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Hydro Chemical Analysis of Surface and Ground Water Quality of Yamuna River at Agra, India

Arti Maheshwari [1,*], Manisha Sharma [1], Deepak Sharma [2]
[1]*Department of Chemistry, Mangalayatan University, Beswan, Aligarh*
[2]*Department of Physics, Mangalayatan University, Beswan, Aligarh*

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* Corresponding Author (Dr. Arti Maheshwari), E mail: arti.chemistry@gmail.com; Phone no. 09634184524

Abstract
The aim of this study is to assess the quality of surface water of Yamuna River. Water samples were collected from Yamuna River along different points and analyzed for various physicochemical parameters during winter and summer seasons. Effects of industrial wastes, municipality sewage and agricultural runoff on the river water were investigated. The study was conducted between the Kailash Mandir and Taj Mahal area. This area is most polluted due to the presence of many chemical fertilizers, iron, leather and other industries. All these industries discharge their untreated toxic waste water directly into the river Yamuna. Various physical and chemical parameters like DO, BOD, COD, pH, total suspended solid, total dissolved solids, Alkalinity, Turbidity, Hardness, Chloride contents, sodium, calcium, Electric Conductivity are determined for different samples and compared with the standard limits recommended by WHO. The analytical results showed that during winter season, the quality of water is more suitable for domestic purposes.

Keywords: BOD; COD; DO; Hydro chemical analysis; Yamuna; Ground water; Surface Water

1. Introduction

Toady, the environmental quality is greatly focused on water because of its importance in maintaining the human health and health of the ecosystem. Fresh water is finite resource, essential for agriculture, industry and even human existence, without fresh water of adequate quantity and quality, sustainable development will not be possible [1]. The addition of various kinds of pollutants and nutrients through the agency sewage, industrial effluents, agricultural run off etc. into the water bodies bring about a series of changes in the physicochemical and characteristics of water, which have been the subject of several investigations [2-5]. Fresh water resource is becoming day-by-day at the faster rate of deterioration of the water quality is now a global problem [6]. Discharge of toxic chemicals, over pumping of aquifer and contamination of water bodies with substance that promote algae growth are some of the today's major cause for water quality degradation. Importantly, groundwater can also be contaminated by naturally occurring sources. Soil and geologic formation containing high levels of heavy metals can leach those metals into groundwater. This can be aggravated by over-pumping wells, particularly for agriculture. Pollution caused by fertilizers and pesticides used in agriculture, often dispersed over large areas, is a great threat to fresh groundwater ecosystems.

These impurities may give water a bad taste, color, odor or turbidity and cause hardness, corrosiveness, staining or frothing [7]. The composition of surface and groundwater is dependent on natural factors (geological, topographical, meteorological, hydrological and biological) in the drainage basin and varies with seasonal difference in runoff volumes, weather conditions and water levels [8]. In India, where groundwater is used intensively for irrigation and industrial purposes, a variety of land and water based human activities are causing pollution of this precious resource [9].

The River Yamuna, the largest tributary of River Ganga has been one of the most prominent & important rivers of India. It has been acclaimed as a holy river in Indian mythology and various pilgrimage centers e.g. Yamunotri (Uttaranchal), Paonta Sahib (Himachal Pradesh), Mathura, Vrindavan, Bateshwar & Allahabad (all in Uttar Pradesh) are located at the banks of this river. In agriculture front also the Yamuna basin is one of the highly fertile and high food grain yielding basin, especially areas in Haryana and Western district in Uttar Pradesh. All this reflects that the River Yamuna not only flows in the hearts of Indian but also plays a significant role in the economy of the country. This river Yamuna is also influenced by the problems imparted by industrialization, urbanization and rapid agricultural developments similar to other revering system.

This study involves the determination of physical and chemical parameters of surface water of Yamuna River at different points of Agra City. The objective of this study is to assess the present water quality, through analysis of some selected water quality parameters like pH, DO, Alkalinity, Hardness, TDS, Ca, Na and Cl and to compare the results with the international standards.

2. Material and Methods

2.1. pH:
The pH of samples was determined by pH meter.

2.2. Dissolved Oxygen (DO):
The DO was determined by using Starch as indicator and (maganous sulphate+ alkaline KI) as fixation reagent.

2.3. Alkalinity:
The alkalinity was determined by titration using phenolphthalein and methyl orange indicators.

2.4. Hardness:
The hardness was determined by titration Erichrome black *T* indicator and standard (0.01 N) EDTA solution.

2.5. Determination of total dissolved solids:
The water sample was filtered through Whatman No 4 and evaporated the sample on hot water bath until whole water was evaporated. After cooling noted the weight of evaporating dish and calculated total dissolved solids.

2.6. Determination of Ca:
The calcium content of water samples was determined by complexometric titration using EDTA solution and Eriochrome black T as indicator.

2.7. Determination of Na:
The sodium content was determined by Flame Photometric method.

2.8. Determination of chloride:
The chloride content was determined by Argentometric titration using K_2CrO_4 as an indicator.

3. Results and Discussion

3.1. Sampling Locations:
The geographical location of studied area is shown in Figure 1. Four sampling sites are chosen four our study i.e. Kailash temple, Nanhai, Poaia Ghat and behind Taj Mahal. Total 8 samples are collected from all sites in winter as well as summer season to compare the physico-chemical characteristics of the river water during different seasons. The water quality analysis has been carried out for different samples in winter as well as summer season by comparing their pH, DO, alkalinity, hardness, TDS, Ca, Na and Cl ion strength.

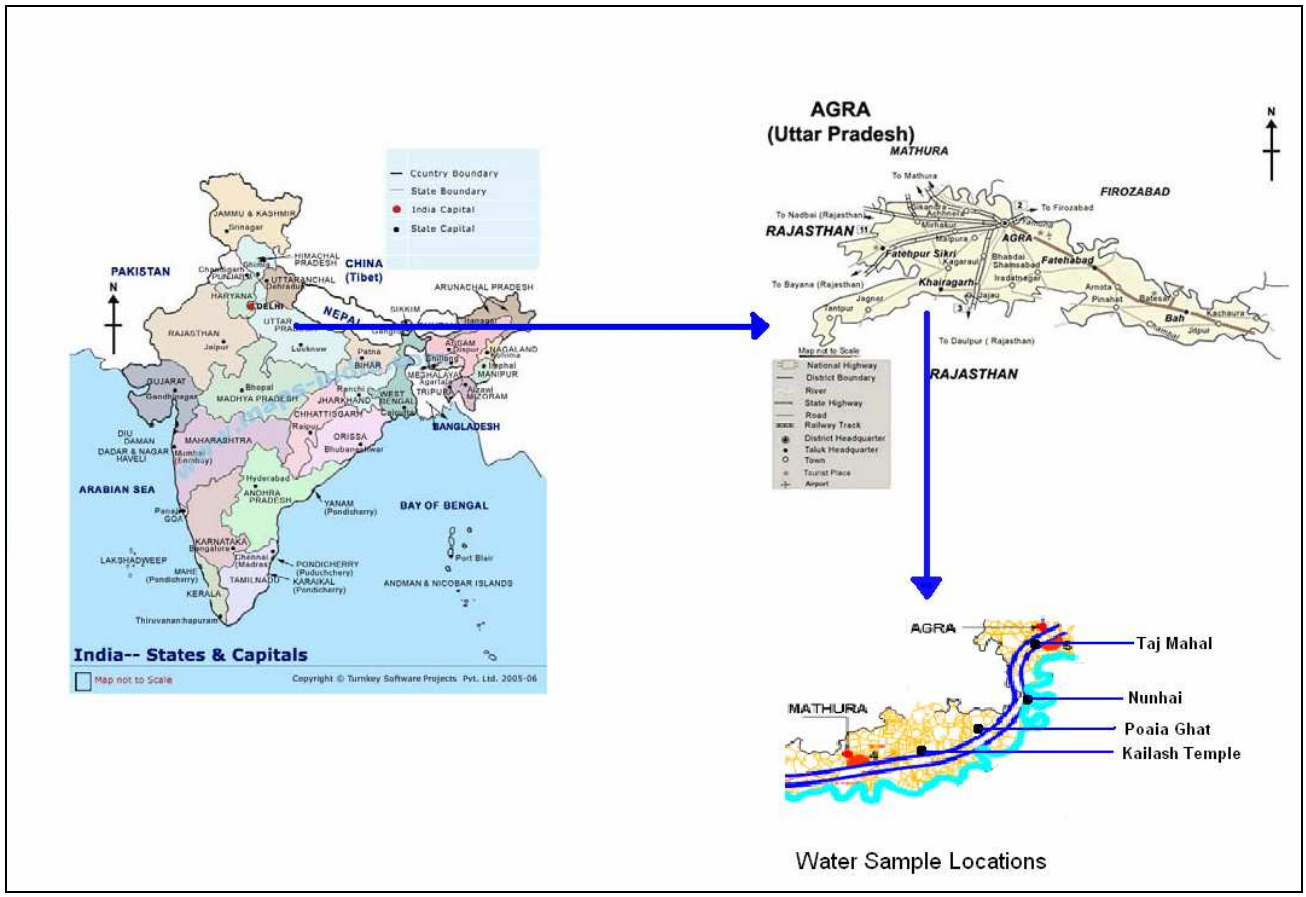

Fig. 1: Geographical location of studied area

3.2. Hydrogen ion concentration (pH):

pH varies from 6.2 to 8.5 in summer and 6.5 to 8.0 in winter. WHO has recommended maximum permissible limit of pH from 6.5 to 9.2 [11]. The values are listed in Table 1. All the samples are showing pH value within the range (Figure 2), but Poaia Ghat is showing slightly low pH. The maximum pH is shown by Kailash Mandir which may be due to either industrial discharge or contributed by soil or by the formation of bicarbonates ions. The high pH values during summer may be due to high photosynthesis of micro and macro vegetation resulting in high production of free CO_2, shifting the equilibrium towards alkaline side [11].

Table1: Physico-chemical analysis of Yamuna water at Agra in Winter (W) and Summer (S) season at four different stations.

Sample	pH		DO (mg/L)		Alkalinity (mg/L)		Hardness (mg/L)		TDS (mg/L)		Calcium (Ca) (mg/L)		Sodium(Na) (mg/L)		Chloride (Cl) (mg/L)	
	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W
1	8.5	8.0	5.5	6.0	156	230	156	230	178	210	65	72	08	16	09	28
2	6.2	6.0	8.2	8.5	212	345	210	367	180	254	88	79	22	49	17	38
3	8.9	7.7	8.0	8.9	250	300	250	279	200	260	84	71	17	40	21	42
4	6.7	6.5	6.5	7.0	200	295	198	235	191	280	69	73	11	35	22	35

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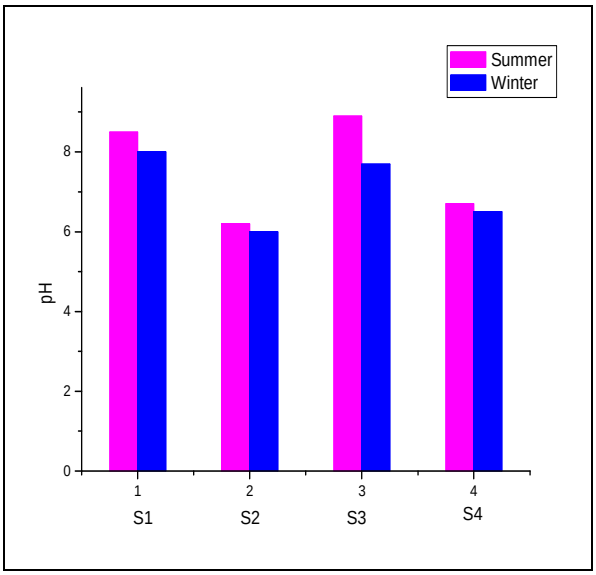

Fig. 2: A plot showing pH variation of water Summer and Winter

3.3. Dissolved Oxygen (DO):

The availability of dissolved oxygen (DO) in river depends on rate and period of photosynthesis, its consumption by aquatic flora, fauna and microorganisms, water temperature etc. DO vary from 5.5 to 8.2 mg/l in summer and 7.0 to 8.9 in winter (Figure 3). According to USPH standard DO values varies from 4.0 – 6.0 mg/l. So, the whole river water is in range in standard value. Value of DO increased in winter due to circulation of cold water as well as high solubility of oxygen at low temperature [12].

3.4. Alkalinity:

Alkalinity of water samples varies from 156 to 210 mg/l in summer and 230 to 345 mg/l in winter season (Figure 4). Alkalinity of the river water was more in winter when the temperature was lower. The higher values of alkalinity during winter indicate greater ability of the river water to support algal growth and other aquatic life in this season.

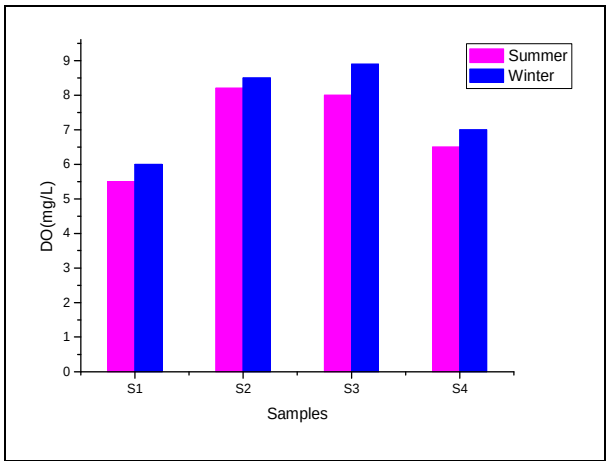

Fig. 3: A plot showing variation of Dissolved samples in Oxygen of water samples in Summer and Winter

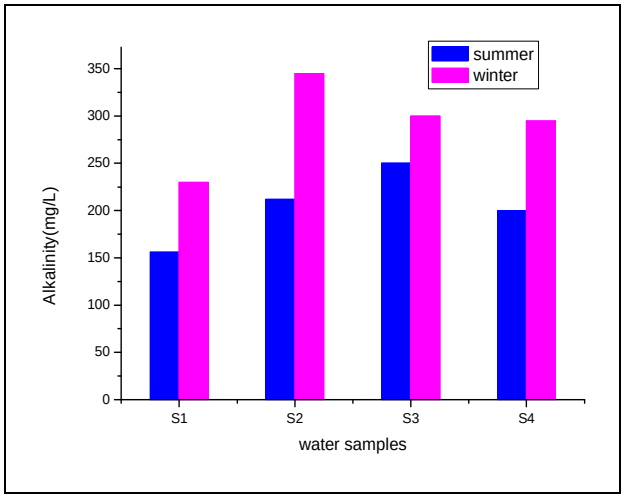

Fig. 4: A plot showing Alkalinity variation of samples in Summer and Winter

3.5. Total Hardness:

Total hardness was found to be in the range from 156 to 250 ppm in summer and 230 to 345 in winter (Figure 5). Water with 50 ppm of hardness is considered to be soft wheras hardness of 300 ppm is however, permissible for domestic use. Harness of Kailash Mandir water sample is lowest so, it is more suitable for drinking purposes. The lowest hardness of this region is observed to be lowest which may be due to the distance from the industrial area of Agra city.

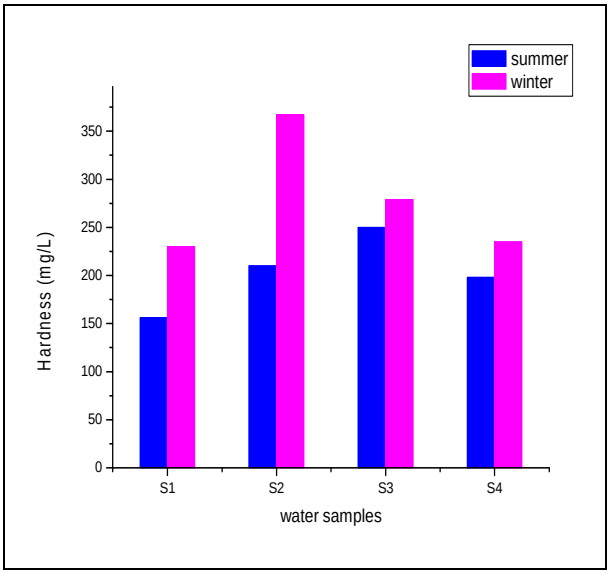

Fig. 5: A plot showing Hardness of water in Summer and Winter

3.6. Total Dissolved Solid (TDS):

The TDS value varies from 178 mg/l to 200 mg/l in summer and 210 mg/l to 280 mg/l in winter (Figure 6). The TDS value is found to be greater in Nunhai nad Taj region, which may be due to the drainage of industrial wastes in this area. The TDS concentration was again found to be more in summer, which may be attributable to greater solubility of ions at higher temperature. Excess of Cl- in inland water are usually taken as index of pollution. The sewage water and industrial effluents are rich in Cl- and hence the discharge of these wastes result in high chloride levels in fresh waters19. During summer, the Cl- content in Kailsh mandir region is quite low indicating cleaner water.

3.7. Calcium, Sodium and Chloride ion concentration:

The concentration of Ca varies from 65 to 88 mg/l in summer and 71 to 79 mg/l in winter (Figure 7), Na varies from 8 to 22 mg/l in summer and 16 to 49 mg/l in winter (Figure 8), whereas the concentration of Cl^- varies from 9 to 22 mg/l in summer and 28 to 42 mg/l in winter (Figure 9). There is indication of greater precipitation of Ca^{+2} in the form of $CaCO_3$, in the Poaia ghat and Nunhai zone, which is also shown by greater hardness of the waters in this region.

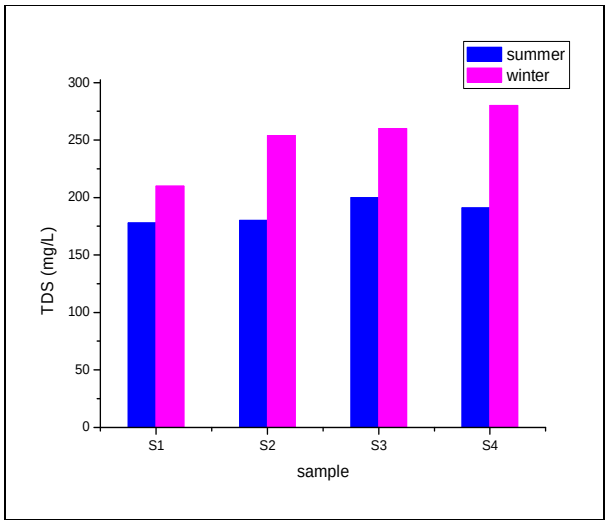

Fig. 6: A plot showing TDS of water samples in and Winter

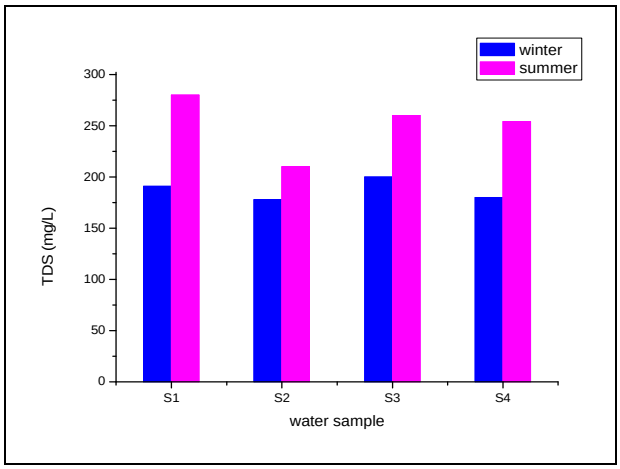

Fig. 7: A plot showing variation of calcium in Summer and Winter

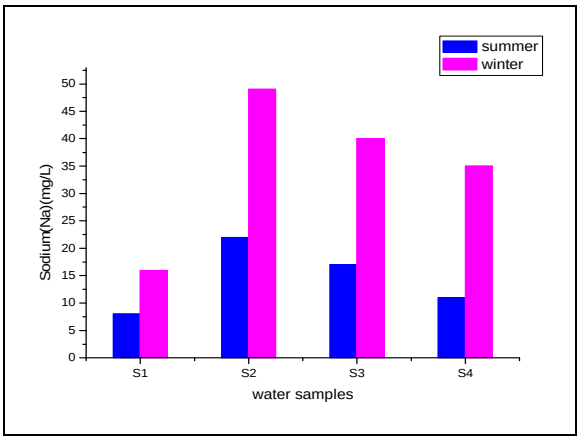

Fig. 8: A plot showing variation of Sodium ion conc. samples in Summer and Winter

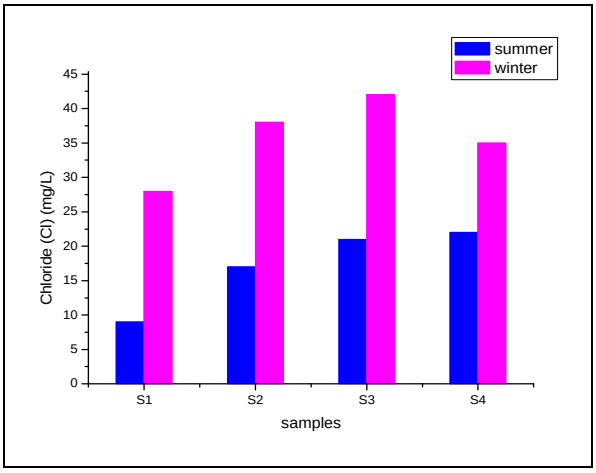

Fig. 9: A plot showing variation of chloride of water conc.of water samples in Summer and Winter

Conclusion

A comparative study of water samples of Yamuna river at four different zone for both seasons winter as well as summer season carried out by taking certain important parameters like pH, total dissolved solid, alkalinity, dissolved oxygen, chloride, sodium, and Calcium. The physico-chemical analysis of water samples concluded that the water quality of these areas is acceptable for drinking as well as for other purposes. But still a few parameters need to be close attention before using such as TDS, DO, hardness and alkalinity. The study reveled that during winter season the quality of water is more suitable for drinking as well as other domestic purposes.

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