 2% villages contained alkalinity below than limit (Table 2). Alkalinity showed positive correlation with EC, TDS, Cl, TH, NO_3^-, Na^+ and K^+ (Table 3). The results are in agreement with the results of Devi *et al.* (2003). High values of alkalinity give undesirable taste to water.

Minimum (39 ± 2.88 mg/l) and maximum (1000 ± 58.31 mg/l) Sodium (Na^+) content was observed from Sukhiya and Ramsinghpura villages respectively (Table 1 and Fig. 11). Almost all the villages (98%) contained higher concentration of Na^+ except in Sukhiya village wherein it was below limit. The acceptable limit for Na^+ is 50 mg/l according to WHO (Table 2). Potassium (K^+) content of water samples varied from 0.782 to 10.557 mg/l. Minimum (0.782 ± 0.22 mg/l) and maximum (10.557 ± 1.62 mg/l) K^+ content were observed from Mandau and Ramsinghpura villages respectively (Table 1, Fig. 12). All the water samples (100%) contained K^+ content lower than permissible limit i.e. 20 mg/l (Table 2). Minimum (6 ± 1.15 mg/l) and maximum (202 ± 1.15 mg/l) nitrate (NO_3^-) content was observed from Narottampura and Ramsinghpura villages respectively. At two villages (Sukhiya and Mandau) NO_3^- was in trace amount (Table 1 and Fig 13). NO_3^- content was lower than permissible limit (40-50 mg/l) in 64% villages; 10% were within limit whereas 26% villages had NO_3^- concentration higher than limit. Higher concentration of NO_3^- in water causes a disease called "Methaemoglobinaemia" or known as "Blue-baby Syndrome". It is particularly infant disease upto 6 months of child (Agrawal, 1999).

DISCUSSION AND CONCLUSION

The data indicate that the groundwater of Sanganer Tehsil is highly deteriorated as it is polluted with high amount of fluoride, nitrate and alkalinity. Most of the parameters were either more than permissible limit or below limit. Therefore, the drinking water of villages of Sanganer Tehsil is not potable. To maintain quality of groundwater, the continuous monitoring of physico-chemical parameters should be done and can be used for cooking and drinking only after prior treatment.

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