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Evaluation of ground water quality in Nawalgarh tehsil, district Jhunjhunu with special reference to fluoride and nitrate contamination

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Abstract
Water is an important natural aid for retaining lifestyles and environment but over the last few many years the water exceptional is deteriorating because of it over exploitation. Water excellent is vital parameter to be studied while the general recognition is sustainable development retaining mankind at focal element. Groundwater is the most supply of consuming water in rural in addition to in urban regions and over 94% of the ingesting water call for is met via groundwater. The have a take a look at come to be completed to assess the ground water nice and its suitability for ingesting motive with specific reference to fluoride and nitrate infection in maximum rural habitations of Nawalgarh tehsil of district Jhunjhunu, Rajasthan, India. for that reason, 20 water samples accumulated from hand pumps, open wells and bore wells of villages of have a examine location had been analyzed for first rate physico-chemical parameters which includes pH, electrical conductivity, preferred alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and sizable dissolved solids.

The examine famous that most people parameters have been exceeding the permissible limits. As in line with the proper and most permissible limit for fluoride and nitrate in consuming water, decided via WHO, BIS and ICMR requirements, 62% and 42% of groundwater resources are undeserving for consuming abilities respectively. Because of the better fluoride and nitrate stages in eating water several instances of dental, skeletal fluorosis and so on. Have appeared at alarming rate in this region. After comparing the statistics of this check it's far concluded that ingesting water of Nawalgarh tehsil isn't always potable and there is an right now need to take ameliorative steps on this location to save you the populace from negative fitness results.

Keywords: groundwater quality, fluoride, nitrate, Nawalgarh tehsil and Rajasthan

1. Introduction

Now days, the modern civilization, urbanization and progressed populace with resulting commercial operation have intensified the vintage hassle of polluting our existence, mother and medium. At present our lifestyles, mom and medium is being polluted or maybe worse scenario is that we come across with shortage of this degraded brilliant of water too. It has raised outstanding simple annoying conditions in our surroundings and we're struggling every the issues of tremendous and quantity of water. In India groundwater is the foremost supply of consuming water and over 94% of the eating water name for is met via groundwater. Water high-quality is vital parameter to be studied while the overall recognition is sustainable development preserving mankind at focal point, considering that it is immediately associated with human welfare.

Most crucial problems are being faced through America due to the presence of more fluoride, arsenic and nitrate in groundwater in certain elements of United States of America of the United States. Fluorine is the maximum electronegative of all chemical factors and is consequently in no manner placed in nature in elemental shape. Blended chemically within the shape of fluorides, it ranks seventeenth in abundance of things inside the earth's crust representing approximately 0.06–0.09% of the earth's crust (WHO, 1994), Fluoride is certainly one of essential life elements to human fitness. Its miles crucial for normal mineralization of bones and formation of dental tooth with presence in small quantity (Chouhan and plants, 2010) [12]; but extra fluoride awareness in eating water has deleterious effects on human fitness. It motives a dreadful illness called fluorosis. Fluoride more than permissible restrict, turn out to be toxic and reasons clinical and metabolic disturbance in animals and individual which encompass dental, skeletal and non-skeletal Fluorosis (Hussain *et al.*, 2002, 2004a, 2010, 2011, 2012; Singh *et al.*, 2007) [15, 16 17, 18].

The permissible restriction of fluoride in ingesting water is 1.5mg/L thru WHO, 1.0 mg/L via the usage of ICMR and 0.6 to one.2 mg/L through the use of BIS. (BIS1991; WHO 1994) The hassle of fluorosis is international and nearly 25 countries of the world are below its dreadful destiny. In Asia, India and China, the maximum populous global places are worst affected. In India problem is maximum said in Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Punjab, Rajasthan, Tamil Nadu, and Uttar Pradesh (Godfrey *et al.* 2006; Ayoob and Gupta 2006; Sharma *et al.* 2007; Khaiwal and Garg 2007; SIHFW 2008; Hussain *et al.* 2012) [13, 5, 21, 3, 4].

Rajasthan is the largest country within the U.S. in phrases of geographic spread. It has a place of 342,239 lakh square kms being biggest kingdom of the U.S. having 10.41 % of America's area and 5.5% of nation's populace but has low water sources i.e. 1% of the use's resources. The country has severe climatic and geographical circumstance and it suffers each the issues of quantity and fine of water. All of the 32 districts of Rajasthan were declared as fluorosis susceptible areas. The worst are Nagaur, Jaipur, Sikar, Jodhpur, Barmer, Ajmer, Sirohi, Jhunjhunu, Churu, Bikaner, Ganganagar and

so forth. (SIHFW, 2008; Singh P *et al.* 2011; Hussain *et al.*, 2012) [3, 4].

Nitrate ($NO3^-$) infection of the groundwater, because of the extensive use of fertilizers has additionally end up an extreme ecological problem in lots of rural regions of India and in lots of developing countries global. the level of nitrate in groundwater has been developing during the last three a few years (Mueller *et al.*, 1995, 1996) [27, 28], generating an correct sufficient quantity of healthy meals without polluting the surroundings is an impressive mission for future agriculture in the international. the global imply nitrogen use overall performance is anticipated to be approximately 50% (Mosier. 2002) [26]. The closing quantity of nitrogen is misplaced into the environment. A massive populace of this nitrogen gets converted into nitrate which, being soluble in water and not retained via the use of soils, gets leached into water our bodies. Leaching of nitrate from agricultural land and from exceptional belongings to groundwater is a worldwide phenomenon. The nitrate attention in groundwater is stimulated thru rainfall. in which the quantities of rainfall are low, the awareness has a tendency to be excessive due to the reality the diluting effect is decreased. Some of employees from India and overseas have advised the presence of high consciousness (3800 ppm) of nitrate in groundwater (Malik *et al.*, 1981; Hamilton *et al.*, 1992) and diagnosed their possibly assets. In India, as excessive 530 mg/l of nitrate has been stated in Churu district of Rajasthan (Sunitha and Rajeswara Reddy, 2006).

Consumption of consuming water with nitrate, at concentrations extra than 45 mg/l may be negative to human health (Canter, 1987). The permissible restrict of nitrate in consuming water is 45mg/L via WHO, 50 mg/L with the useful resource of ICMR and a hundred mg/L by way of the usage of BIS. (BIS1999; WHO 2006) babies under 12 months old are particularly at danger from excessive portions because it cause methaemoglobinaemia, typically referred to as blue baby syndrome, by using blockading the oxygen-carrying capacity of haemoglobin, whilst about 70% of the complete hemoglobin have been transformed to methaemoglobin (WHO, 1983), infants are most liable to nitrate infection because they have under advanced metallic enzyme, incredibly small blood quantity and more reactivity of fetal hemoglobin. A similarly mission is that nitrate may be transformed by the use of bacteria within the digestive tract into nitrosamines which can be in all likelihood carcinogenic. However, whereas low stages of nitrate are dangerous is regularly contested (Sunitha and Rajeswara Reddy, 2006).

Evaluate at the literature showed that no studies had been undertaken within the study area with regard to physico-chemical traits of water yet. So the aim of this study turn out to be to analyze the satisfactory of eating water (underground water) with special connection with the awareness of fluoride and nitrate in maximum rural habitations of Nawalgarh Tehsil of Jhunjhunu, Rajasthan, India.

2. Material and methods

2.1 Study Area

Nawalgarh is part of the Shekhawati region and is midway between Jhunjhunu and Sikar. It is 30 km from Sikar and 39 km from Jhunjhunu. Nawalgarh is famous for its fresco and havelis and considered as Golden City of Rajasthan. It is also the motherland of some great business families of India. Many Bollywood/Hollywood/Tollywood movies are shot in Nawalgarh like Paheli, Ae Dil e Mushkil etc. There are no major surface water sources in the study area however, main sources of drinking water are open wells, hand pumps and bore wells.

2.2 Water Sampling

Ground water samples of a total of 20 villages in Nawalgarh Tehsil of Jhunjhunu district were collected in pre-cleaned and rinsed polythene bottles of two liter capacity with necessary precautions. (Brown *et al.* 1974) [2] The samples were collected, during April 2016 to March 2017 from manually operated hand pumps, open wells and bore wells.

2.3 Physico-chemical Analysis

All the samples were analyzed for the following Physico-chemical parameters; pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Calcium hardness (Ca H), Magnesium hardness (Mg H), Chloride, Nitrate, Fluoride and Total Dissolved Solid (TDS), The analysis of water samples were carried out in accordance to standard analytical methods (APHA, 2005) [1], All the chemicals used were of AR grade and double distilled water used for preparation of solutions. Details of the analysis methods are summarized in Table-1.

Table 1: Parameters and methods employed in the physicochemical examination of water samples

S. No.	Parameters	Unit	Method Employed
1.	pH	-	Digital pH-meter
2.	Electrical Conductivity	µmhos/cm	Digital Conductivity-meter
3.	Total Alkalinity	Mg/L	Titrimetric method (With HCl)
4.	Total Hardness (as $CaCO_3$)	Mg/L	Titrimetric method (with EDTA)
5.	Calcium Hardness (as $CaCO_3$)	Mg/L	Titrimetric method
6.	Magnesium Hardness (as $CaCO_3$)	Mg/L	Titrimetric method
7.	Chloride (as Cl^-)	Mg/L	Titrimetric method (With $AgNO_3$)
8.	Nitrate (as NO_3^-)	Mg/L	Spectrophotometric method
9.	Fluoride (as F^-)	Mg/L	Ion Selective Electrode
10.	Total Dissolved Solids	Mg/L	Digital Conductivity-meter

3. Result and conclusion

The respective values of all water quality parameters in the groundwater samples are illustrated in Table-2. All the results are compared with standard permissible limit recommended by the Bureau of Indian Standards (BIS), Indian Council of Medical Research (ICMR) and World Health Organization (WHO), depicted in Table-3.

pH

pH is measure of intensity of acidity or alkalinity of water. All chemical and biological reactions are directly dependent upon the pH of water system (Rao, 2006) [29]. In our findings pH varied between 6.4-8.6. Maximum pH was recorded at S15 in village *Dhigal* and minimum pH was recorded at S5 in village *Swami Ki Dhani*, which are not within the permissible limit prescribed by BIS, ICMR and WHO. The variation of pH in ground water samples of study area is shows that most of the samples are alkaline in nature. The pH of water is very important indication of its quality and provides information in many types of geochemical equilibrium or solubility calculations (Mitharwal *et al.*, 2009) [25].

Electrical conductivity

The electrical conductivity of water depends upon the concentration of ions and its nutrient status. Based on electrical conductivity values the water quality can be classified as poor, medium or good (Gulta, Sunita, & Saharan, 2009), In the present investigation maximum conductivity 6000 µmhos/cm was observed at S19 in village *Hanuman Ji Ki Dhani* and minimum 1200 µmhos/cm at S8 in village *Sainipura.* The maximum limit of EC in drinking water is prescribed as 1400 µmhos/cm (WHO: 2006).

Total alkalinity

Total Alkalinity ranges from 90 mg/L to 820 mg/L; the maximum value was recorded in village *Balwantpura* (S9) and minimum in village *Ambedkar Nagar* (S18). These values are more than the permissible limits of BIS, ICMR and WHO. In ground water, most of the alkalinity is caused due to carbonates and bicarbonates.

Total hardness

Hardness is the property of water which prevents lather formation with soap and increases the boiling point of water. Hardness of water mainly depends upon the amount of calcium or magnesium salt or both (Singh *et al.*, 2012), It is an important criterion for determining the usability of water for domestic, drinking and many industrial supplies (Mitharwal *et al.*, 2009) [25], In our findings the value of hardness fluctuates from 50 mg/L to 890 mg/L (Table-2), which are beyond the permissible limit as prescribed by BIS, ICMR and WHO. The minimum value was found in S6 (Village - *Shiv Nagar*) and maximum value was found in samples S18 (village- *Ambedkar Nagar*).

Calcium hardness

Calcium Hardness varies from 30 mg/L to 2600 mg/L as illustrated in Table-2. It may be due to the presence of high amounts of calcium salts in ground water samples.

Magnesium hardness

Magnesium Hardness of groundwater is varying from 30 mg/L to 4800 mg/L as shown in Table-2. High values of magnesium hardness can be attributed to the large amounts of magnesium salts in ground water.

Chloride

Chloride contents in fresh water are largely influenced by evaporation and precipitation. Chloride ions are generally more toxic than sulphate to most of the plants and are best indicator of pollution (Rao, 2006) [29], Chloride found high during the study ranged from 50 mg/l to 3240 mg/l (Table-1), Minimum value was observed at samples S3, S8 and maximum value was observed at S18 in village *Ambedkar Nagar.* These unusual concentrations may indicate pollution by organic waste. Chloride salts in excess of 100 mg/1 give salty taste to water and when combined with calcium and magnesium, may increase the corrosive activity of water (Tatawat and Singh- Chandel, 2007).

Total dissolved solid

Total dissolved solid is an important parameter for drinking water and water to be used for other purposes beyond the prescribed limit, it imparts a peculiar taste to water and reduce its potability (Mitharwal *et al.*, 2009) [25], Total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of Calcium, Magnesium, Sodium, Potassium, Manganese, organic matter salt and other particles (Siebert *et al.*, 2010), In the present finding TDS value varied from 790 to 4400 mg/L (Table-2), which is also not within the prescribed permissible limits. Maximum TDS recorded at S19 in village *Hanuman Ji Ki Dhani* and minimum at S7 in village *Rampura*.

Table 2: Analysis of ground water quality parameters in villages of Nawalgarh Tehsil (Jhunjhunu, Rajasthan, India)

S. No.	Sampling Site	Code	pH	EC	Alk. mg/l	TH mg/l	Ca H mg/l	Mg H mg/l	Cl^- mg/l	NO_3^- mg/l	F^- mg/l	TDS mg/l
1.	Ajeetpura	S1	7.9	1600	540	80	150	60	60	58	1.00	1140
2.	Devipura	S2	7.7	1700	470	100	130	80	200	88	1.00	1210
3.	Durjanpura	S3	7.3	1700	580	60	260	40	50	34	0.56	1210
4.	Paniyan Ki Dhani	S4	6.6	1300	360	190	60	130	120	108	6.5	1620
5.	Swami Ki Dhani	S5	6.4	2300	810	80	50	60	100	33	7.9	1210
6.	Shiv Nagar	S6	7.4	1700	540	50	80	30	100	80	2.5	1600
7.	Rampura	S7	7.1	2000	160	70	120	50	70	35	8.5	790
8.	Sainipura	S8	7.5	1200	340	90	140	70	50	31	2.4	1560
9.	Balwantpura	S9	7.4	2300	820	110	150	70	110	11	11.4	1140
10.	Ranasar	S10	7.9	1800	600	110	40	60	80	28	8.4	1560
11.	Meel Nagar	S11	8.4	2300	800	100	50	60	90	28	10.9	1630
12.	Lohargal	S12	8.7	2400	780	280	50	50	70	204	10.4	2020
13.	Johar Ki Dhani	S13	8.5	2600	660	200	40	180	140	50	2.28	2300
14.	Dundlod	S14	7.3	2800	180	80	40	120	480	226	3.28	3210
15.	Dhigal	S15	8.6	4200	720	110	30	60	580	208	3.6	3780

16.	Deogaon	S16	8.3	5100	180	140	50	70	1000	148	5.1	3840
17.	Barwa	S17	8.0	5200	500	680	80	100	740	144	4.1	1120
18.	Ambedkar Nagar	S18	7.4	4500	90	890	40	480	3240	70	6.3	3260
19.	Hanuman Ji Ki Dhani	S19	7.2	6000	400	310	50	160	760	14	2.36	4400
20.	Bhojnagar	S20	6.9	3300	660	960	40	180	1340	52	3.1	2440

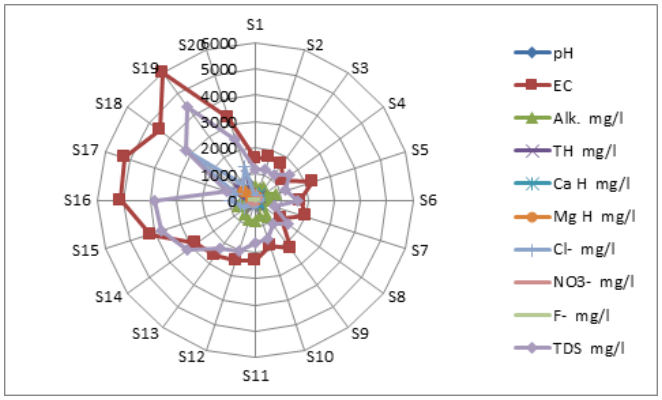

Fig 1: Result showing Ground water quality parameters

Table 3: Standards for drinking water quality

S. No.	Parameter	BIS: 1999	ICMR: 1975	WHO: 2006
1.	pH	6.5-8.5	7.0-8.5	6.5-8.5
2.	EC (µmhos/cm)	-	-	1400
3.	TA	600	600	120
4.	TH	600	600	500
5.	Cl-	1000	200	200
6.	NO3-	100	50	45
7.	F-	1.5	1.5	1.5
8.	TDS	2000	1500	500

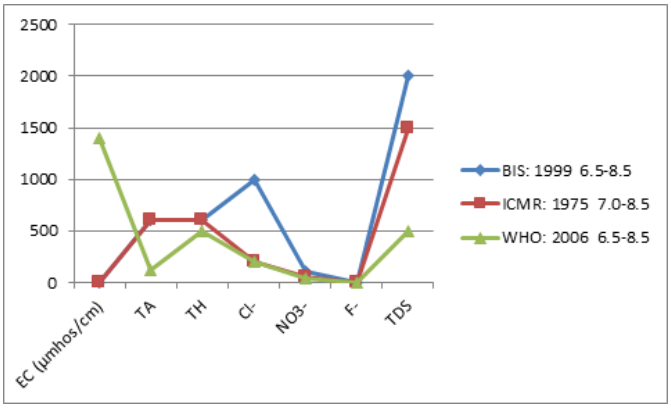

Fig 2: showing parameters of standard drinking water quality

Sources of fluoride

The presence of fluoride in ground water may be attributed to geological motives. (Ashok Kumar Yadav *et al.* 2009) [25] Fluoride exists naturally in water sources. Normally maximum groundwater sources have higher fluoride concentrations than surface water. The principle source of fluoride in groundwater is essentially from the rocks minerals. These minerals are usually related to the country rocks thru which the ground water percolates underneath variable temperature conditions. Except these minerals, alkali rocks, hydrothermal answers, phosphate fertilizers, burning of coal, production procedure of aluminum, steel and bricks may additionally make contributions to better awareness of fluoride in groundwater.

The attention of fluoride in water sources relies upon different factors like supply of water, solvent movement of water on the rocks and soil of earth's crust, porosity of the rocks or soil through which water passes, the rate with which water flows, the temperature of the interaction of the rock and water, the hydrogen and calcium ion concentration, amount of annual rainfall and so on. (Ashok Kumar Yadav *et al.* 2009; Tailor & Chandel 2010; Singh P *et al.* 2011; Hussian *et al.* 2012) [25]

Effects of fluoride on human health

Fluoride in drinking water has both fine and terrible outcomes on human health. Low stages of fluoride in ingesting water consequences in incorporation of fluoride in to tooth during the early life of children, which makes the tooth proof against decay and development of dental caries. (Tailor and Chandel, 2010) but, high intake of fluoride causes each brief term and longtime results. Acute high stage publicity to fluoride causes on the spot belly ache, immoderate salivation, nausea and vomiting. Seizures muscle spasms, muscle fibrillation and numbness of mouth may additionally arise. (Singh P *et al.* 2011) long time impact of extra fluoride through water, seem to create fluorosis which manifests itself as dental, skeletal and non- skeletal fluorosis. In dental fluorosis, immoderate fluoride commonly reasons yellowing of tooth, white spots, and pitting or mottling of tooth. The herbal shine or luster of the enamel disappears. Within the early degree, the tooth seems chalky white and then regularly grows to be yellow, brown or black. The discoloration could be horizontally aligned on the teeth surface as "strains" far from the gums. Dental fluorosis affects both the inner and outer floor of the tooth. The ailment has by and large beauty implications and has no remedy.

Immoderate fluoride intake may also result in slow, progressive crippling scourge called skeletal fluorosis. It causes pain and damage to bones and joints. Skeletal fluorosis affects the bones/skeleton of the body. Skeletal fluorosis can have an effect on both old and young alike. One may have aches and ache in the joints. The joints which are normally tormented by skeletal fluorosis are neck, hip, shoulder and knee, fluoride especially receives deposited in those joints and makes it difficult to walk and moves are painful. Stress or stiffness of joints also unit's in. (Beg, 2009) at advanced stage vertebrae may additionally fuse together and a sufferer may be crippled. (Meenakshi and Maheshwari, 2006) [24].

Other than bones and tooth an extra intake of fluoride can harm or impart sick results on other soft tissues, organs and structures also, categorized as non-skeletal fluorosis. A overview with the aid of in advance people reveals that almost all systems of body including muscle, liver, kidney, blood, cardiovascular and even reproductive, are affected. The signs consist of gastro-intestinal lawsuits, lack of appetite, and pain in belly, constipation observed by way of

intermittent diarrhea. Muscular weak point and neurological manifestations leading to excessive thirst tendency to urinate more often are common a few of the bothered individuals. Cardiac troubles may also stand up due to cholesterol production. Repeated abortions or still beginning, male infertility because of sperm abnormalities also are some of the headaches. (Tailor and Chandel, 2010; Singh P et al, 2011)

Nitrate and human health

Nitrate ($NO3^-$) contamination of the groundwater is mainly due to the intensive use of fertilizers. Leaching of nitrate to groundwater is due to excessive application of N- fertilizer, the absence of proper soil and water management practices, septic tanks, improper disposal of domestic wastes.

Nitrate content in groundwater serves as a basis for detecting pollution. High nitrate levels found in drinking water have been proven to be the cause for numerous health conditions across the world such as gastrointestinal cancers, methaemoglobinaemia, Alzheimer's disease, vascular dementia, multiple sclerosis in human beings. Nitrate contamination leads to Eutrophication of water bodies (Sunitha *et al.*, 2012).

Ingested nitrites and nitrates also have a potential role in developing cancers of the digestive tract through their contribution to the formation of nitrosamines. In addition, some scientific evidences suggest that ingested nitrites and nitrates might result in mutagenicity, teratogenicity and birth defects, contribute to the risks of non-Hodgkin's lymphoma and bladder and ovarian concerts, and play a role in the etiology of insulin dependent diabetes mellitus and in the development of thyroid hypertrophy, or cause spontaneous abortions and respiratory tract infections. Indirect health hazards can occur as a consequence of algal toxins causing nausea, vomiting, diarrhea, pneumonia, gastroenteritis, hepatoenteritis, muscular cramps and several poisoning syndromes. Other indirect health hazards can also come from the potential relationship between inorganic nitrogen pollution and human infectious diseases (malaria, cholera Camargo and Alonso, 2006) [10], Nitrate contamination is a long-term problem and remedial action is necessary. (Susiladevi *et al.* 2010) [22].

4. Conclusion

The analysis of ground water samples collected from extraordinary villages of Nawalgarh Tehsil in District Jhunjhunu revealed that, in samples nearly all water pleasant parameters (pH, electrical conductivity, general alkalinity, general hardness, calcium hardness, magnesium hardness, and chloride, TDS, nitrate and fluoride) are beyond the permissible restriction as consistent with BIS, ICMR and WHO standards. In evaluation to all different parameters there's an acute trouble of extraordinarily high degrees of Fluoride, Nitrate, overall Dissolved Solids and Chloride.

The top resources of nitrate enrichment are leaching from the sewage effluents being utilized extensively for irrigation, leakage from sewerage structures, septic tanks and herbal drains wearing municipal wastes, and application of fertilizers.

The results of current look at indicate that the consuming water, utilized by the human beings living in villages of Nawalgarh Tehsil, isn't potable. So, the right environment management plan must be adopted to manipulate drinking water pollutants without delay. Based totally on those results and evaluation of water samples, it's also endorsed to apply water most effective after boiling and filtering or through reverse Osmosis remedy for drinking motive by the individuals to prevent destructive fitness effects.

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6. References

1. APHA. Standard Methods for the Examination of Water and Waste Water (21th ed.), Washington DC: American Public Health Association, 2005.
2. Brown E, Skougstad MW, Fishman MJ. Method for collection and Analysis of water sample for dissolved minerals for dissolved minerals and gases (Book No. 5), Washington, DC: US Department of Interior, 1974.
3. Arif M, Hussain I, Hussain J. Sharma S, Kumar S. Potential Fluoride Contamination in the Drinking Water of Nagaur Tehsil of Nagaur District, Rajasthan, India, Bulletin of Environmental Contamination & Toxicology (BECT), 2012. (DOI 10.1007/s00128-012-0572-4 Online Published on 14 March, 2012),
4. Arif M, Hussain I, Hussain J, Kumar S. Fluoride Distribution in Ground Water and Survey of Dental Fluorosis in Villages of Didwana Tehsil of Nagaur District of Central Rajasthan, India. India Water Week 2012- Water, Energy and Food Security, 2012.
5. Ayoob S, Gupta AK. Fluoride in drinking water: A review on the status and stress effects. Critical Reviews in Environmental Science and Technology. 2006; 36:433-487. Doi: 10.1080/10643380600678112.
6. Beg MK. Geospatial Analysis of Fluoride Contamination in Ground Water of Tamnar Area, Raigarh District, Chhattisgarh State. Thesis submitted in ITC and IIRS, 2009.
7. Bureau of Indian Standard (BIS), Indian standard specification for drinking water, Delhi, 1991, 2-4. BIS, IS 10500.
8. Bureau of Indian Standards. Indian Standards Drinking Water Specification: New Delhi. IS: 10500, 1999.
9. Canter LW. Nitrates in groundwater from agricultural practices-causes, prevention and clean up. Report to United Nations Development Program, University of Oklahoma, Norman, Oklahoma, 1987.
10. Camargo JA, Alonso A. Ecological and toxicological effects of inorganic nitrogen pollution in aquatic ecosystems: A global assessment. Env. Int., 2006; 32:831-849.
11. Central Ground Water Board, Ministry of Water Resources, Government of India, Ground Water Scenario, Jaipur District, Rajasthan, CGWB, Jaipur, 2007.
12. Chouhan S, Flora SJS. Arsenic and Fluoride: Two Major Groundwater Pollutants, Indian J Experimental Biology. 2010; 48:666-678.
13. Godfrey S, Wate S, Kumar P, Swami A, Rayalu S, Rooney R. Health-based risk targets for fluorosis in tribal children of rural Madhya Pradesh. In India

32ndWEDC international conference. Colombo, Sri Lanka, 2006.
14. Gulta DP, Sunita, Saharan JP. Physico chemical analysis of ground water of selected area of kaithal city (Haryana) India. Researcher. 2009; 1(2):1-5.
15. Hussain I, Hussain J, Sharma KC, Ojha KG. Fluoride in drinking water and health hazardous: Some observations on fluoride distribution Rajasthan. In Environmental Scenario of 21st Century, New Delhi: APH, 2002, 355-374.
16. Hussain J, Sharma KC, Hussain I. Fluoride in drinking water and its ill effect on Human Health: A review. Journal of Tissue Research. 2004a; 4(2):263-273.
17. Hussain J, Hussain J, Sharma KC. Fluoride and Health hazards: Community Perception in a fluorotic area of Central Rajasthan (India) An arid environment, Environmental Monitoring and Assessment. 2010; 162:1-14.
18. Hussain I, Arif M, Hussain J. Fluoride Contamination in Drinking water in Rural Habitations of Central Rajasthan, India, Environmental Monitoring and Assessment, 2011. (DOI: 10.1007/s10661-011-2329-7) Online Published on 20 September, 2011),
19. Hamilton AP, Shedlock JR. Are fertilizers and pesticides in the groundwater. A case study of the Delmarve Peninsula, Delaware, Maryland, Virginia, VSGS circular, 1992; 1080:1-16.
20. Jaipur Development Authority, Master Development Plan-2025, Jaipur Region, JDA, Jaipur, 2012, 1.
21. Khaiwal R, Garg VK. Hydro-chemical survey of groundwater of Hisar City and assessment of defluoridation methods used in India. Environmental Monitoring and Assessment. 2007; 132(1-3):33-43. Doi: 10.1007/s10661-006-9500.
22. Susiladevi M, Pugazhendy K, Jayachandran K, Jayanthi C. Nitrate contamination in ground water of Cuddalore Town, Tamil Nadu, India. International Journal of Recent Scientific Research. 2010; 4:97-101.
23. Malik S, Banerji S, Nitrate pollution of ground water as a result of agriculture developmentin Indo-Gango Plain, India, In: proc; Int. symp. on Quality of Groundwater the Nether lands, 1981.
24. Meenakshi, Maheshwari RC. Fluoride in Drinking Water and its Removal. Journal of Hazardous Materials. 2006; 137(1):456-463.
25. Mitharwal S, Yadav RD, Angasaria RC. Water Quality analysis in Pilani of Jhunjhunu District (Rajasthan)- The place of Birla's Origin. Rasayan Journal of Chemistry. 2009; 2(4):920-923.
26. Mosier AR, Nutr. Cycl. Agroecosyst. 2002; 63:101-106.
27. Mueller DN, Hamilton PA, Helsel DR, Hitt KJ, Reddy BC. Nutrients in ground water and surface water of the united states – an analysis or data through 1992, water-resources investigations report 95-4031, United State Geological Survey, Denver, 1995.
28. Mueller DK, Helser DR. Nudrienty in the nation's water-too much of a good thing? U.S Geological Survey circular 1136, United States Geological Survey, Denver, 1996.
29. Rao NS. Seasonal variation of groundwater quality in a part of Guntur District, Andhra Pradesh, India. Environmental Geology. 2006; 49:413-429.
30. Saxena S, Saxena U. Study of fluoride contamination status of ground water in Bassi Tehsil of district Jaipur, Rajasthan, India. International Journal of Environmental Sciences. 2013; 3(6):2251-2260.