Original Research Article

Assessment of ground water quality in different areas of Uttar Pradesh and Haryana

Shabnam Ain*, Qurratul Ain, Sneha Pandey, Vishakha Tyagi, Yashvardhan Vats, Nidhi Ruhela and Babita Kumar

Sanskar College of Pharmacy and Research (SCPR), Sanskar Educational Group, Ghaziabad Pin-201302, Uttar Pradesh, India

*Address for correspondence: **Dr. Shabnam Ain**

Head of Department, Sanskar college of Pharmacy and Research,

Jindal Nagar, Ghaziabad Utter Pradesh-201302 India

Email: shabnam.ain@sanskar.org

Phone No. + 91-9310807567

Abstract

The objective of the present study was to assess the quality of ground water on the basis of its physical and chemical properties. Ground water (hand pump) is an essential natural source of drinking water. For this purpose, Gurgaon, Hapur and Ghaziabad are the locations from where all the samples were collected. They are listed as most polluted cities in the country. In this article we have included the latest research data of 2024, impact of pathogens and bacteria in drinking water and presence of Iron, lead, nitrates above acceptable limit. Underground water gets contaminated by the indirect ways like industrial waste, pesticides, insecticides, waste disposal in water bodies. This water should be treated before drinking and household purposes. Major ions that are found in the normal fresh drinking water which is benefit for health are CO_3^{2-}, PO_4^{3-}, NO_3^-, Cu^{2+}, F^-, Na^+ and K^+. Underground water sample was collected for study from eight different areas of Uttar Pradesh and Haryana. From this study we concluded that these sources was contaminated and cannot be used for consumption for human and animal use. Major pollutants are from industries, plastic and chemical sources. Water can only be used after proper treatment and after maintaining ion-dissolve salts ratio in drinking water. Few approaches like MARVI, rainwater borewells are used to improve level of ground water.

Key words: Drinking water, Underground water contamination, Industrial pollutants and Hardness.

1. Introduction

India is a developing country, it has many of the developing cities form IT sector like Gurgaon and area near the National Capital Regions like Ghaziabad and Hapur are the

developing cities of India. These are the places where the boom of technologies is higher and futuristic. These areas have high industrialization and modern towns in this state. Ghaziabad has the higher rate for the civilization in the state Uttar Pradesh and Hapur one of the district of Uttar Pradesh lesser rate of industrialization and good population ratio (www.newhealthadvisor.org , 2014; Deepti *et al*., 2021). Apart from this all the areas are listed under the most polluted cities of the country Gurgaon has the higher ground water problems in last few years, Ghaziabad and Hapur are on the peak for consumption of the polluted drinking water from the natural water sources (Chris *et al*., 2007; Ain *et al.*, 2009). Civilization of these areas are suffering for the basic needs and requirement of fresh water and facing the problems. The shortage of purified water is with every second citizen of these areas. They are using unhealthy and polluted water every day for the daily use of water (Chris *et al.*, 2007; Dohare *et al.*, 2014; Ain *et al*., 2021). As the day by day and year by year is passing the level of pollution is increasing, these cities result shows the level of the pollution and contamination of the water source that is making the source unfit for consumption. The first factor for the life of the living creature on this planet Earth is water which is going to be brutal every day (Dohare *et al*., 2014; Aggarwal *et al*., 2022). Now our country has arrived at this stage where the source of fresh water is becoming extinct and only the polluted water bodies will remain. Due to all the industrialization and civilization in the metro Politian cities has shown the side effect of this unbearable changes of our water source (Dohare *et al.*, 2014; Amanial *et al.*, 2015). By which they are losing their purity of fresh source the same can be seen with our holy Indian river, Ganga. The reaction between the atmosphere and the water bodies, dissolution, precipitation causes the debris composition in the water bodies and the indirect involvement of humans causes the major factor for this cause (Ain *et al*., 2008) Many of the human made pollutants such as plastic, gasoline, road salts, oils, chemicals, and many of other factors that pollute the water (Amanial *et al.*, 2015; Ain *et al*., 2009). Other than these causes, the pesticides and insecticides, fertilizers that are using in the crop fields that direct dissolve in the soil and mixed in the ground water these chemicals are used to kill the insects and weeds but actually killing the human beings and animals (Verma *et al*., 2021; Kumar *et al* 2020). Many of the disease like jaundice, diarrhoea, cholera, gastric disorders are cause by drinking polluted water. Fresh water source of ground water is only source for good quality drinking water and that requires the judicial use for long use of water consumption of drinking water to maintain the life form on this earth, in some countries death

of millions of the infants in a year due to consumption of unsafe polluted drinking water (Gupta *et al*., 2013; Dhama *et al*., 2022). This present study address the quality of ground water from the different regions of Uttar Pradesh and Haryana that is Hapur (Delhi NCR) and Gurgaon area respectively (World Health Organization, 2009).

2. Materials and methods

2.1 Study area

The different areas of Hapur (west UP) includes Awas Vikas, vill. Assora, haddi mill area, accheja, new mandi and vill. Sarava. Some areas near Ghaziabad, vill. Galand (Delhi NCR) region and IMT Manesar industrial area near Gurgaon are taken for the collection of samples.

2.2 Collection and analysis of ground water samples

Samples of ground water were collected from different sources such as Hand pump and river. It causes pollution of heavy metal on the surface and underground water resources that automatically cause soil pollution and greater effect on food, major pollution is caused by mined ores that is dumped on ground surface (Denchak *et al*., 2018; Verma *et al*., 2013). It was collected in plastic bottles from the site of sampling area of Hapur, Ghaziabad and Gurgaon of Uttar Pradesh during October to December 2022. The bottles are clean and washed with soaking it overnight in 15% nitric acid and washed with deionized water and kept in room temperature for drying. For sufficient amount of flushing, rinsing of the container was done many times from good or fresh water source also the water sample was collected after pumping 10 times. For maintaining the quality and to preserve the water sample from the effect of temperature it is carried in the jar of icebox. It prevent the samples from the environmental effect (US Environmental Protection Agency, 2016). All the samples are carried in laboratory kept into the refrigerator at 4℃ before they are taken for use. In this experiment the method for collecting, preparation and preservation of the sample was proposed by APHA (American Public Health Association) in precise manner (Elton *et al*., 1963).

2.3 Experimental work done

Systronic pH meters, type 335 and buffer solution were to be used for the measurement and standardization of pH values of the river/ ground water samples which are taken for analysis. Buffer solution of pH 4 and pH 9.2 were used in this experiment. Using titration method determination of total alkalinity of the sample solution titrating it with N/50 H2SO4 using methyl orange indicator and total hardness with complexometric titration with EDTA using Eriochrome black T as external indicator (Tuthill *et al.*, 1981; Kumar *et al*., 2021; Verma *et al*., 2010). Cadmium hardness of the water samples was determined using complexometric titration with EDTA using ammonium perpurate as an indicator (Ain *et al*., 2016; Ain *et al*., 2017). While Chloride ion determination was done successfully by titrating it with water solution against the standard solution of silver nitrate using potassium chromate as an indicator (Chinoy *et al.*, 1991; Ain *et al*., 2015). Estimation of ions like Na^+ and K^+ was done by Flame photometer and ions like NO_3^-, SO_4^{2-}, F^- are estimated using U.V. Spectrometer. Gravimetric method is used to analysis the measurement of Total Dissolve Solid, which is the famous quantitative method for titration. Value of EC under investigation is measured by systronic EC meter. Various parameters has been recorded and followed as per requirements (Reda *et al.*, 2016; Ain *et al*., 2022). So, our data recording as in Table 1 (widmans lab, 2022) analysis of water has been done in three tabular forms of charts as in Figure 1. These minerals that is present in sample water is above acceptable limit.

Table 1: Physical and chemical parameters of ground water sample from Haddi mill BSR, Awas Vikas and New Mandi.

S.No.	Parameter	Haddi mill BSR	Awas Vikas	New Mandi
1.	Odour	Agreeable	Agreeable	Agreeable
2.	pH	7.15	7.49	7.58
3.	Total dissolved solids, max	880.0	560.0	530.0
4.	Total Hardness (as CaCO3), max	477.0	342.0	324.0
5.	Ca^{2+}	119.0	79.4	64.9
6.	Mg^{2+}	43.7	34.9	39.4
7.	Na^{+}	72.6	150.0	595.3
8.	K^{+}	332.9	375.0	345.5
9.	Cl^{-}	223.3	64.5	44.7
10.	SO^{4-}	67.0	34.0	30.6
11.	Fe^{2+}	BDL	BDL	BDL
12.	NO_3	1.2	3.3	3.9
13.	F^{-}	1.2	0.75	0.75
14.	Colour, max	Colourless	Colourless	Colourless
15.	Electrical Conductivity	873	932	896

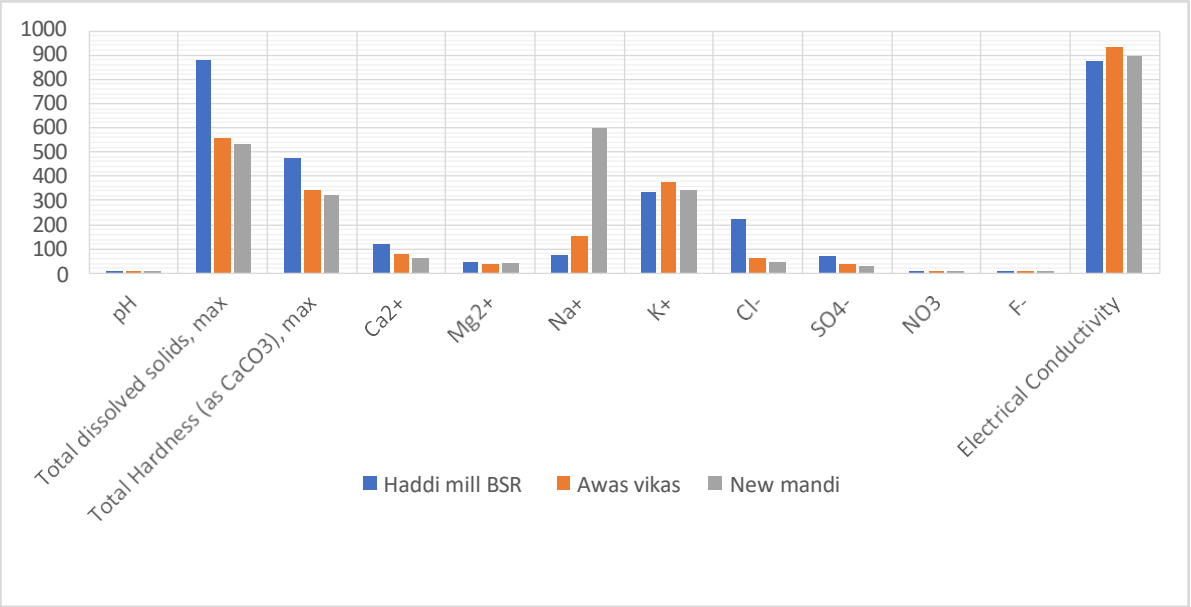

Figure 1: Physical and chemical parameters of ground water sample from Haddi mill BSR, Awas Vikas and New Mandi.

Table 2: Physical and chemical parameters of groundwater from IMT Manesar, Galand factory area and Sarava Kithod

S. No.	Parameters	IMT Manesar	Galand factory area	Sarava Kithod
1.	Odour	Agreeable	Agreeable	Agreeable
2.	Ph	7.40	7.59	7.61
3.	Total dissolved solids, max	470.0	400.0	670.0
4.	Total Hardness (as CaCO3), max	288.0	243.0	315.0
5.	Ca^{2+}	57.7	46.9	72.1
6.	Mg^{2+}	34.9	30.6	32.8
7.	Na^{+}	67.3	122.5	136.8
8.	K^{+}	233.5	239.5	232.1
9.	Cl^{-}	89.3	39.7	99.3
10.	SO^{4-}	28.0	26.0	36.8
11.	Fe^{2+}	BDL	BDL	BDL
12.	NO_3^{-}	2.8	4.9	6.8
13.	F^{-}	0.40	0.30	0.9
14.	Colour, max	Colourless	Colourless	21.0
15.	Electrical Conductivity	775	885	799

Figure 2: Physical and chemical parameters of groundwater from IMT Manesar, Galand factory area and Sarava Kithod.

Table 3: Physical and chemical parameters of groundwater from Assora & Accheja.

S. No.	**Parameters**	Assora	Accheja
1.	Odour	Agreeable	Agreeable
2.	pH	7.38	7.89
3.	Total dissolved solids, max	638.0	780.0
4.	Total Hardness (as CaCO3), max	342.0	423.0
5.	Ca^{2+}	68.5	108.3
6.	Mg^{2+}	41.6	37.2
7.	Na^{+}	66.5	132.2
8.	K^{+}	341.2	259.6
9.	Cl^{-}	54.6	124.1
10.	SO^{4-}	35.0	47.0
11.	Fe^{2+}	BDL	BDL
12.	NO_3^{-}	2.9	4.6
13.	F^{-}	0.55	1.1
14.	Colour, max	Colourless	Colourless
15.	Electrical Conductivity	741	823

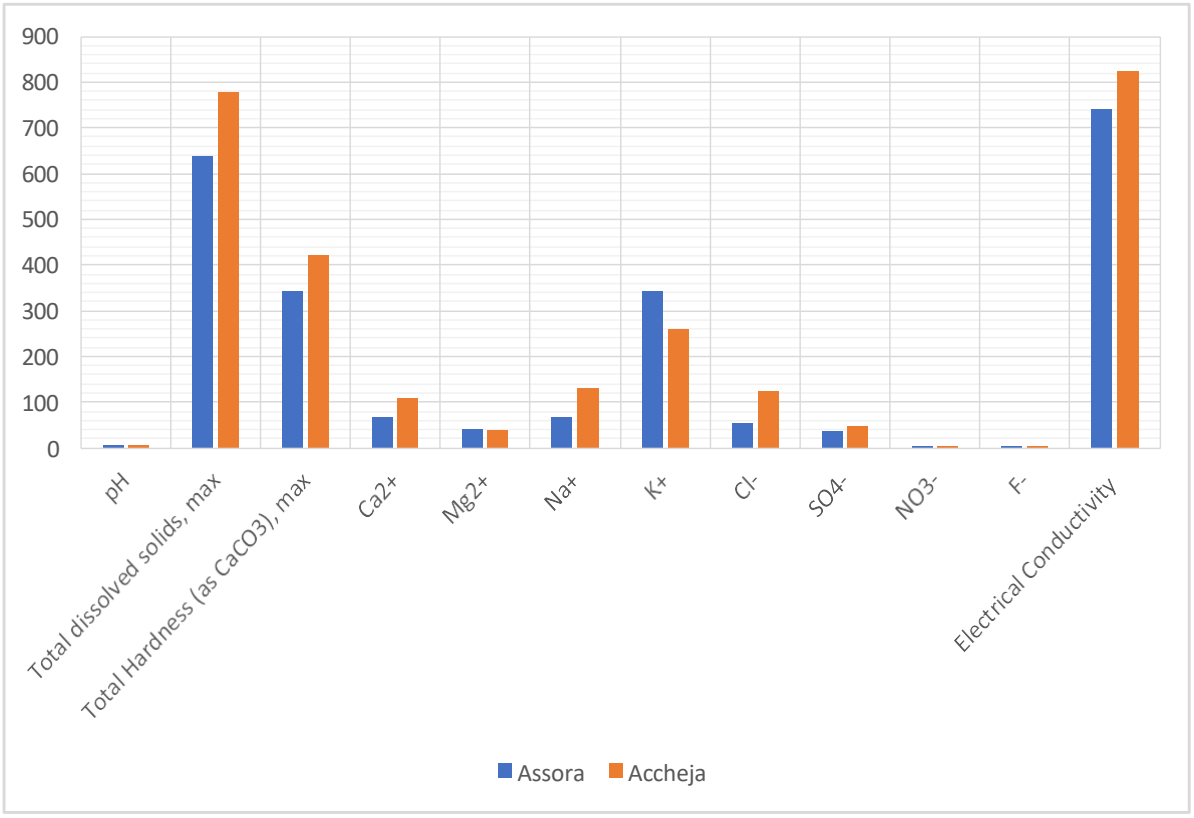

Figure 3: Physical and chemical parameters of groundwater from Assora and Accheja.

Table 4: Physical and chemical properties of groundwater and list of substances found in the groundwater along with their effect and methods.

S.No.	Physical and Chemical Parameters	Unit	Acceptable limit	Permissible limit	Types of problems	Test methods
1	Colours	Hazen unit	5.0	15.0	-	IS:3025 (Pt-4)
2	Odor	NA	Agreeable	Agreeable	-	IS:3025 (Pt-5)
3	pH	NA	6.5 – 8.5	No Relaxation	-	IS:3025 (Pt-11)
4	Turbidity	ntu	10	25	-	-
5	Total Dissolved Solids, Max	Mg/l	500	2000	-	IS:3025 (Pt-16)
6	Ammonia	Mg/l	0.5	0.5	Portability, Corrosiveness	-
7	Boron	Mg/l	0.5	1.0	Corrosiveness	-
8	Calcium	Mg/l	75	200	Encrustation	IS:3025 (Pt-40)
9	Chloride	Mg/l	250	1000	Portability, Corrosiveness	IS:3025 (Pt-32)
10	Fluoride	Mg/l	1.0	1.5	Fluorosis	IS:3025 (Pt-60)
11	Magnesium	Mg/l	30	100	Encrustation	IS:3025 (Pt-46)

12	Nitrate	Mg/l	45	45	Methemo-Globinemia	-
13	Total alkalinity	Mg/l	210	620	Portability, Health aspects	-
14	Sulphate	Mg/l	200	400	Portability	IS:3025 (Pt-24)
15	Total Hardness (as CaCO3), Max	Mg/l	200	600	-	IS:3025 (Pt-21)
16	Temperature	℃	-	-	-	-
17	Sodium	Mg/l	-	-	Hypertension	-
18	Iron	Mg/l	0.30	0.3	Encrustation, staining of laundary and toilet fixtures	IS:3025 (Pt-2)
19	Cadmium	Mg/l	0.01	-	Portability, corrosiveness	-
20	Chromium	Mg/l	0.05	0.05	Portability, corrosiveness	-
21	Zinc	Mg/l	5.0	10.0	Portability, corrosiveness	-
22	Manganese	Mg/l	0.1	0.5	Encrustation, staining of laundary and toilet fixtures	-
23	Nickel	Mg/l	0.02	0.02	Portability, Health aspects	-
24	Silica	-	-	-	Encrustation	-

associated with various health related and heart related problems, in these minerals Iron is most essential micronutrient (in table 2 widmanslab, 2022 and graph in Figure 2) which is good for metabolism but long term higher consumption may cause severe problems (shown in Table 3 widmanslab, 2022) and lead is also hazardous, neurotoxin and cause abnormalities in human beings (Khan et al., 2023). As there are several agents of pollution (in Figure 3) nitrates and radionuclides are dangerous and some pathogenic bacteria that cause infection are transferred through contaminated drinking water which cause disease and even epidemics situation for everyone (Khan et al., 2023, Koryakov et al., 2023).

3. Results and discussion

According to WHO guidelines, drinking water for humans lies between pH ranges of 6.8 - 8.5 whereas pH 7 is the neutral pH for science (table 4 widmanslab, 2022). Water samples of the different areas were collected for analysing the extent of deterioration and contamination was studying and compressing on the basis of pH analysis (Koryakov *et al*., 2023). The output of the collected samples shows the result of pH values ranges from 9.78-11.28, it shows the indication of high alkaline nature in the water bodies. Those which have the value more than 7 on the scale of pH meter that alkaline water is commonly known as the beverage where it has the desirable limit for the total alkalinity is 200mg/L. A high value of pH level of the drinking water which can be seen in the water samples which causes the medical complications and sever health disorders such as gastrointestinal disorders which lowers the naturally occurring acidity for the stomach which is produced by the intestinal acid HCl, that

helps in killing of bacteria and pathogens from affecting our body and stops the entry into the blood stream (Fatula *et al*., 1963). By drinking of large amount of alkaline water day by day it reduces the normal pH of the body which brings our body into the sever condition of metabolic alkalosis which may be fatal if it lasted for months as it can cause the multiple organ failure. Many of the long term disorder may also caused by this contaminated water has been found such as kidney failure, cardiovascular attacks, intestinal disorder and other many metabolic complications. Other from drinking of bad and alkaline water which cause this sever disorders this can cause several epidermal layer infections and sever irritations. Due to increase in pH of water samples which cause sun dry in many cities and main cause of the same was the higher concentration of fertilizers and the pesticides mixed in the ground water which is collected from the site of sample collection. There are many approaches for conserving the drinking water one of the great approach is MARVI which is an innovative step towards management of ground water for village level managing step (Fatula *et al*., 1963, Sarma *et al.*, 2023). This project focuses on developing village participatory approach towards demand of farmers and stakeholders to limit and reduce the supply the drinking water and reduce the use of pesticides and insecticides in crop field. There should be Rainwater recharges borewells for the limiting the dependence of water tanker and improve level of ground water (Sarma et al., 2023).

4. Conclusion

After analysing the sample collected for the study of physical and chemical parameters of the ground water and comprising the quality of ground water of different areas of Hapur (NCR) and Gurgaon which shows the higher differences in the values of the observed parameters at Awas Vikas and IMT Manesar areas of Hapur and Gurgaon respectively (water-Specification, ISD, 2012). That shows the result of contamination of the ground water in these areas have high number of mixed pollutants in the water source that is chemical waste from industries, soil dust and many mineral pollutants. It was observed that the water of these area should not be used for the consumption for the human beings and if it is used then soon there is harmful situation may occur for the large number of population in these areas where severe medical disorders and multi organ failure can be seen. Thus this study recommended to carry out a water quality program and development of effective practices for utilization of water resources in these areas.

Thus we can only cure this condition with properly following the guidelines and the norms for pollution control advised by our government of India. Everyone should strictly follow and support it. For the drinking we should use the water filters for removal of harmful pollutants which affect our body. We should not neglect the reality that pure ground water is an anticipated requirement for all the living life form on the earth. Ground water from these areas should be treated before it was certified fit for the use and consumption to the humans.

Acknowledgement

The authors are thankful to Dr. Amit Kumar Bishnoi, managing director for his valuable support and Widsman laboratories, manesar, Haryana for providing laboratory facility and essential data for this research.

Source of funding

NIL

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

References

1. Aggarwal, B.; Ajeet, Ain, S.; Ain, Q.; Garg, R. K., Sharma P., Lamba, H. S. and Adhana, A. (2022). Physicochemical evaluation of endocarp of *Cocos nucifera L*. Journal of Phytonanotechnology and Pharmaceutical Sciences, 2(3): 14-18.
2. Ain, Q.; Ain, S.; Verma, R. K. and Parveen, S. (2009). Prevalance of lung disease in the workers of scissors manufacturing Industries in Meerut city– a survey, The Pharma Research, 1: 188-191.
3. Ain, S.; Ain, Q. and Kumar, B. (2015). Investigations on novel bio-binder isolated from *aegle marmelos* used in ibuprofen tablets. International Journal of Pharmacy and Pharmaceutical Sciences, 7 (7): 414-415.
4. Ain, S.; Ain, Q.; Chaturvedi, S. and Kumar, B. (2021). Comparative assessment of ground water quality in different areas of Delhi NCR (Ghaziabad, Noida) and East UP (Varanasi). Indian Journal of Pharmacy and Pharmacology, 8 (1): 58-64.
5. Ain, S.; Ain, Q. and Parveen, S. (2009). An overview on various approaches used for solubilization of poorly soluble drugs. The Pharma Research, 2: 84-104
6. Ain, S.; Betty, P. and Pathak, K. (2008). Preformulative assessment of preformed complexes of gemfibrozil, with cyclodextrins. PDA Journal of Pharmaceutical science and Technology, 62 (4): 300-308.
7. Ain, S.; Kumar, B. and Pathak, K. (2017). QbD based development, optimization and evaluation of cyclodextrin inclusion complex loaded matrix tablet formulation of famotidine. European Journal of Pharmaceutical and Medical Research, 4 (8): 438-452.
8. Ain, S.; Kumar, B. and Pathak, K. (2017). Development and characterization of controlled release famotidine matrix tablets containing complexes. International Journal of Applied Pharmaceutics. 9 (4): 8-46.
9. Ain, S.; Mishra, G.; Kumar.; B. Ain, Q. and Garg, R. K. (2022). Antidiabetic potential of developed solid lipid nanoparticles loaded with quercetin: *In vitro* and *in silico* studies. Annals of Phytomedicine, 11(2): 732-742.

10. Ain, S.; Singh, R. and Ain, Q. (2016). Characterization and intrinsic dissolution rate study of microwave assisted cyclodextrin inclusion complexes of gemfibrozil. International Journal of Pharmacy and Pharmaceutical Sciences, 8(10): 160-163.
11. Ali, M.; Ain, S.; Kumar, B. and Ain, Q. (2022). Development and evaluation of eugenol-based gel formulation for analgesic and anti-inflammatory action. Annals of Phytomedicine, 11(1): 338-345.
12. Ali, Z.; Ain, S.; Kumar, B. and Ain, Q. (2022). Method development and validation for estimation of Cefadroxil in different marketed tablets by UV spectrophotometry method and anti-inflammatory studies using *in-silico* approaches. Oriental Journal of Chemistry, 38(4): 898-905.
13. Amanial, H. R. (2015). Assessment of physicochemical quality of spring water in Arbaminch, Ethiopia. J Environ Anal Chem 2(157): 2380-2391.
14. Chinoy, N. J. (1991). Effects of fluoride on physiology of animals and human beings. Indian J Environ Toxicol 1(1): 17-32.
15. Chris, W. (2007). Water pollution: An introduction.
16. Denchak, Melissa. (2018). Water pollution: Everything you need to know. Nat. Resour. Def. Counc. NY.
17. Deepti, A.; Gupta, R. D.; Ain, S. and Sharma, V. (2021). Quantitative determination and validation of clarithromycin in pharmaceutical using quantitative nuclear magnetic resonance spectroscopy. World Journal of Pharmaceutical Research, 10(4): 1665-1694.
18. Dhama, P. K.; Ain, S.; Kumar, B. and Ain, Q. (2022). Development and evaluation of topical ointment formulation containing gallic acid as an active pharmaceutical ingredient against bacterial infection and oxidative damage. Annals of Phytomedicine, 11(1): 439-449.
19. Dohare, D.; Shriram, D. and Atul, K. (2014). Analysis of groundwater quality parameters: A review. Research Journal of Engineering Sciences, 3(5): 26-31.
20. Elton, N. W.; William, J.; Elton, Jose, P. N. (1963). Pathology of acute salt poisoning in infants. American Journal of Clinical Pathology, 39: 252-264.

21. Fatula, M. I. (1967). Frequency of arterial hypertension among persons using water with elevated sodium chloride content. Sovetskaia Meditsina 30(5): 134-136.

22. Gupta, V.; Ain, S.; Kumar, B.; Ain, Q. and Dahiya, J. (2013). Solubility enhancement of the poorly water-soluble antiulcer drug famotidine by inclusion complexation. International Journal of Pharmaceutical Science and Nanotechnology, 6(1): 1983-1989.

23. Khan, M. A.; Nawaz, K.; Ahmad, A.; Kumar, R.; Singh, A.; Chaurasia, D.; Neogi, S.; Kumar. and Chaturvedi, P. (2023). Potential health risk assessment, spatio-temporal hydrochemistry and groundwater quality of Yamuna river basin, Northern India. Chemosphere 311: 136880.

24. Koryakov, A.; Svetlana, M.; Artem L. and Eugenia M. (2023). Peculiarities of statistical water quality assessment in an industrial region. Polish Journal of Environmental Studies, 32(1): 1-14.

25. Kumar, A.; Ain, S.; Ain, Q.; Gupta, R.; Rai, A. and Ikram. (2021). A comparative study of mineral contents of bottled water and tap water in the western Uttar Pradesh. World Journal of Pharmacy and Pharmaceutical Sciences, 10(12): 818-428.

26. Kumar, A.; Ain, Q.; Gupta, R.; Rai, A.; Ikram and Sharma, N.K. (2021). A review of potential treatments for novel corona virus disease (covid-19). World Journal of Pharmacy and Pharmaceutical Sciences, 10(12): 429-442.

27. Kumar, V.; Ain, S.; Kumar, B.; Ain, Q. and Gaurav. (2020). Optimization and evaluation of topical gel containing solid lipid nanoparticles loaded with luliconazole and its anti-fungal activity. International Journal of Pharmaceutical Research, 12(2):2901- 2912.

28. Reda, Amanial, H. (2016). Physicochemical characterization of tannery effluent and its impact on the nearby river. Journal of Environmental Chemistry and Ecotoxicology 8(6):44-50.

29. Sarma, Shankar Prasad (2023). EAC-PM/WP/9/2023.

30. Tuthill, Robert, W. and Edward, J. C. (1981). Drinking water sodium and blood pressure in children: a second look. American Journal of Public Health 71(7):722-729.

31. US Environmental Protection Agency (2016). Clean watersheds needs survey 2012 report to congress.

32. Verma, R. and Pratima, D. (2013). Heavy metal water pollution-A case study. Recent Research in Science and Technology 5(5):98-99.

33. Verma, H. K.; Kumar, V.; Ain, S.; Kumar, B. and Ain, Q. (2021). Optimization and evaluation of developed topical ointment formulation containing cefadroxil and its antibacterial activity. International Journal of Pharmaceutical Research, 13(2):3086-3096.

34. Verma, R. K.; Sindhu, S. K.; Ain, Q. and Kusum. (2010). Development of perchlorate and thiocyanate selective membrane electrodes based on schiff base macrocylic complexes in biological wastes. The Pharma Research, 3:92-98.

35. Widmans Laboratory (2022). Plot No. 155E, Sector 7, Imt Manesar, Gurugram, Haryana 122050https://www.widmanslab.com/

36. World Health Organization (2009). Calcium and magnesium in drinking water: public health significance. World Health Organization.

37. www.newhealthadvisor.org, 2014 /Diseases-Caused-By-Water-Pollution.html