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Fluoride and nitrate in groundwater of north-western part of Jodhpur district of Rajasthan, India

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Abstract
Groundwater is a vital source for drinking and agricultural purposes in North-Western Part of Rajasthan. The present field survey was conducted to study the ground water quality in respect of chemical characteristics of North-Western Part of Jodhpur District of Rajasthan during the years 2019-20. The results reported that the chemical characteristics, pH ranged between 7.19 to 9.90, EC 0.56 to 12.40 dSm^{-1}, fluoride 0.02 to 2.52 mg L^{-1} and nitrate 1.10 to 130.50 mg L^{-1} in underground water of Jodhpur district.

Keywords: Fluoride, nitrate, ground water, irrigation

Introduction
Water is one of the most important questions for those resources that are needed for the production of plant-based products. Add it to irrigation water is important in India, where it is in the third place, on the surface, is found in an arid and semi-arid climate, the precipitation, which makes that it is seasonal and unstable. The semi-arid climate in the southern region of Jodhpur district of Rajasthan dictates the need to use more water, to optimize the production of the crop. Most of the underground as well as the water pipe, which is composed of a high concentration of salt, and their continued use of the irrigation system, and has a negative impact on crop production and causes a degradation in the country. This requires continuous monitoring of groundwater to assess the potential damage to the soil's health, based on salinity and alkaline geostricili. India has 6.73 million hectares of land which is exposed to the levels of salinity and sodicity (Singh *et al.*, 2009) [18]. Every year, based on the lack of irrigation water to approximately 10 million acres of land was lost. Out of the total cultivated cropped area in Rajasthan, 1.183 m ha of land is salt-affected (AICRP, 2006-2010) [1]. In Rajasthan, the arid and semi-arid tracts account for nearly three-quarters of the state and the groundwater of questionable quality are the most important irrigation water source at a time. It has a resolution had the salts are greater than with a common element in groundwater in the western Rajasthan (Garg, 2011) [5]. However, the chemical quality of most of the western parts of Rajasthan is brackish to saline. The arid districts of western Rajasthan *viz*., Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jalore, Jodhpur, Nagaur and Pali have saline groundwaters. The majority of the underground water in the western arid district have EC up to 10 dSm^{-1} whereas, in semi-arid and humid districts waters have EC up to 5 dSm^{-1} and 2.2 dSm^{-1}, respectively. The salt content of the soil is closely related to the salt content of irrigation water (Khandelwal and Lal, 1991) [7] therefore, the quality of irrigation water concerning its impact on soil properties is of particular interest in arid and semi-arid areas.
A systematic study of water is necessary for better utilization of water resources to tackle water problems. It is necessary, to improve the quality of the output of the crops in this area. All information's are not yet available about the quality of groundwater of this tract, which was essential for effective water management. Therefore, an urgent need was felt for extensive and well-planned investigation both in the field and laboratory for suggesting guidelines towards better utilization of irrigation water and soil of this tract in the Jodhpur district of Rajasthan.

Material and Methods
The field survey was conducted to study the groundwater quality in respect of ionic composition and chemical characteristics of the North-Western Part of Jodhpur District of Rajasthan. The area studied lied in the agro-climatic zone IA (Arid North-Western Sandy Plain) and IIB (Alluvial Plain of Luni Basin).

Jodhpur district situated in the western part of Rajasthan at 26˚00′ N to 27˚37′ N latitude and 72˚ 55′ E to 73˚ 55′ E longitude, comprising six tehsils, *viz.*, Balesar, Bap, Denchu, Lohawat, Phalodi and Shergarh, where the survey was conducted. Phalodi and Bap tehsils are situated in the Northern part of the Jodhpur district, Shergarh and Balesar in the Western part of the Jodhpur district, while, Lohawat and Denchu are in the North-West part of Jodhpur district. Geo-referenced 170 water samples were collected from one hundred thirteen villages of Bap, Phalodi, Lohawat, Denchu, Balesar and Shergarh tehsils of Jodhpur district during March 2019 from the tube wells/open wells, which were used for irrigating the fields. The data regarding water quality like pH, EC was analysed as per standard procedures suggested by Richards (1954) [14], Nitrate was analysed by standard procedures of Phenol disulphonic acid method suggested by Prince (1945) and Fluoride was analysed by standard procedures of Ion- selective electrode method suggested by Villa (1979).

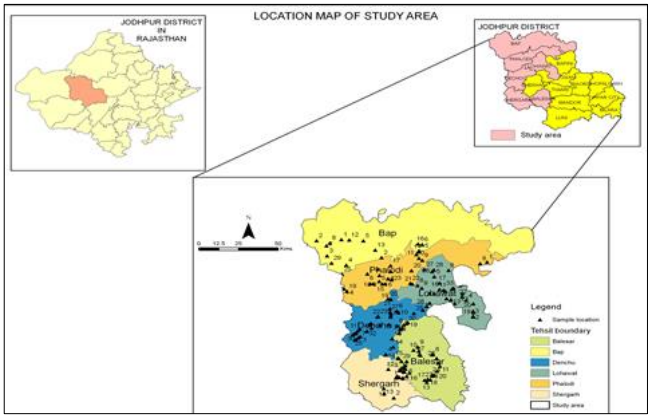

Fig 1: Location map of north-western part of Jodhpur district of Rajasthan

Results and Discussions

pH

A perusal of data (Table 1) revealed that the pH of irrigation water of Jodhpur district was varied from 7.19 to 9.90 with an average value of 8.01. Tehsil wise, the pH value was ranged between 7.60 to 8.35 with an average value of 7.97 in Balesar, 7.52 to 8.33 with the mean value of 7.84 in Bap, 7.19 to 8.33 with the mean value of 7.96 in Denchu, 7.60 to 8.53 with the mean value of 8.16 in Lohawat, 7.43 to 8.62 with the mean value of 8.03 in Phalodi, 7.30 to 9.90 with the mean value of 8.01 in Shergarh, tehsils. These results get support from the finding of Daisy and Khan *et al*. (2008) [4], Tank and Chandel *et al*. (2010) [19] and Kumar *et al*. (2016) [8].

Electrical conductivity (dS m^{-1})

The electrical conductivity of underground water of Jodhpur district was ranged between 0.56 to 12.40 with the mean value of 3.43 dSm^{-1} (Table 1). The tehsil wise minimum, maximum and mean values of electrical conductivity were recorded 0.97 to 4.31 & 2.33 in Balesar, 0.56 to 9.77 & 5.14 in Bap tehsil, 1.26 to 7.35 & 3.32 in Denchu tehsil, 0.67 to 5.03 &1.86 in Lohawat tehsil, 0.99 to 9.47 & 3.98 in Phalodi, 1.99 to 12.40 & 4.89 dSm^{-1} in Shergarh tehsil. The results are in agreement with the findings of Daisy and Khan *et al*. (2008) [4], Tank and Chandel *et al*. (2010) [19], Garg (2011) [5] and Yadav *et al*. (2012) [21].

Table 1: pH and EC of underground irrigation water of Jodhpur district

Tehsils/District	pH	EC (dSm^{-1})
Balesar tehsil		
Range	7.60-8.35	0.97-4.31
Mean	7.97	2.33
C.V.	2.99	40.47
Bap tehsil		
Range	7.52-8.33	0.56-9.77
Mean	7.84	5.14
C.V.	2.70	37.46
Denchu tehsil		
Range	7.19-8.33	1.26-7.35
Mean	7.96	3.32
C.V.	3.31	39.29
Lohawat tehsil		
Range	7.60-8.53	0.67-5.03
Mean	8.16	1.86
C.V.	2.46	72.55
Phalodi tehsil		
Range	7.43-8.62	0.99-9.47
Mean	8.03	3.98
C.V.	3.42	52.81
Shergarh tehsil		
Range	7.30-9.90	1.99-12.40
Mean	8.01	4.89
C.V.	5.42	55.81
The district as a whole		
Range	7.19-9.90	0.56-12.40
Mean	8.01	3.43
C.V.	3.67	62.20

Fluoride content (mg L^{-1})

The tehsils wise Fluoride content were presented in Table 2 and revealed that the tehsils wise Fluoride content of irrigation water ranged between 0.02 to 1.34, 0.02 to 1.85, 0.04 to 0.85, 0.30 to 0.90, 0.03 to 1.50 and 0.02 to 2.52 with the mean values of 0.46, 0.75, 0.47, 0.56, 0.63 and 0.71 mg L^{-1} in Balesar, Bap, Denchu, Lohawat, Phalodi and Shergarh, respectively. The Fluoride content in irrigation water of Jodhpur district was ranged between 0.02 to 2.52 with the mean value of 0.58 mgL^{-1}, respectively. Pradeep and Singh *et al*. (2016) [13], Verma *et al*. (2016) [20] have also reported that similar results.

Nitrate content (mg L^{-1})

The data presented in Table 2 also revealed that the tehsils wise Nitrate content of irrigation water ranged between 1.10 to 114.40, 5.30 to 53.10, 1.50 to 128.20, 2.10 to 130.50, 2.70 to 120.60 and 1.40 to 123.00 with the mean values of 52.67, 33.92, 31.79, 46.06, 32.93 and 46.65 mg L^{-1} in Balesar, Bap, Denchu, Lohawat, Phalodi and Shergarh, respectively. The Nitrate content in irrigation water of Jodhpur district was ranged between 1.10 to 130.50 with the mean value of 41.36 mgL^{-1}, respectively. The results of present investigation get support from findings of Pradeep and Singh *et al*. (2016) [13], Selvakumar *et al*. (2017) [16].

Table 2: Fluoride and nitrate of underground irrigation water of Jodhpur district

Tehsils/District	Fluoride (Mg L^{-1})	Nitrate (Mg L^{-1})
Balesar tehsil		
Range	0.02-1.34	1.10-114.40
Mean	0.46	52.67
C.V.	73.73	62.81
Bap tehsil		
Range	0.02-1.85	5.30-53.10
Mean	0.75	33.92
C.V.	69.83	43.15
Denchu tehsil		
Range	0.04-0.85	1.50-128.20
Mean	0.47	31.79
C.V.	44.75	103.73
Lohawat tehsil		
Range	0.30-0.90	2.10-130.50
Mean	0.56	46.06
C.V.	30.49	84.24
Phalodi tehsil		
Range	0.03-1.50	2.70-120.60
Mean	0.63	32.93
C.V.	59.67	85.36
Shergarh tehsil		
Range	0.02-2.52	1.40-123.00
Mean	0.71	46.65
C.V.	101.84	59.56
District as a whole		
Range	0.02-2.52	1.10-130.50
Mean	0.58	41.36
C.V.	73.76	77.18

Table 3: Characteristics of underground irrigation waters of north-western part of Jodhpur district of Rajasthan

S. No.	Sample Code	pH	EC (dS m^{-1})	Fluoride (mg L^{-1})	Nitrate (mg L^{-1})
Balesar tehsil					
1.	Bas	8.32	0.98	0.46	52.30
2.	Bel_1	7.76	1.25	0.33	40.10
3.	Bel_2	8.35	1.21	0.62	30.50
4.	Bel_3	8.30	1.67	0.77	45.00
5.	$Bhar_1$	7.65	3.49	0.03	103.70
6.	$Bhar_2$	8.10	3.02	0.05	108.40
7.	$Bhar_3$	7.86	4.31	0.64	104.10
8.	Dar	7.70	1.39	0.04	47.00
9.	Dev_1	7.64	2.79	0.03	103.80
10.	Dev_2	8.32	2.85	0.96	20.50
11.	Devg	8.12	1.58	0.63	45.20
12.	$Devn_1$	8.04	2.12	0.46	20.60
13.	$Devn_2$	7.60	3.79	0.22	1.10
14.	Dhe_1	8.14	3.49	0.84	47.50
15.	Dhe_2	8.29	3.94	0.97	12.40
16.	Dhep	8.07	1.60	0.36	45.10
17.	$Durg_1$	7.85	1.01	0.07	42.60
18.	$Durg_2$	7.64	1.48	0.09	12.30
19.	Gee	8.03	3.19	0.35	48.20
20.	Gop	8.11	1.81	1.34	49.50
21.	$Jawn_1$	8.15	2.01	0.08	37.00
22.	$Jawn_2$	7.66	2.35	0.68	40.30
23.	Ket_1	7.82	2.53	0.28	103.60
24.	Ket_2	7.70	2.28	0.02	47.20
25.	Mor	7.91	1.98	0.44	48.30
26.	Navb	7.90	0.97	0.35	75.00
27.	Rawg	7.70	1.86	0.85	5.30
28.	$Sekh_1$	8.00	2.81	0.75	46.10
29.	$Sekh_2$	8.11	2.01	0.35	114.40
30.	Tha_1	8.14	3.12	0.70	105.20
31.	Tha_2	8.18	3.25	0.50	30.60
Bap tehsil					

1.	Amap	7.65	5.16	1.00	20.70
2.	Baar	7.74	4.36	1.20	10.20
3.	Bamp	8.06	3.95	0.80	38.30
4.	Bap$_1$	8.06	6.01	1.58	11.40
5.	Bap$_2$	7.80	5.31	1.85	32.50
6.	Cha	7.65	9.77	0.55	53.10
7.	Dho	7.95	4.21	0.75	43.50
8.	Dur	8.10	4.55	0.70	40.60
9.	Nne$_1$	7.90	3.56	0.09	40.50
10.	Nne$_2$	7.69	4.61	0.75	35.10
11.	Nne$_3$	7.74	6.09	0.50	30.20
12.	Ran	7.73	4.87	0.02	5.30
13.	Sek	7.72	6.48	0.40	44.30
14.	Sev$_1$	8.33	0.56	0.06	48.10
15.	Sev$_2$	7.52	5.89	1.20	40.30
16.	She	7.75	6.91	0.52	48.60
Denchu tehsil					
1.	Anap	8.07	2.73	0.60	128.20
2.	Bhe	8.10	1.26	0.37	46.30
3.	Bud	7.86	3.17	0.57	1.50
4.	Cha$_1$	7.59	2.31	0.45	40.30
5.	Cha$_2$	7.90	2.03	0.04	30.60
6.	Den	7.19	3.84	0.38	11.70
7.	Dho	7.86	4.20	0.05	1.50
8.	Fat$_1$	7.82	3.69	0.40	13.60
9.	Fat$_2$	8.25	3.22	0.65	1.70
10.	Govp$_1$	8.33	4.95	0.20	1.50
11.	Govp$_2$	8.25	3.09	0.50	11.30
12.	Gump$_1$	7.92	2.81	0.60	95.40
13.	Gump$_2$	7.94	3.30	0.40	9.60
14.	Gump$_3$	8.33	4.62	0.40	11.70
15.	Kal	8.32	1.57	0.06	8.30
16.	Kan$_1$	7.92	2.75	0.50	39.60
17.	Kan$_2$	7.90	1.80	0.85	57.50
18.	Khi	7.61	2.40	0.28	114.30
19.	Kolp$_1$	8.30	5.29	0.40	2.60
20.	Kolp$_2$	8.29	4.93	0.55	38.30
21.	Kolr	7.61	4.80	0.30	1.80
22.	Mank$_1$	8.11	2.75	0.50	46.30
23.	Mank$_2$	8.14	3.20	0.35	48.50
24.	Nya$_1$	8.02	3.18	0.85	40.70
25.	Nya$_2$	8.04	3.90	0.64	20.20
26.	Pab	8.06	4.07	0.75	10.30
27.	Road	7.60	4.32	0.70	8.50
28.	San$_1$	7.70	7.35	0.40	56.40
29.	San$_2$	7.88	1.39	0.40	49.20
30.	San$_3$	7.90	2.14	0.75	13.30
31.	Urd	7.90	2.86	0.48	34.10
32.	Uth	8.10	2.47	0.52	2.50
Lohawat tehsil					
1.	Bagn	8.10	3.80	0.75	6.30
2.	Bhek$_1$	7.82	4.19	0.65	50.20
3.	Bhek$_2$	8.09	2.64	0.55	38.10
4.	Bend	8.08	0.87	0.65	56.40
5.	Cha	8.18	0.99	0.70	125.50
6.	Cham	8.10	4.66	0.90	3.60
7.	Chan	8.03	1.23	0.30	58.20
8.	Chi$_1$	8.13	1.02	0.45	4.30
9.	Chi$_2$	8.04	1.42	0.50	60.40
10.	Bhok	8.53	3.90	0.30	20.20
11.	Han	8.21	1.35	0.60	37.10
12.	Jamn$_1$	8.12	1.20	0.85	130.50
13.	Jamn$_2$	8.02	0.89	0.75	110.40
14.	Jor$_1$	8.17	0.72	0.60	52.70
15.	Jor$_2$	8.25	0.67	0.40	55.10
16.	Moo$_1$	8.01	1.21	0.75	12.30
17.	Moo$_2$	8.08	1.10	0.50	11.50

18.	Nos$_1$	8.53	1.23	0.74	12.70
19.	Nos$_2$	8.48	1.43	0.45	2.10
20.	Nos$_3$	8.28	0.95	0.80	2.30
21.	Pal$_1$	8.18	1.30	0.45	70.50
22.	Pal$_2$	8.23	0.92	0.48	14.90
23.	Pal$_3$	8.15	0.94	0.52	60.80
24.	Pavd	7.60	5.03	0.80	3.40
25.	Pee	8.41	3.24	0.55	3.50
26.	Ramn$_1$	8.44	0.70	0.45	125.40
27.	Ramn$_2$	8.21	1.45	0.35	63.30
28.	Raj	7.89	3.62	0.60	33.20
29.	Sha$_1$	7.90	3.94	0.40	46.50
30.	Sha$_2$	8.23	0.99	0.35	55.30
31.	Sin	8.32	1.08	0.50	46.50
32.	Than$_1$	8.15	0.97	0.30	100.80
Phalodi tehsil					
1.	Aau	7.98	3.19	0.40	32.30
2.	Bavk	7.76	5.43	1.50	12.40
3.	Bar	8.01	4.25	0.80	8.30
4.	Bee$_1$	8.62	2.34	0.50	120.60
5.	Bee$_2$	7.92	3.33	0.08	45.70
6.	Ben	7.92	3.64	0.40	50.30
7.	Bha	8.18	2.13	1.20	12.10
8.	Bhoj	8.09	5.44	0.50	46.20
9.	Bho	8.06	4.04	0.50	3.50
10.	Kun$_1$	7.97	6.01	0.60	75.30
11.	Kun$_2$	7.45	5.36	0.03	48.30
12.	Dan$_1$	8.17	2.68	0.30	22.40
13.	Dan$_2$	8.27	2.29	0.70	70.10
14.	Hanp	7.75	8.56	0.70	54.30
15.	Hop$_1$	8.29	4.16	0.58	5.20
16.	Hop$_2$	8.23	2.03	0.52	10.60
17.	Jag	7.80	3.72	0.80	49.70
18.	Kal	8.30	3.37	1.00	12.80
19.	Kha	7.43	9.47	0.05	4.30
20.	Khe	7.96	3.84	0.30	8.70
21.	Lor$_1$	8.26	0.99	0.55	52.10
22.	Lor$_2$	8.13	2.75	0.35	13.50
23.	Mok	8.12	2.93	1.30	62.60
24.	Pha$_1$	7.74	5.57	0.50	3.10
25.	Pha$_2$	8.10	8.13	0.80	2.70
26.	Pha$_3$	7.95	3.32	0.50	28.40
27.	Satn$_1$	8.47	1.36	1.30	13.30
28.	Satn$_2$	8.31	1.26	1.00	49.50
29.	Tek	7.71	3.79	0.40	36.60
Shergarh tehsil					
1.	Bhu	7.90	12.40	0.52	10.10
2.	Daln	7.68	2.82	0.40	20.30
3.	Devg$_1$	7.70	2.53	0.57	1.40
4.	Devg$_2$	7.76	3.77	0.08	72.60
5.	Dunp	7.76	8.14	1.08	35.40
6.	Gud	7.73	3.20	0.75	45.60
7.	Himp$_1$	7.62	6.17	0.05	108.70
8.	Himp$_2$	9.90	5.58	2.52	123.00
9.	Himp$_3$	8.16	12.40	0.78	38.60
10.	Khen	7.60	5.42	2.07	24.30
11.	Khik$_1$	7.83	4.11	0.43	48.10
12.	Khik$_2$	7.91	2.68	0.04	60.30
13.	Khik$_3$	8.30	4.22	0.30	1.60
14.	Khik$_4$	8.07	2.78	0.05	32.50
15.	Khik$_5$	8.28	2.17	0.46	47.60
16.	Narn	8.14	5.80	0.58	60.30
17.	Nyag	7.30	2.43	0.02	60.40
18.	Ramg	8.15	6.29	1.23	68.60
19.	Rang	7.62	8.05	0.58	46.50
20.	Rays	8.04	5.07	1.25	48.40
21.	Sai	8.07	5.69	0.84	88.30

22.	$Sheg_1$	8.25	4.06	0.65	11.50
23.	$Sheg_2$	7.99	4.52	0.96	47.20
24.	$Sheg_3$	7.82	5.21	0.07	58.30
25.	She_4	7.99	1.99	2.02	28.50
26.	$Soit_1$	8.13	3.71	0.04	40.30
27.	$Soit_2$	8.11	2.85	0.06	57.60
28.	Solt	8.05	8.11	2.50	28.10
29.	$Uttn_1$	8.32	2.23	0.03	45.30
30.	$Uttn_2$	8.05	2.31	0.48	40.10

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