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# Assessment of Physicochemical Properties of Water Samples

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**ABSTRACT**

**Water is life and abundant on earth but is not safe for human consumption due to anthropogenic activities and puts people at risk of developing waterborne diseases. There are physical and chemical parameters of water that must be checked regularly and compared to the guidelines provided to determine whether it is safe for human consumption. In the current study, water samples were collected from different locations at Sharda University, Greater Noida, and standard tests were carried out to analyze their physicochemical parameters, including temperature, odour, taste, colour, pH, total dissolved solids, electrical conductivity, turbidity, hardness, alkalinity, and chloride content to assess the quality of the water. Our results demonstrated that drinking water collected from different sites was more suitable for human consumption than groundwater.**

***Keywords-*** Water samples, Physico-chemical analysis, TDS, hardness, pH, Sharda University, Greater Noida.

## I. INTRODUCTION

The presence of water on our planet is a mercy given by God. Earth is the only planet filled with 70% of water, only 2% of which is fresh or drinkable, while the remaining 98% is salty. Sadly, our little fresh water is not readily available for consumption as it is polluted by anthropogenic activities such as untreated sewage water in freshwater bodies, overuse of metal-based fertilizers, etc. When consumed, this polluted water leads to the development of different waterborne diseases that affect the health of humans and other organisms that depend on water. Polluted water is also destroying aquatic life. Increased water pollution causes the water's Biological Oxygen Demand (BOD) value to increase, which lowers the amount of dissolved oxygen in the water. As a result, aquatic life will not receive enough oxygen to live if the amount of dissolved oxygen in the water declines. Water

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contamination is a factor in the decline of aquatic life, which is also a food source for most people.[1]

Many minerals taken through the water, like sodium, potassium, chlorine, etc., are important for human health. Drinking water rich in these minerals would help people reap their benefits such as strengthened teeth, glowing skin, and many more. Therefore, drinking clear, clean water with the recommended amount of minerals is very important. These days, many people make use of the Reverse Osmosis (R.O.) systems to purify water for consumption as it is the most reliable method to get clean drinking water. However, R.O. water may not be the most suitable. According to the World Health Organisation (WHO), the human body can easily absorb 600 ppm (parts per million) of Total Dissolved Solids (TDS) present in water, but R.O. water only has 50-60 ppm TDS. This will lead to health issues in the long run. The recommended TDS in drinking water should not exceed 100 ppm. The other characteristics of suitable drinking water are odourless, pH of 7, low alkalinity, low BOD value, and no heavy metals present. The human body cannot easily absorb heavy metals, so they accumulate and adversely affect human health. In order to identify the most suitable water for human consumption, we have conducted a physicochemical analysis of water samples collected from different sites in our locality.[2]

## II. PHYSICO-CHEMICAL PARAMETERS

***2.1. Colour***

The colour of the water should be transparent. It shows that the water is clean and there is not much bacterial growth. The colour of the water is the normal parameter by which we decide whether the water is clean or not. Today there are very few water bodies left with transparent water.

***2.2. Odour***

Water with an unpleasant odour may not necessarily house harmful substances but may have a high level of biological activity. This could be a result of water treatment and distribution inadequacies. This could also have a negative impact on society and cause panic, economic loss, and psychological fear regarding water safety.[3]

***2.3. Temperature***

The temperature of the water is also an important parameter that can be used to judge its physical and chemical properties. At a temperature of more than 100 ℃, the water is in the vapor phase while the water solidifies and forms ice at temperatures below 0 ℃. Therefore, the right temperature of water for use is between 0 to 100 ℃. If the water is used for drinking purposes, the temperature should be around room temperature. This can be increased or decreased according to one's preference. The thermal capacity, density, specific weight, viscosity, surface tension, specific conductivity, salinity, solubility of dissolved gases, and other significant physical properties and features of water are all influenced by its temperature. The rate of chemical and biological reactions accelerates as the temperature rises. The standard assumption is that reaction rates will double for every 10 °C increase in temperature. Water in rivers and streams around the world ranges in temperature from 0 to 35 °C [4].

***2.4. pH***

The pH scale, which ranges from 0–14, is a measure of acidity and alkalinity. The mathematical representation of pH is given as $pH = -log_{10}[H^+]$, where $[H^+]$ is the concentration of hydrogen ions in Molar (M). It can be used to assess the corrosive nature of water. Most biochemical processes are affected by pH such as enzyme activity, solubilization, and uptake of certain ions. A water body is said to be alkaline if it has a pH as high as 9.0 for prolonged periods of time. Highly alkaline water would lead to decreased reproduction, reduction in biodiversity, retarded growth, and damage to body organs such as the eyes [5]. The recommended pH of drinking water should be in the range of 6.5–8.5. Suppose the pH of water falls below 6.5. In that case, the water is too acidic for consumption and would lead to tooth decay, hindered calcium ion absorption, bone loss, and an accumulation of heavy metals.

***2.5. Electrical Conductivity (EC)***

Electrical conductivity (EC), denoted by σ, expresses the ability of a substance to conduct electricity [6]. The concentration level, mobility, valence, and relative concentration of ions, in addition to the water temperature, are all variables that influence EC. In general, a high EC shows that the water carries more electrolytes. Water with a high EC is not adequate for irrigation and is thus a significant indicator of irrigation water quality. EC is also the inverse of electrical resistivity [7].

***2.6. Alkalinity***

Alkalinity is a water body's capacity to function as a buffer. It gauges a water body's capability to balance out acids and bases as well as maintain a relatively stable pH. Alkalinity is due to the presence of bicarbonates, carbonates, and hydroxides that react with the hydrogen $(H^+)$ ions in the water and raise its pH, making it more basic. A water body with high alkalinity will be able to neutralize acidic pollution from rain or basic inputs from sewerage. Phosphates and silicates are commonly found in organic supplies in significant concentrations in the home. These ionic compounds are used in a range of water treatment processes. Most water supplies benefit from moderate alkalinity as it controls the corrosive effects of acidity. However, very high alkalinity can be problematic. [8]

Sulfuric acid and a digital titrator are usually employed for measuring alkalinity. Sulfuric acid is added in measured amounts to the water sample until the

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three main forms of alkalinity, that is bicarbonate, carbonate, and hydroxide, are converted to carbonic acid. High alkalinity is associated with high TDS. TDS levels in secondary drinking water are set at 500 ppm. The following is the classification system for alkalinity:
Low Alkalinity: < 20 ppm of $CaCO_3$
Moderate Alkalinity: 20 to 160 ppm of $CaCO_3$
High Alkalinity: > 160 ppm of $CaCO_3$

***2.7. Total Dissolved Solids (TDS)***

The total dissolved solids (TDS) in water are inorganic salts such as carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, etc., of calcium, magnesium, manganese, sodium, potassium, and other cations. It is an important parameter that is used to assess the quality of drinking water. Water containing large amounts of inorganic salts often has taste and hardness problems. For example, water containing a high amount of sodium chloride (NaCl) is not suitable for drinking. According to WHO, the recommended TDS range for drinking water is 100–600 ppm.[9]

***2.8. Turbidity***

The relative clarity of a liquid is assessed by its turbidity. Turbidity is an optical property of water as it determines the amount of light dispersed by the materials in the water when a light source is shone through it. Turbidity rises linearly with the intensity of dispersed light. Inorganic and organic particles as fine as clay, silt, algae, dissolved coloured organic compounds, plankton, and other microscopic creatures can all contribute to the turbidity of water.[1]

***2.9. Hardness***

The hardness of water is expressed in terms of milligrams of Calcium Carbonate ($CaCO_3$) per liter mg/L, also known as ppm. Calcium carbonate concentrations in water range from 60 ppm to 180 ppm, with 60 ppm to 120 ppm being moderately hard, 120 ppm to 180 ppm being hard, and 180 ppm being very hard. Hard Water (HW) needs considerably extra soap to make lather than plain water, so it's the traditional indication of water's capacity to react with soap. HW frequently causes a noticeable deposit of precipitate such as salts, soaps, or insoluble metals in containers, like that of a "bathtub ring". Plenty of other dissolved polyvalent metallic ions, mainly calcium and magnesium cations, but also including aluminium, barium, iron, manganese, strontium, and zinc, all contribute to the hardness of the water. Dissolved polyvalent metallic ions from sedimentary rocks, seepage, and runoff from soils are the primary natural sources of hardness in water. The two main ions, calcium and magnesium, are present in many sedimentary rocks, with limestone and chalk being the most abundant. They occur frequently as vital mineral components in the diet as well.

***2.10. Chlorides***

Chlorides occur naturally as sodium chloride, potassium chloride, and calcium chloride. These salts are soluble in both cold and hot water. Chlorides leach into soil and water by weathering rocks containing chloride ions and can easily be carried to water bodies. Anthropogenic activities also contribute to the chloride content in the environment. Some sources include inorganic fertilizers, landfill leachates, septic tank effluents, animal feeds, industrial effluents, and irrigation drainage. Using chlorine to treat water also contributes to the chloride content in the water. At least 9 mg of chloride per kilogram of body mass is recommended for adults, while that for children up to 18 years of age is 45 mg daily. Water is, therefore, a good source of chloride provided that the chloride content in the water does not exceed the recommended amount, as it would lead to chloride toxicity and health issues in humans. High chloride content increases the EC of the water, making it corrosive, and this would damage water pipes. A chloride concentration in water greater than 250 ppm affects the taste of drinking water.[10]

## III. MATERIALS AND METHODS

The present study was carried out for five different areas, of which three sites are for groundwater samples and two for drinking R.O. water samples. These sites were located in Sharda University Campus, Greater Noida, U.P. In the present study, the sampling was done during morning hours, and all water samples were collected in polyethylene bottles. The water temperature, colour, odour, and taste were analyzed immediately after the collection, whereas the remaining parameters were analyzed in the laboratory. The study was carried out for a period of one week (March 2023). The collected water samples were brought to the laboratory, and relevant analysis was performed.

pH was determined using a pH meter, and turbidity was determined using a Nephelo turbidity meter. TDS and electrical conductivity were determined using a TDS meter and electrical conductivity meter, respectively. The remaining parameters of the water samples were determined by titration. Hardness was determined by complexometric titration with standard ethylene diamine tetraacetate (EDTA) solution using erichrome black T (EBT) as an indicator. Alkalinity was determined by titration with standard hydrochloric acid, phenolphthalein, and methyl orange as indicators. Chloride content was determined by argentometric titration with standard silver nitrate solution and potassium chromate solution as indicators.

## IV. RESULTS AND DISCUSSION

Standard procedures were followed to determine the physicochemical parameters of the water samples, and calculations were done where necessary. The results of these procedures are presented in Table 1.

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**Table 1: Results of the Physico-Chemical Analysis of the Collected Water Samples**

| S No. | Parameters | Ground Water 1 | Ground Water 2 | Ground Water 3 | Drinking Water 1 (RO Water) | Drinking Water 2 (RO Water) |
|---|---|---|---|---|---|---|
| 1. | Temperature (℃) | 25 | 25 | 25 | 25 | 25 |
| 2. | Odour | Odourless | Odourless | Odourless | Odourless | Odourless |
| 3. | Colour | Colourless | Colourless | Colourless | Colourless | Colourless |
| 4. | Taste | Tasteless | Tasteless | Tasteless | Tasteless | Tasteless |
| 5. | pH | 7.8 | 7.5 | 7.3 | 7.4 | 7.8 |
| 6. | TDS (ppm) | 654 | 665 | 921 | 69 | 66 |
| 7. | EC (us/cm) | 1308 | 1330 | 1842 | 150 | 132 |
| 8. | Turbidity (NTU) | 29 | 29 | 39 | 39 | 31 |
| 9. | Hardness (ppm) | 41.25 | 41.25 | 73.33 | 10 | 10 |
| 10. | Alkalinity (ppm) | 575 $HCO_3^-$ | 700 $HCO_3^-$ | 425 $HCO_3^-$; 100 $CO_3^{2-}$ | 100 $HCO_3^-$ | 75 $HCO_3^-$ |
| 11. | Chloride (ppm) | 177.5 | 156.2 | 24.8 | 28.4 | 58.6 |

All the water samples had the same physical properties as they were all 25 ℃, odorless, colourless, and tasteless. The pH of the water samples was nearly similar and around neutral pH, with only slight differences. According to WHO, the pH range for drinking water is between 6.5 and 9.5. Water is referred to as acidic if the pH is below 6.5 and has the tendency to corrode pipelines and hand pumps. Alkaline water has a pH above 8.5 and tends to taste bitter or carbonated [14]. The pH levels in the current study were measured within the WHO-recommended acceptable range for drinking water.

The total dissolved solids (TDS) were higher in the groundwater samples, ranging from 654 to 921 ppm while the drinking water samples had TDS values of 66 and 69 ppm. Drinking water with high TDS concentrations or a limit value of more than 300 ppm is not advisable. TDS must be within a range of 500 ppm. As shown in Table 1, the TDS concentration in the examined water samples in the current study ranged from 66 to 921 ppm. Groundwater samples had high TDS readings that exceeded the allowable limit. For R.O. drinking water samples, the overall TDS values were found to be within the desired range (500 mg/l). Therefore, TDS levels in drinking water are safe (Tables 1 and 2). High TDS impacts water's flavour, hardness, and corrosion properties, which impact the osmoregulation of freshwater organisms [15]. The results show a directly proportional relationship between TDS and electrical conductivity (EC) – the higher the TDS, the higher the EC. The groundwater samples had higher EC compared to the drinking water.

The turbidity of the water samples was in close range. The hardness of water, as a result of the presence of calcium ions, was higher in the groundwater samples. The drinking water samples had the same hardness. When alkalinity was determined, only groundwater sample 3 had carbonate ions ($CO_3^{2-}$) present, while the remaining samples did not. Hydrogen carbonate ions ($HCO_3^-$) were present in all the samples, with the highest concentration present in groundwater sample 2, with groundwater sample 1 in second place, and groundwater sample 3 in third place. Drinking water samples had lower alkalinity. The chloride content of the first two groundwater samples is quite high, while groundwater sample 3 has a lower reading closer to that of the drinking water samples.

According to the WHO, the maximum permissible limit for total hardness is 600 ppm, whereas 200 ppm is a desirable limit. The range of water samples with hardness measurements is 10 to 74 ppm, which is below the WHO-recommended desirable level of 200 ppm.

The majority of the causes of chloride concentrations countrywide are anthropogenic or human-caused sources. When sewage water is mixed with a water source, the water sample will have a significant concentration of chloride ions. It denotes incorrect sewage disposal, solid and animal waste dumping close to a water source, tainted residential effluents, connections between septic tanks and underground subsurface water, etc. The main reason for the elevated chloride level is human activity. Chloride levels in drinking water are permitted to range between 250 and 1000 ppm [16]. The local rock permeability and soil porosity both have a significant impact on how much chloride is present. All sampling sites in the current investigation had chloride readings that ranged between 2.2 and 14 mg/L. according to Table 4.

The World Health Organization (WHO) and Environmental Protection Agency (EPA) have provided recommended readings and values of the physicochemical parameters of water included in this study and other parameters, which are presented in Table

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2. Indian standard is also included. These were compared to the results we obtained in our analysis. By comparing our results with the standard guidelines, both drinking water samples meet the WHO, EPA, and Indian standards. The groundwater samples failed to meet these guidelines as they had higher alkalinity than recommended by the Indian standard. The source of occurrence and potential health effects of the parameters are summarized in Table 3.

**Table 2: Recommended Standard Physico-chemical Parameters of Water According to WHO, EPA, and Indian Guidelines [11, 12, 13]**

| Sr. No. | Parameters | Technique Used | WHO Standard | Indian Standard | EPA Guidelines |
|---|---|---|---|---|---|
| 1. | Temperature (°C) | Thermometer | - | - | - |
| 2. | Colour | Visual | - | 5 Hazen units | - |
| 3. | Odour | Physiological sense | Acceptable | Acceptable | - |
| 4. | pH | pH meter | 6.5-9.5 | 6.5-9.5 | 6.5-9.5 |
| 5. | Electrical Conductivity | Conductivity meter | - | - | 2500 us/cm |
| 6. | Total Dissolved Solids (TDS) | | 500 ppm | | 500 ppm |
| 7. | Alkalinity | Acid-Base titration | - | 200ppm | - |
| 8. | Acidity | Acid-Base titration | - | - | - |
| 9. | Bicarbonate | Titration | - | - | - |
| 10. | Carbonate | Titration | - | - | - |
| 11. | Chloride | Argentometric titration | 250ppm | 250ppm | 250ppm |
| 12. | Turbidity | | | | |
| 13. | Total Hardness | Complexometric titration | 200ppm | 300ppm | <200ppm |

**Table 3: Different Analytical Water Quality Parameters Used for Testing of Quality of Water and their Source of Occurrence and Potential Health Effects [12]**

| S No | Parameter | Source of Occurrence | Potential Health Effect |
|---|---|---|---|
| 1 | Turbidity | Soil run-off | Water with a high level of turbidity is associated with disease-causing bacteria. |
| 2 | Colour | Dissolved salts | - |
| 3 | Odour | Biological degradation | Bad odour is unpleasant |
| 4 | Electrical conductivity | Dissolved solids | High conductivity increases the corrosive nature of water |
| 5 | pH | pH changes due to different dissolved gases and solids in the water | Affects mucous membranes, bitter taste; corrosion |
| 6 | Hardness | Presence of Calcium ($Ca^{2+}$) and Magnesium ($Mg^{2+}$) ions in the water | Poor lathering with soap; deterioration of the quality of clothes; scale forming |
| 7 | Alkalinity | Due to dissolved carbon dioxide gas | Embrittlement of boiler steel. Boiled rice turns yellowish. |
| 8 | TDS | Dissolved salts | Undesirable taste; gastro-intestinal irritation; corrosion or incrustation |
| 9 | Chloride | Water additives are used to control microbes and disinfect them. | Eye/nose irritation; stomach discomfort. Increase the corrosive character of water. |

## V. CONCLUSION

This study was undertaken to determine the quality of water samples collected by analyzing their physicochemical parameters. The findings showed that groundwater is not suitable for human consumption as it has an alkalinity higher than recommended by Indian standards. This is a problem as consumption of this water would lead to health issues. Drinking R.O. water is more suitable for human consumption, but it is not

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perfect as it has a lower TDS than recommended. It has a lower amount of minerals present, but this is not a huge problem as the minerals can be taken from other sources, such as food.

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