Assessing groundwater quality of Sirsa City and its village: A comparative study on physiochemical parameters

Rajender Kumar[1*] & Sunita Rani[1]

[1]*Dept. of Chemistry, Guru Kashi University, Talwandi Sabo, Punjab.*
**Author for correspondence: rajenderchem9@gmail.com*

Abstract
Underground water quality parameters depend upon several factors. We have tested the physicochemical parameters of the underground water of Sirsa city and two villages of Sirsa district. This paper makes a comparative assessment of the quality of underground water in Sirsa city and two villages in the Sirsa district. Physicochemical parameters like TDS, p-alkalinity, m-alkalinity, BOD, COD, dissolved oxygen, pH, hardness, heavy metals, and conductivity were measured using different techniques. The different physicochemical parameters were compared with WHO standards. It was found that the underground of Sirsa city was fit for drinking purposes whereas the water of Kharekien and Morriwala villages was fit for irrigation purposes.

Keywords: *Physicochemical parameters, Total Hardness, COD, BOD, Total dissolved Solids, Water quality index.*

1. Introduction:

Water is very essential for sustaining life on the earth. Water used for drinking and irrigation purposes should be clean, pure, and should be free from impurities. But due to a large number of industrial and other developmental activities water available for drinking and agricultural purposes is being polluted constantly. There are different sources of water like rainwater, river water, pond water, groundwater, seawater, etc. The quality of water (Physical and Chemical) varies a lot depending on the source of water [1-3]. Sea water is not fit for drinking and agriculture due to the large amount of dissolved salts (3.0 % NaCl) make it unfit for use. The quality of groundwater also varies a lot from place to place. The quantity of groundwater is also decreasing day by day. The groundwater level is going down day by day and in some places, groundwater is available below 500 feet. It is very essential to know the effects of the addition of pesticides in the fields on the groundwater quality, heavy metal contents in groundwater, and the effects of industrial influences on the quality of underground water in the Sirsa district [4,5].

Hence, studies on the physico-chemical parameters of groundwater of Sirsa district (Haryana) and their seasonal variation in agricultural and residential areas are essentially required. That is why, we have chosen our research topic to study on Physico-Chemical parameters of the groundwater of Sirsa district (Haryana).

Water is very essential for both plants as well as human beings. No one can even think of life without water. Water is very essential in shaping human, land, and climate life. During the past few years, there has been a huge demand for large amounts of fresh water due to a burst in population and an increase in industrial activities due to the growth in industrial civilization.

The quality of water has a very large impact on agriculture and human beings. Hence, it is very essential to know the quality of water to be supplied for drinking and irrigation purposes. We have observed that few or no researchers have reported their work on studies on the Physico-Chemical Parameters of Ground Water and their Seasonal Variation in Agricultural and Residential Areas of Sirsa (Haryana). Hence, studies on the groundwater quality index of Sirsa district (rural and Urban) is required. Parameters like Temperature, pH, Electrical conductivity, total dissolved solids, Ca, Mg, K, Na, carbonate, bicarbonate, chloride, sulfate, nitrate, total hardness as $CaCO_3$, Fluoride, Fe, Pb, Zn, Cd, Mn, alkalinity, biochemical oxygen demand, chemical oxygen demand, transition metal cation etc. needs to be estimated in rural and urban district of Sirsa (Haryana) [6-9].

Quality of water has a very large impact on the life of human beings. Impurities enter into our body through water and accumulate in the form of a food chain. According to a study, 80% of diseases are waterborne. Clean and pure water for drinking purposes is our basic requirement other than food, air, and shelter. Hence, it is very essential to know the quality of water to be supplied for drinking and irrigation purposes. We have observed that few or no researchers have reported their work on studies on the Physico-Chemical Parameters of groundwater and their Seasonal variation in agricultural and residential areas of Sirsa (Haryana) [10]. Hence, studies on the groundwater quality index of Sirsa district (rural and Urban) are required. Parameters like Temperature, pH, Electrical conductivity, total dissolved solids, Ca, Mg, K, Na, CO_3, HCO_3, chloride, SO_4, NO_3, total hardness as $CaCO_3$, Fluoride, Fe, Pb, Zn, Cd, Mn, Heavy metal ions, alkalinity, biochemical oxygen demand, chemical oxygen demand, transition metal cation etc. needs to be estimated in rural and urban district of Sirsa (Haryana) [11-13].

2. Experimental

2.1 Total Hardness:

Procedure: Take a 20 ml sample of ground water. After this add 5ml buffer solution of Ammonium Chloride (NH_4Cl) and Ammonium Hydroxide (NH_4OH) with Eriochrome Black T(EBT). Here, EBT is used as an Indicator. It is blue in colour in a buffered solution at pH10. It turns red when it forms a complex with calcium, magnesium or other metal ions. After adding EBT it appears a wine red colour. The new solution becomes 25 ml. Now take about 10 ml of the new solution in conical flask. And take 0.1 M Ethylene diamine tetraacetic acid (EDTA) in burette. Now titrate the new solution with EDTA till the end point appears blue color. Again, took 10 ml of the new solution and titrate it with EDTA till the end point appears.

2.2 Permanent Hardness:

Procedure: Take a 100 ml sample of ground water. Now heat the given sample until it becomes half. Filter the obtained sample with filter paper. Now add 50ml of distilled water to it. The new solution becomes 100 ml. Now take 20 ml of the new solution in conical flask. Add 5 ml buffer solution of Ammonium Chloride (NH_4Cl) and Ammonium Hydroxide (NH_4OH) with Eriochrome Black T(EBT). Now titrate it with 0.1 M EDTA till the end point appears blue color.

2.3 Temporary Hardness:

Temporary Hardness = Total Hardness – Permanent Hardness.

2.4 Alkalinity:

p-Alkalinity:

Procedure: Take 20 ml of ground water in a conical flask. Add 2 drops of **Phenolphthalein** indicator in it. Phenolphthalein indicator shows colourless in acidic medium and it shows red in basic medium. Now titrate it with 0.1 N HCl solution. After titration, the color changes from light pink to colorless due to the acidic medium of HCL.

m-Alkalinity:

Procedure: Take 20ml of ground water in a conical flask. Add 2 drops of Methyl orange indicator in it. The methyl orange indicator shows a red colour in an acidic medium and it shows yellow in the basic medium. Now titrate it with 0.1 N HCl solution. After titration the colour changes from yellow to red due to acidic medium of HCl.

Total Alkalinity:

Total Alkalinity = p-Alkalinity + m-Alkalinity.

2.5 Dissolved Oxygen:

Requirements: Manganese Sulphate ($MnSO_4$), Alkali Iodide Azide, Sulphuric Acid (H_2SO_4), Starch, Sodium Thiosulphate ($Na_2S_2O_3 . \times H_2O$).

Procedure: Take 100ml water sample in a conical flask. Now add 0.68 g of $MnSO_4$ to it. After this add 2 ml Alkali Iodide Azide from Calibrate pipette. Now add 2 ml H_2SO_4.

Now, titrate the new solution with Sodium Thiosulphate till the end point appears a pale yellow color. After titration add 2ml starch solution in obtained pale yellow solution. The new solution becomes blue in color. Now titrate continuously the solution until the blue color disappears.

2.6 Test for COD (Chemical Oxygen Demand):

Preparation: Add 3.5 g of Iron Sulphate heptahydrate and 7.5 g of phenanthroline monohydrate to 400 ml of distilled water. Mix to dissolve and make up to 500 ml of distilled water.

Procedure (COD): "Take 10 ml of a sample of a round bottom flask. Add some glass beads to prevent the solution from bumping the glass by heating. Add 1 ml of Mercury sulfate solution to the flask and mix by swirling the flask. Add 5 ml of Potassium dichromate solution. Now add slowly and carefully 15 ml Silver sulfate- Sulphuric acid solution. Connect the reflux condenser and use a hot plate for 2 hours. After digestion cool the flask and rinse the condenser with 25 ml of distilled water collected in the same flask. Add 2-4 drops of ferroin indicator to the flask and titrate with 0.025 M ferrous ammonium sulfate solution to the endpoint. Make the blank preparation in the same manner as the sample using distilled water instead of the sample".

2.7 BOD: (Biochemical Oxygen Demand)

Material required: Alkaline Iodide-azide solution, Manganese sulfate, Sulphuric acid, Starch solution 0.025 N sodium thiosulphate.

Procedure: "Collect the water sample of a pond. Carefully fill a BOD bottle with sample water without making air bubbles. Add 2 ml of manganese sulfate to the BOD bottle carefully by inserting the pipette just below the surface water. So that you can avoid the formation of air bubbles. Add 2 ml of alkali-iodide-azide reagent in the same manner. Close the bottle and mix the sample by inverting many times. A brownish cloud will appear in the solution as an indicator of the presence of Oxygen. Allow the brown precipitate to settle out to the bottom. Add 2ml of Sulphuric acid carefully without forming air bubbles. Close to the bottle and mix the solution well to dissolve the precipitate. Keep the bottle in a BOD incubator of 5 days of incubation. After incubation, titrate 50ml of sample water with 0.025 N Sodium thiosulphate to a pale yellow color. Then add 2 ml of starch solution. So, the samples turn in blue. Continue the titration till the sample gets clear and note the readings. The concentration of dissolved oxygen in the sample is equivalent to the number of milliliters of titrant used".

2.8 pH Procedure: The pH meter was calibrated using a buffer solution of pH 7.0 and 9.0. 50 ml of water from a different source was taken in a beaker and pH glass electrode was immersed and the initial pH of the solution was measured on a pH meter. Five different readings were taken for the water and the average reading was noted down at room temperature.

2.9 Conductance:

The conductivity meter was calibrated using KCl solution by finding its cell constant. 50 ml of water from different sources was taken in a beaker and conductivity cell was immersed and the initial conductance of the solution was measured on a conductivity meter. Five different readings were taken for the water and the average reading was noted down at room temperature.

2.10 Turbidity (NTU)

It is the instrument to measure turbidity. NTU (Nephelometric Turbidity Unit) was calibrated by hydrazine and hexamine. The calibrating solution was formed by 1.0 g of hydrazine sulfate in 100 mL water (A) and 10 g of hexamine in 100 mL water (B). Took the mixture of 25 mL of A and

25 mL of B in the beaker and keep it for 24 hours then there was the formation of 1000 NTU. Then the formed NTU was diluted up to 100 NTU this procedure is the working of calibrating the turbidity meter. Then took the water sample in the Borosil bottle and kept it in the turbidity meter. Then after starting the turbidity meter, we got a reading and we found the turbidity amount of the water sample. Then, in the same way, we measure the turbidity of the remaining ten water samples.

2.11 Flame Photometer Evidence

The Flame photometer is used for the measurement of the intensity of emitted light when a source is subjected to flame. Both qualitative and quantitative types of information can be obtained from Flame photometry experiments. The sample is first spayed into the flame where it gets vaporized absorbs extra energy and goes to an excited state. The reverse path is followed. A flame photometer is mainly used to measure the amount of Na^+ and K^+ ions in the water.

3. Results and Discussion

Table 1. Flame Photometric evidence and UV-VIS Spectrophotometric evidence of Sirsa City and Villages.

Water Sample No.	Na (ppm)	K (ppm)	Nitrate (at 220.0 nm)	Phosphate (at 690.0 nm)	Sulphate (at 420.0 nm)
Bus stand Sirsa	5.8	0.12	0.2780	0.3395	0.2957
Khairenkan	75.5	1.43	0.5689	0.3187	1.7245
Moriwala	29.0	0.12	2.8835	0.4755	1.7449

Table 2. Physico-chemical properties (pH) of different water samples of Sirsa City district and two villages.

S. NO.	Water Sample No.	pH
1.	Bus stand Sirsa	7.88
2.	Khairenkan	7.41
3.	Moriwala	7.50

Table 3. Physico-chemical properties (Conductivity) of different water samples of Sirsa city and two villages.

S. No.	Water Sample No.	Conductivity(mS)
1.	Bus stand Sirsa	223.4
2.	Khairenkan	213.4
3.	Moriwala	228.34

Table 4. Physico-chemical properties (TDS) of different water samples of Sirsa City and two villages of district Sirsa.

S. NO.	Water Sample No.	TDS (ppm)
1.	Bus stand Sirsa	180.6
2.	Khairenkan	195.7
3.	Moriwala	235.6

Table 5. Physico-chemical properties (Turbidity) of different water samples of Sirsa city and two villages of Sirsa district.

S. No.	Water Sample No.	Turbidity (NTU)
1.	Bus stand Sirsa	52.2
2.	Khairenkan	31.6
3.	Moriwala	23.6

Table 6. AAS analysis of water samples of different regions of Sirsa city and two villages of the district, Sirsa.

Water Sample No.	Iron (Fe)	Copper (Cu)	Chromium (Cr)	Lead (Pb)
Bus stand Sirsa	0.110	ND	ND	0.594
Khairenkan	0.159	ND	ND	0.594
Moriwala	0.259	ND	1.723	0.809

Table 7. Volumetric titration analysis (Hardness) of different water samples of Sirsa city and two villages of Sirsa district.

S. No.	Water Sample	Hardness ($CaCO_3$ equivalence)		
		Total	Permanent	Temporary
1	Bus stand Sirsa	230	230	0
2	Khairenkan	250	250	0
3	Moriwala	260	260	0

Table 8. Volumetric titration analysis (Alkalinity) of different water samples of Sirsa city and two villages of the district Sirsa.

S. No.	Water Sample	Alkalinity (mEq/L)		
		p-alkalinity	m-alkalinity	Total
1	Bus stand Sirsa	01	10	11
2	Khairenkan	0	12	12
3	Moriwala	01	25	26

Table 9. Volumetric titration analysis (dissolved oxygen) of different water samples of Sirsa district.

S. No.	Water Sample	Dissolved O_2 (ml)
1	Bus stand Sirsa	0.4
2	Khairenkan	0.1
3	Moriwala	0.1

WHO DATA

Na = 200 mg/L
K = 50 mg/L
Fe = 0.2 mg/L
Cu = 2.0 mg/L
Cr = 50 µg/L
Pb = 10 µg/L
pH = 6.5 - 8.5
Phosphate = 0.5 µg/L
Sulfate = 0.1 µg/L
Nitrate = 0.5 µg/L

TDS = 300 mg/L , good
300-600 mg/L , fair
600-900 mg/L, poor
900-1200 mg/L, unacceptable

Conductivity = 250 µS/cm

Turbidity = 4-5 NTU

Total Hardness = 200-600 mg/L

Alkalinity = 200-600 mg/L

Dissolved O_2 = 2-5 mg/L

The order of dissolved oxygen in two villages and Sirsa city is as follows:

Bus stand Sirsa > Khairenkan = Moriwala.
The order of total alkalinity in the two villages of Sirsa district and Sirsa city is as follows:
Moriwala > Khairenkan > Bus stand Sirsa.
The order of total hardness in two villages of Sirsa district and Sirsa city is as follows:
Moriwala > Khairenkan > Bus stand Sirsa.

The order of turbidity (NTU) in two villages of Sirsa district and Sirsa city is as follows:
Bus stand Sirsa > Khairenkan > Moriwala.

The order of TDS in two villages of Sirsa district and Sirsa city is as follows:
Moriwala> Khairenkan > Bus stand Sirsa.
The order of conductivity in the two villages of Sirsa district and Sirsa city is as follows:
Moriwala > Bus stand Sirsa > Khairenkan
The order of pH in two villages of Sirsa district and Sirsa city is as follows:
Bus stand Sirsa > Moriwala > Khairenkan.

Conclusions

The present study provides a comprehensive comparative analysis of the physicochemical parameters of underground water in Sirsa city and two villages, Kharekein and Morriwala, in the Sirsa district. By evaluating key parameters such as TDS, p-alkalinity, m-alkalinity, BOD, COD, dissolved oxygen, pH, hardness, heavy metals, and conductivity, and comparing them against WHO standards, significant differences in water quality were observed. The underground water in Sirsa City meets the WHO standards for drinking purposes, indicating its suitability for human consumption. However, the water in Kharekein and Morriwala villages, while unsuitable for drinking due to deviations in critical parameters, is deemed fit for irrigation purposes, highlighting its potential utility in agricultural applications. These findings emphasize the importance of localized water quality assessments and underscore the need for targeted measures to address specific water quality challenges in rural areas. Future studies may explore the impact of anthropogenic activities, seasonal variations, and mitigation strategies to enhance water quality in these regions. It was concluded that based on Physico-chemical studies of the underground water of two villages of Sirsa district, and Sirsa city, the underground water of the Bus stand, in Sirsa is more suitable for drinking purposes and the underground water of Moriwala village is more suitable for agricultural purposes.

Acknowledgements

We are very thankful to the authorities of Guru Kashi University, Talwandi Sabo, Panjab for providing infrastructural facility for this research work.

References

[1] *Asadullah, K. Nisa and S. I. Khan, Sci., Tech. and Development, 32 (1),* ***(2013)****, pp. 28-33.*

[2] *U.M. Qureshimatva, R.R. Maurya, S.B. Gamit, R.D. Patel, and H.A. Solanki, J. Environ. Anal. Toxicol. 5(4),* ***(2014)****, pp. 288.*

[3] *N. Jain, Internat. J. of Scientific Res. Engg. & Tech., 7(1),* ***(2018)****, pp. 01-09.*

[4] *D. Kamal, A.N. Khan, M.A. Rahman, F. Ahamed, Pak. J. Biol. Sci. 10(5),* ***(2007)****, pp. 710-717.*

[5] *A. Begum, S.Y, Noorjahan, C. M., Dawood, S.V. Sharif, "Physicochemical and fungal analysis of a fertilizers factory effluent", Nature Environment & Pollution Tech. 4(4),* ***(2005)****, pp. 529-531.*

[6] *Pawar, Anusha, C., Nair, J. Kumar, N. Jagdav, V. Devi, V. Pawar, C. Smita, "Physicochemical study of groundwork samples from Nacharam Industrial area, Hyderabad, Andhra Pardesh", J. of Aquatic Biology, 21(1),* ***(2006)****, 118-120.*

[7] *D. Kallol, S.C. Mohapatra, M. Bidyabati, "Assessment of water quality parameters of the river Brahmani at Rourkela", J. of Indust. Pollution Control, 21(2),* ***(2005)****, pp.265-270.*

[8] *R.P. Chavan, R.S. Lokhande, S. I . Rajput, "Monitoring of organic pollutants in Thane creek water", Nature Environ. & Pollution Tech., 4(4),* ***(2005)****, pp. 633-636.*

[9] *A. Agarwal, F. Rafique, E. Rajesh, and S. Ahmed, "Urban flood hazard mapping using change detection on wetness transformed images", Hydrol. Sci. J., 61,* ***(2016)****, pp. 816-825. https:/doi.org.10.1080/02626667.2014.952638*

[10] *N. Gupta and et.al., "Physico-Chemical Analysis of Drinking Water Quality from 32 locations in Delhi", J. of Indian Water Works Association, 9* ***(2010)****.*
[11] *S. Tagy and et al., "Water Quality Assessment in terms of Water Quality Index", American J. of Water Resources, 1(3),* ***(2013)****, pp. 34-38.*
[12] *R. Kavitha and K. Elangovan, "Review article on Groundwater quality characteristics at Erode district, (India)", I.J.E.S., 1(2),* ***(2010)****.*
[13] *S. Mittal and S. Sharma, J. of Environ. Res. & Amp; Development, 3(1),* ***(2018)****, pp. 129-136.*