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Analysis of ground water quality using physico-chemical parameters of five locations of district Yamuna Nagar, Haryana, India

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Abstract
The present study reveals ground water quality assessment of five locations of district Yamuna Nagar, Haryana, India. The quality was assessed using some physico-chemical parameters such as pH, electrical conductivity, total dissolved solids, salinity, dissolved oxygen, total hardness, calcium and magnesium hardness, total alkalinity, OH^- alkalinity, CO_3^{2-} and HCO_3^- alkalinity, Na^+ and K^+ concentration. The observed parameters were compared with standard values proposed by World Health Organisation (WHO) and Indian Standard (IS). The analysis shows that some parameters are found to lie beyond the permissible limits of IS and WHO limits.

Keywords: ground water, PH, TDS, hardness, salinity, alkalinity

1. Introduction
About 70% of Earth's surface is covered by water. Of all the water on Earth 97% is in oceans, which is of little use to humankind. Only 3% left is fresh water which is useable. India has about 4% of world's freshwater reserve ranking it among top ten water rich countries [1]. The major sources of freshwater are groundwater and surface water. The groundwater is considered to be one of the most reliable sources of freshwater in terms of quantity as well as quality as it is a renewable source, believed to be much clean and less vulnerable to pollution than surface water. But with the advent of increasing industrialization, green revolution and urbanization the scenario has changed. Ground water, a precious source gift of nature, is becoming scarce in terms of quantity as well as quality. This contamination of water adversely affects the health and causes serious health problems. So this is the need of the hour to critically assess the quality of water that we are intaking, identifying any existing problems and any issues that could emerge in future. We should ensure that the quality of world's most valuable resource is as high as possible. Due to social relevance of the subject and concern for worsening condition of water, the present study therefore is aimed at examining the quality of ground water supply at five different locations in Yamuna Nagar district of Haryana, India. Various studies have been carried out by many researchers in the past on the groundwater quality of various parts of Haryana, India and abroad. In this regard, Bishnoi *et al.* [2] carried out physiochemical analysis of groundwater of 41 locations of Panipat and all samples were found to be very hard and even fluoride content was found to be higher than permissible limits. Rout *et al.* [3] studied drinking water quality of Ambala Cantonment area and reported water quality to be moderately hard. Kumari *et al.* [4] investigated water quality index of ground water in Smalkhan and reported that majority of water samples fall in poor category. The groundwater quality has been investigated in some other parts also including Hisar, Faridabad, Rohtak, Jhajjar etc. by various researchers [5-9]. Meenakshi *et al.* [10] reported the presence of excessive salinity, hardness, etc. from different parts of Haryana. This type of studies are not limited to Haryana but also many studies has been reported for different regions of India and outside India as this is directly related with the social benefits [11, 12].
In this study, characterization of the physio-chemical parameters of groundwater from five different locations in Yamuna Nagar district, Haryana was carried out. To monitor the water quality various parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), salinity, dissolved oxygen (DO), total hardness, calcium (CaH) and magnesium hardness (MgH), total alkalinity, OH^-alkalinity, CO_3^{2-} and HCO_3^-alkalinity, Na^+ and K^+ ions concentration were studied. To assess the quality of water, the observed parameters were compared with standard values given by World Health Organization (WHO) and Indian Standard (IS).

2. Materials and Methods
Ground water samples were collected from fresh water taps at Yamuna Nagar, Jagadhari, Chhachrauli, Radaur and Sadaura. Water samples were collected in the month of September 2017 and store in cleaned polythene bottles. The water samples were clear, odourless and taste was agreeable.
The parameters like pH, EC, TDS, salinity, DO were determined using on spot water testing analyzer of Systronics (Model 371). Na^+ and K^+ ions concentration was estimated in the samples using Systronics flame photometer (Model 128). Total hardness, CaH and MgH hardness were determined using well known ethylenediaminetetraacetic acid (EDTA) titration method and the total alkalinity, OH^- alkalinity, CO_3^{2-}, HCO_3^- alkalinity were determined using titration against standard acid [13].

3. Results and Discussions

A comparison of physico-chemical parameters of water samples with acceptable limits of WHO and IS standards are summarized in Table 1.

Table 1: Physico-chemical parameters of water samples with acceptable limits of WHO and IS standards

Sr. No.	Parameters	Unit	Acceptable Limit		Observed Value				
			WHO [14]	IS [15]	Chhachrauli	Sadaura	Yamuna Nagar	Jagadhari	Radaur
1.	pH	-	6.5-8.5	6.5-8.5	7.36	6.89	6.64	6.37	7.09
2.	EC	μScm^{-1}	-	300	207	1300	223	362.56	1702
3.	TDS	ppm	300	300	690	461	760	535	386
4.	Salinity	ppm	-	-	380	270	450	260	190
5.	DO	ppm	-	-	7.9	6.89	6.64	7.2	6.96
6.	Total hardness	ppm	100	300	272.3	202.4	391	325.47	202.83
7.	CaH	ppm	75	75	94	59.4	123.7	160.38	96.7
8.	MgH	ppm	150	30	178.3	143.5	267.3	165.09	106.13
9.	Total alkalinity	ppm	-	200	90	35	50	45	25
10.	OH^- alkalinity	ppm	-	-	0	0	0	0	0
11.	CO_3^{2-} alkalinity	ppm	75	75	0	20	40	0	0
12.	HCO_3^- alkalinity	ppm	150	30	90	15	10	45	25
13.	Na^+ conc.	ppm	-	-	7.53	33.03	49.71	35.0	40.20
14.	K^+ conc.	ppm	-	-	1.26	0.81	12.96	8.60	4.40

3.1 Hydrogen Ion Activity (pH)

pH is a term used to express the hydrogen ion concentration, more precisely, the hydrogen ion activity. pH is an important parameter in assessing the water quality. Acidic conditions will prevail as pH value decreases and alkaline conditions will prevail as the pH value increases. The WHO and IS limits for drinking water is 6.5-8.5 (Table 1). pH value in analyzed water samples varied from 6.37 to 7.36. The results show that pH of all the water samples lies within permissible limits.

3.2 Electrical Conductivity (EC)

It is ability of a solution to conduct an electrical current by the migration of ions in solutions and is dependent on the nature. It is a useful tool to assess the purity of water. According to WHO and IS standard, the permissible limit for EC is 300 µS cm^{-1}. The comparison of EC of samples with standard value is shown in Figure 1. EC of the collected samples are ranged from 207 to 1702 µS cm^{-1}. The EC of Radaur and Sadaura samples is very high as compared to the acceptable limits and other samples. This shows that these water samples contain large number of ions as compared to others.

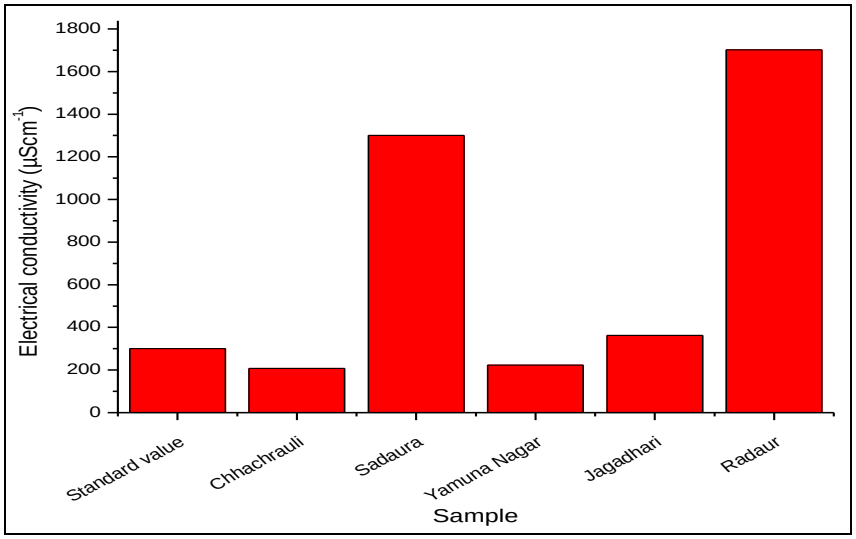

Fig 1: Comparison of electrical conductivity of samples with standard value

3.3 Total Dissolved Salts (TDS) and Salinity

TDS represents the total concentration of dissolved substances in water however salinity is an estimate of the level of salt in a water sample. TDS is not only objectionable to consumers but also results in scaling in pipes, household appliances and boilers and reduce the vapour pressure [14]. As per IS standard, the TDS of drinking water should be 300 ppm however this limit can be extended to 600 ppm if no alternate source is available [15]. Water is not fit for drinking if TDS is too high. The palatability of water with TDS level of less than about 600 ppm is generally considered to be good. The range of TDS of analyzed water samples varied between 386-760 ppm (Table 1) which is beyond permissible limits in Chhachrauli and Yamuna Nagar samples. All the water sample are non-saline as per the salinity classification given in Table 2 as suggested by Robinove *et al.* [16]. The salinity range of

samples is 190-450 ppm. So, it can be concluded that in case of non-availability of any other water-source, groundwater of studied areas is suitable for drinking purposes from salinity point of view.

Table 2: Classification of groundwater on the basis of TDS and total hardness

TDS (ppm)	Description
<1000	Non saline
1000-3000	Slightly saline
3000-10000	Moderately saline
>1000	Very saline

3.4 Dissolved Oxygen (DO)

DO is a significant parameter in determining the water quality. This indicates the physical and biological processes prevailing in the water. The DO values indicate the degree of pollution in water bodies. The value of dissolved oxygen in samples varies from 6.64 to 7.9 ppm. It is found maximum in case of Chhachrauli sample and minimum in case of Yamuna Nagar sample. Depletion of dissolved oxygen in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to sulfide. However, very high levels of dissolved oxygen may exacerbate corrosion of metal pipes.

3.5 Total Hardness, Calcium and Magnesium Hardness

In groundwater, hardness is mainly contributed by bicarbonates, carbonates, sulphates and chlorides of calcium and magnesium. So, the principal hardness causing ions are calcium and magnesium. The total hardness of analyzed water samples varies from 202.4-391 ppm. The CaH and MgH values of samples varies 106-267.3 ppm. All samples falls in the very hard catogery as per classification proposed by Durfor and Becker [17] (Table 3).

Table 3: Classification of water on the basis of total hardness

Total hardness (ppm)	Nature of water
0-60	Soft
61-120	Moderate
121-180	Hard
>181	Very

3.6 Total Alkalinity, OH^-, CO_3^{2-} and HCO_3^- alkalinity

Carbonates and bicarbonates in water are present mainly in association with Ca^{2+} and Mg^{2+}. The hydroxide alkalinity is zero in all samples. The carbonate content of analyzed water samples varied from 0-40 ppm which lies within the permissible limits but HCO_3^- content varied from 20-90 ppm which is higher in case Chhachrauli and Yamuna Nagar samples according to IS but lies within WHO limits. Total alkalinity of all samples is found to be less the than permissible limit and it is not harmful to human being.

3.7 Na^+ and K^+ concentration

In the assessed samples, the Na^+ concentration lie within the range 7.53-49.71 ppm however K^+ concentration lie within the range 0.81-12.96 ppm. It means Na^+ concentration is more as compared to K^+ concentration in the samples. These ions also contribute in salinity of water samples.

4. Conclusions

In the present study water samples from five different locations in Yamuna Nagar district of Haryana are assessed. To assess the quality of ground water each parameter was compared with the standard desirable limits prescribed by World health organization (WHO) and Indian Standard (IS). The estimated parameters i.e. pH, EC, TDS, salinity, DO, total hardness, CaH, MgH, total alkalinity, OH^- alkalinity, CO_3^{2-} alkalinity, HCO_3^- alkalinity, Na^+ and K^+ concentration were found to lie in range 6.37-7.36, 207-1702 μScm^{-1}, 386-760 ppm, 190-450 ppm, 6.64-7.9 ppm, 6.64-7.9 ppm, 202.4-391 ppm, 59.4-160.4 ppm, 106.3-267.3 ppm, 25-90 ppm, 0 ppm, 0-40 ppm, 25-90 ppm, 7.53-49.71 ppm and 0.81-12.96 ppm, respectively. The range of TDS and HCO_3^- alkalinity of Chhachrauli and Yamuna Nagar samples is found to be lie beyond permissible limits of WHO and IS standards. Further, it is concluded that water samples are very hard and are not suitable for drinking. So it is suggested that ground water the study area should be softened before consumption. The results also suggest that the contamination problem is not alarming at present but groundwater quality may deteriorate with time. Therefore, proper care should be taken to avoid any groundwater contamination. Further, it is a case study which can not be generalized to other part of the region.

5. Acknowledgement

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