

Salinity and Toxicological Studies of Waters of Rajasthan Desert*

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Abstract. Detailed studies on quality of ground waters of Western Rajasthan have been carried out by analysing about 1500 water samples for presence of total dissolved solids (TDS) and other normal chemical constituents. 109 ground water samples were tested for presence of 8 toxic substances viz. *As*, *Ba*, *Cd*, Cr^{+6} , *Pb*, *Se*, *Ag*, and *CN* and *F* and NO_3 . About 9 percent of the waters conform to the normal standards of drinking water i.e. contain less than 500 mg/l TDS. None of the water points has been found to be contaminated with toxic substances. However, fluoride and nitrate were present in all the samples.

A survey of water-borne diseases, kidney diseases and fluorosis carried out to establish the possible correlation between prevailing diseases and dissolved solids in waters indicate that 82 percent of the reported cases are due to water-borne diseases. The guinea-worm (*Dracunculus medinensis*) has been found in the surface waters and sulphate reducing bacteria (*Desulphovibrio desulphuricans*) in the brackish water.

1. Introduction

The arid region of Western Rajasthan—a part of the Thar desert—is mostly sandy and full of sand-dunes. It is a characteristic feature of the ground waters of the desert areas that they are generally highly brackish. The degree of brackishness varies from region to region and also within the same locality from well to well. The water table is very deep and aquifers are limited in thickness. Potable water is scarce and the distance from one source to another is quite large. The fluoride and nitrate are widely distributed in ground waters and in certain pockets these are present in alarming concentrations.

The paper discusses the results¹ of a detailed chemical analysis of (i) 1500 ground water samples from representative water points of the region for presence of TDS, and other normal chemical constituents; (ii) 109 ground water samples for presence of 8 toxic substances—*As*, *Ba*, *Cd*, Cr^{+6} , *Pb*, *Se*, *Ag*, *CN* and two health affecting substances *F* and NO_3 . The isolation of sulphate reducing bacteria in brackish waters and presence of guinea-worm in surface waters have also been reported². A survey

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of water-borne diseases, kidney diseases and fluorosis has been carried out with a view to examining any correlation between the prevailing diseases and dissolved solids in the drinking waters of this region.

2. Material and Methods

The water samples were collected in polythene bottles and submitted to physico-chemical analysis. The *pH*, electrical conductivity, TDS, hardness, *Cl*, *SO*₄, *HCO*₃, *CO*₃, *Ca*, *Mg*, *As*, *Ba*, *Cd*, *Cr*⁺⁶, *Pb*, *Se*, *Ag*, *CN*, *F*, and *NO*₃ were determined.

During collection of water samples, surface waters were carefully examined using magnifying glass and further examined under microscope in the laboratory for presence of guinea-worm. 5 ml of the brackish water sample was carefully taken in a 60 ml glass stoppered bottle filled with Starkey's medium³ ensuring that air bubbles are not entrapped. It was incubated at 36°C under anaerobic conditions for 72 hours, and then subjected to various tests for classification.

A survey of water-borne diseases, kidney diseases and fluorosis was also carried out in the Military Hospitals at Jodhpur and Bikaner for the period of 1971 to 1974.

3. Results and Discussion

The maximum and minimum values of different physico-chemical properties and constituents are given in Table 1. It is concluded that only about 9 percent waters of Western Rajasthan conform to normal standard of drinking water i.e. containing TDS less than 500 mg/l, if 2000 mg/l TDS is taken as the maximum allowable concentration then 49 percent of available waters are potable.

Table 1. Physico-chemical characteristics of ground waters of Western Rajasthan.

Sl. No.	Details	Maximum	Minimum
1.	<i>pH</i>	9.0	6.5
2.	Conductivity (micromhos/cm) at 25 °C	48500	254
3.	TDS (mg/l)	33820	160
4.	Hardness as <i>CaCO</i> ₃ (mg/l)		
	(i) Total	8095	18
	(ii) Temporary	5556	Nil
	(iii) Permanent	4032	4
5.	Chloride (<i>Cl</i> ⁻) mg/l	13640	14
6.	Sulphate (<i>SO</i> ₄ ⁻) mg/l	6787	Nil
7.	Bicarbonate (<i>HCO</i> ₃ ⁻) mg/l	2013	Nil
8.	Carbonate (<i>CO</i> ₃ ⁻) mg/l	168	Nil
9.	Calcium (<i>Ca</i> ⁺⁺) mg/l	1168	2
10.	Magnesium (<i>Mg</i> ⁺⁺) mg/l	805	1
11.	Fluoride (<i>F</i> ⁻) mg/l	20	0.3
12.	Nitrate (<i>NO</i> ₃ ⁻) mg/l	400	0.5

The percentage frequency of ground waters with different ranges of salinity expressed as $NaCl$ is given in Table 2. It is observed that beyond 10,000 mg/l TDS, the frequency is only 5 percent. The maximum number (80 percent) lie within 5000 mg/l TDS. The chloride content varied from 14 to 12,361 mg/l. The maximum number of samples having chloride (43%) lie within 0-1000 mg/l. All the trace elements— As , Ba , Cd , Cr^{+6} , Pb , Se , Ag , and CN were found absent in the 109 water samples

Table 2. Percentage frequency of ground waters of Western Rajasthan having different TDS and Cl^{-} * range.

Sl. No.	TDS Range (mg/l) & Cl^{-} as $NaCl$ (mg/l)	Frequency (%)	
		TDS (mg/l)	Cl^{-} * (mg/l)
1.	0 – 500	9	15
2.	501 – 2000	40	40
3.	2001 – 5000	31	30
4.	5001 – 10000	15	12
5.	above 10000	5	3

* Cl^{-} as $NaCl$

Table 3. Scrutiny of medical records at Military Hospitals at Jodhpur and Bikaner.

Diseases	Jodhpur			Bikaner		
	1971-72	1973	1974	1971-72	1973	1974
1. Total No. of cases reported	9350	6096	6879	1322	1220	1244
2. Total No. of cases due to water-borne diseases	1266	667	708	168	132	90
(i) Infective hepatitis	913 (72%)	136 (21%)	113 (16%)	103 (61.5%)	12 (9%)	12 (13%)
(ii) Other water-borne diseases*	157 (12%)	395 (59%)	447 (67%)	40 (24%)	73 (55%)	53 (59%)
(iii) Kidney diseases**	127 (10%)	123 (18%)	105 (15%)	24 (14%)	47 (36%)	23 (26%)
(iv) Fluorosis/carries teeth	69 (6%)	13 (2%)	13 (2%)	01 (0.5%)	Nil	2 (2%)

*1. Hepato Intestinal Amoebiasis

2. Hook Worm

3. Dracontiasis

4. Bilateral Calcaneal Spurs (Calcium deposition in bones)

5. Ac-Enteritis

6. Gastro-Enteritis

7. Ac-Gastritis

8. Amoebic Hepatitis & Hyper Chloro hydric Dyspepsya

9. Enteric fever

10. Cholera.

**1. Ureteric calculus

2. Renal calculus

3. Nephritis

analysed, but fluoride and nitrate were found to be present in all. The fluoride concentration varied from 0.3 to 20.0 mg/l while nitrate varied from 0.5 to 400 mg/l. 51 percent samples contain fluoride above the maximum permissible limit of 2 mg/l while two percent ground waters contain nitrate more than allowable concentration i.e. 50 mg/l.

Medical records of the Military Hospitals at Jodhpur and Bikaner were scrutinised, under a project approved by the Armed Forces Medical Research Committee, for the prevailing water-borne diseases, kidney diseases and fluorosis for the period 1971-74 and the data are shown in Table 3. It is observed that out of 26,111 cases reported at these hospitals, 3031 (12 percent) cases are due to above diseases. Of these 3031 cases 82 percent are due to water-borne diseases (43 percent infective hepatitis and 39 percent others), 15 percent due to kidney diseases and three percent due to fluorosis/caries teeth. The findings suggest a correlation between the water quality and the incidence of these diseases. However, more extensive work will have to be done to confirm the above tentative correlation.

During the survey and collection of water samples, surface waters of the region were generally found contaminated with embryos of guinea-worm and the users of these water sources had a significant incidence of dracontiasis. This is also confirmed from the scrutiny of medical records given in Table 3. However, the disease is not common in the urban population where drinking waters are supplied by public water works.

Some of the brackish water points were also found smelling of H_2S . These samples on bacteriological examination showed the presence of a gram negative, non-sporulating, mesophilic type and highly motile bacteria. It was concluded from the detailed study² that the type of sulphate reducing bacteria in these waters is *Desulphovibrio desulphuricans*.

References

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