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Correlation studies of Physico-chemical Parameters of Ground Water of Kasganj City, India

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ABSTRACT

This paper presents an evaluation of various physico-chemical parameters to assess the suitability of groundwater, mainly for drinking purpose in Kasganj. The city is situated on the bank of Kali River. Groundwater samples collected from various parts of city were analyzed for pH, Electric Conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Total Hardness (TH), turbidity, fluoride (F^-) and chloride (Cl^-). The geochemical study shows that ground water is generally hard (TH > 260 mg L^{-1}) and alkaline in nature (pH > 7). A large percentage of samples exceeded permissible limits of various parameters as given by various National/International bodies. Water from sampling locations S5 and S6 far exceeds the fluoride limit. Apart from already affected people, a larger part of city population is at risk.

Graphical Abstract

Kasganj District

Keywords: Fluoride, Drinking water, Fluorosis, Physico-chemical parameters, Yamuna.

INTRODUCTION

Water is an important component for life on Earth, which contains minerals extremely important in human nutrition [**1, 2**]. Groundwater contamination is a serious global issue today. Continuously increasing level of contamination with a variety of toxic substances and lowering down of the groundwater table due to over-exploitation to meet globally increasing water demand followed by the declining annual recharge have brought them under severe constrains worldwide. Interferences altering the natural water balance have further influenced the redox chemistry of the aquifers resulting in mobilization of several chemical constituents present in the solid matrices [**3, 4**]. The problem of excessive fluoride in ground water in India was first reported in 1937 in the state of Andhra Pradesh [**4**]. In India, approximately 62 million people including 6 million children suffer from fluorosis because of consumption of water with high fluoride concentrations [**5**]. Groundwater and surface water are the major source of drinking water in both urban and rural areas. The modern civilization, industrialization, urbanization and increase in population have laid to the fast degradation of our groundwater quality [**1-7**].

Kasganj city is selected for the study as it is known to be hotspot of drinking water supply because of the presence of major problems such as inadequate water supply, declining groundwater level and poor water quality. The major source of drinking water in city is groundwater and most of the drinking water supply depending on it. The Kasganj district is situated in western U.P., between 27.11'degree Latitude North and 78.0' degree to 78.2'degree Longitude East. Its Altitude is 169 meters above sea level (Map 1). On the North it is bounded by Badaun District, on the South it is bounded by Hathras District, on the East it is bounded by Farukhabad District and on the West, it is bounded by Aligarh. Kasganj is situated on the bank of Kali River.

Map 1. Kasganj District

MATERIALS AND METHODS

Sample Collection: Water samples were collected in the winter season (December-2012). Samples were collected in pre-cleaned Blue coloured sampling bottle of one litre capacity with necessary precautions and brought to the laboratory for analysis. Water samples were collected from Bore wells and hand pumps. The sampling locations are given below in table 1. The stations are chosen to make maximum representation.

Table 1. Sampling stations

S.No.	Place	Area Type	Direction	Depth(approx)
1	Jaura Bhaura Kuan	Mohlla	NE	20m
2	Barah Patthar	Playing Field	E	15m
3	Barahdwari	Market	S	20m
4	S.S.S.M.V. Vikas N.	Institute	Center	30m
5	Nadarai Gate	Residential	W-SW	40m
6	Gantaghar	Market	N	40m

Analysis of Physico-chemical parameters: Analysis were carried out for the determination of Physico-chemical parameters of drinking water samples such as pH, Electric Conductivity (EC),Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Total Hardness (TH), turbidity, fluoride(F^-) and chloride (Cl^-) using standard methods [6, 7]. All the reagents used for the analysis were AR grade and double distilled water was used for preparation of solutions.

RESULTS AND DISCUSSION

The Physico-chemical parameters of drinking water samples from six different locations of Kasganj city are given in table-2 [mean ± S.D.]. These results were compared with WHO (2006) and BIS (1991) drinking water standard [2, 8]. The correlation matrix for various parameters is given in table 3. Correlation quantifies the extent to which two quantitative variables, X and Y, "go together." When high values of X are associated with high values of Y, a positive correlation exists. When high values of X are associated with low values of Y, a negative correlation exists.

Table 2. Water quality parameters of Kasganj city ground water as compared with standard values of WHO and BIS

Parameter	S1	S2	S3	S4	S5	S6	WHO	BIS
pH	7.2± 0.26	7.5± 0.24	7.3± 0.28	7.4± 0.26	7.8± 0.23	7.2± 0.26	7-8.5	7-8.3
D.O. (mg L^{-1})	4.8± 0.39	4.6± 0.40	4.1± 0.34	8.0± 1.0	7.1± 0.37	5.8± 0.38	-	-
T.D.S. (mg L^{-1})	175± 6.45	177± 6.55	185± 7.24	327± 6.45	106± 7.48	225± 11.45	500	500
T.H. (mg L^{-1})	350 ± 9.30	453± 10.8	460± 12.30	310± 10.36	360± 10.12	280± 11.3	200	200
E.C. (mS)	2.67± 0.66	2.74± 0.56	2.77± 0.61	5.15± 1.66	1.80± 0.76	3.46± 1.06	-	-
Turbidity (NTU)	30± 7.3	10± 5.3	10± 7.31	11± 7.4	9± 5.3	10± 7.39	2.5	-
F^-(mg L^{-1})	0.68± 0.19	0.65± 0.11	0.7± 0.18	0.4± 0.1	2.1± 1.18	2.2± 1.12	1.5	1.5
Cl^- (mg L^{-1})	780± 64.62	709± 61.12	673± 24.62	1191± 104.6	283± 19.62	1311± 114.62	250	250

Table 3. Correlation table

Parameter	pH	D.O.	T.D.S.	T.H.	E.C.	Turbidity	F^-	Cl^-
pH	1							
D.O.	0.438986	1						
T.D.S.	-0.45861	0.415962	1					
T.H.	0.205792	-0.66663	-0.43198	1				
E.C.	-0.39319	0.485762	0.996706	-0.46204	1			
Turbidity	-0.47122	-0.28204	-0.08724	-0.14132	-0.11221	1		
F^-	0.28236	0.227638	-0.43481	-0.44439	-0.40818	-0.31976	1	
Cl^-	-0.70444	0.189019	0.840199	-0.59871	0.818214	-0.00023	-0.08624	1

pH: Although the pH of pure water is 7.0, drinking water and natural water exhibits a pH range above 7.0 because it contains dissolved minerals and gases. Water with a pH less than 6.5 is considered acidic. This water typically is corrosive and soft. Water with a pH higher than 8.5 is considered basic or alkaline. This water often is hard water, the pH values of water samples under study varied between 7.23 and 7.58 and were found within the limit prescribed by WHO and BIS.

Dissolved oxygen: In liquid wastes, dissolved oxygen is the factor that determines whether the biological changes are brought about by aerobic or by anaerobic organisms. It is an importance factor in natural water both as a measure of metabolic process of biotic community & indicator of aquatic health. Dissolved oxygen values are found in range of 4.0-8.1 mg L^{-1}. The D.O. study confirms the fact that organic pollution is mild in the study zone.

Total Dissolved Solids: Various types of minerals present in a dissolved state i.e., true solution; constitute the total dissolved solids in water. Apart from these, some dissolved organic matter may also contribute to TDS. Total dissolved solids indicate the salinity behavior of groundwater. Water containing more than 500 mg $L^{-1}$of TDS is not considered desirable for drinking purpose [9]. TDS values are found in between 116 and 337 mg L^{-1}

Total Hardness: Hard water is not suitable for washing purpose, as the lather formation with soap is hindered by the hardness. It also increases the boiling point of water. The maximum allowable limit of total hardness is 500 mg $L^{-1}$and the most desirable limit is 100 mg L^{-1} as per the WHO standards. Total hardness of water is caused by the presence of Ca and Mg salts. Groundwater of all stations is within limit of T.H.

Electric conductivity: The ability of an aqueous solution to carry an electrical current is expressed in terms of a numerical expression called conductivity. This depends on the presence, mobility, valency and concentrations of the ions. It also depends on the temperature at which observation is made. Therefore, the presence of most inorganic acids, bases and slats increases the conductivity of water sample. Electrical conductivity values in this study ranges as 1.80-5.15 mS. The higher EC values are observed in S4 and S6 sampling locations. It indicates the higher amount of total dissolved salts [9].

Turbidity: Turbid water cannot be used directly in most industries and require treatment before use. The photosynthetic activities in the river water are also affected as the penetration of sunlight is hindered. The probability of pathogenic organism's presence is more in turbid water which is also aesthetically objectionable for drinking and many other uses. The drinking water limit for turbidity is 2.5 NTU (W.H.O.). The observed values of turbidity (Table 2) vary from 9 to 30 NTU all exceeding W.H.O. limit. The cost of water treatment goes up when the intake water becomes more turbid [10]. Clear waters are particularly needed for manufacturing uses like beverage products, food products, drinking products, etc.

Fluoride: Knowledge of fluoride content of drinking water is important for public and health care professionals to know. Planning of preventive dental care programmes depend on the correct assessment of F intake by the people as enamel fluorosis from excessive ingestion of F can lead to long term adverse health effects [11, 12]. In the present study two stations S5 and S6 exceed the recommended limit of F.

Chloride: The most common inorganic anion present in water and waste waters is chloride in the form Cl^- ion. Chloride values in present study ranged from 283.6- 1311.6 mg L^{-1}. Station S6 has highest concentration of chloride 1311.6 mg L^{-1}. Chlorides when reaches concentration above 250 mg L^{-1}; imparts an unacceptable salty taste to waters although no adverse effect have been observed on human beings regularly consuming water with much higher concentrations of chloride [13, 14].

APPLICATION

These results are useful to motivate Public and for taking necessary measures.

CONCLUSION

Water quality standards WHO (2006) and BIS (1991) shows water quality of all the samples is not suitable for drinking purpose without prior treatment. The two samples S5 and S6 are not potable for drinking purpose. These contain high amount of Cl^-, TH and F^- (table 2). The values of EC are quite high. Higher values of EC indicate higher TDS. Overall water from all sampling stations has excessive concentration of dissolved solids & hard water. Therefore, all the water samples can be used for drinking purpose only after proper treatment like reverse osmosis. As seen in correlation table chloride show strong positive correlation with TDS and EC. Also, TDS and EC are also strongly correlated. It suggests that if any one increase the other two also show increasing trend. Fluoride on the other hand shows negative correlation with TH that indicates that if the hardness increases fluoride decreases which is in agreement with other researchers [**15, 16**].

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