**Assessment of physiochemical water quality parameters in and around Warangal district of Telangana state**

**ABSTRACT**

The relationship between humans and the environment is symbolic, and it is essential to maintain a balance between the two. As the population continues to grow, the demand for limited resources increases, leading to environmental contamination. Contaminated water sources can result in severe waterborne diseases that affect human health. This research was conducted in and around Telangana state to evaluate the quality of water from various sources. A total of 100 samples were collected and assessed for several parameters, including pH, temperature, electrical conductivity, total dissolved solids (TDS), salinity, and redox potential. The results revealed significant variability in water quality. The pH values ranged from 4.82 to 9.28, indicating both acidic and alkaline conditions. Conductivity values varied from 48 ms to 940 ms, reflecting different levels of dissolved ions. TDS levels ranged from 48 ppm to 1470 ppm, with several samples exceeding the recommended limits for drinking water. Salinity and hardness levels also varied widely, with some samples showing high salt content that could limit their suitability for consumption and agriculture. These findings highlight the importance of regular monitoring and targeted water treatment strategies to ensure the safety and usability of bore water resources in the studied regions.

***Keywords:*** *Water quality, pH, Electrical Conductivity, Total Dissolved solids*

**INTRODUCTION:**

Water is essential for life and influences both climate and landscape. It is one of the most essential compounds and has a profound impact on life. Water quality is typically defined by its physical, chemical and biological properties. The rapid pace of industrialization, along with the indiscriminate use of chemical fertilizers and pesticides in agriculture, is leading to significant pollution in aquatic environments. This pollution results in the degradation of water quality and the decline of aquatic life. India is facing a considerable challenge regarding natural resource scarcity, particularly water, due to population growth and economic development . Freshwater bodies worldwide are becoming increasingly polluted, which reduces the availability of potable water. All forms of life rely on water, which exists in various natural forms, including oceans, rivers, lakes, clouds, rain, snow, and fog. However, from a chemical standpoint, completely pure water does not remain in its pure state for any significant duration in nature. Overall, water is vital in shaping the land and regulating the climate, profoundly influencing life (Gorde and Jadhav, 2013). Groundwater is utilized globally for domestic and industrial water supplies, as well as for irrigation. In recent decades, the demand for freshwater has surged dramatically due to rapid population growth and accelerated industrialization. The World Health Organization (WHO) estimates that approximately 80% of all human diseases are linked to water. (Kavitha and Elangovan,2010)

As urbanization increases, surface water is becoming more contaminated, which requires stricter treatment processes to ensure it is safe for drinking. This situation has created a growing need to identify additional water sources to meet rising demand. Groundwater, known for being safe and potable, is often suitable for drinking and other essential human needs. Therefore, it is crucial to study the physico-chemical characteristics of groundwater to assess its suitability for drinking and other beneficial uses. (Dohare *et al.,* 2014)

**Kumar and Kumar (2013) conducted an experimental study on the physico-chemical properties of groundwater in Uttar Pradesh, India. The research aimed to assess the environmental impact of granite mines located in Goramachia, Jhansi, by determining the level of physicochemical contamination in the groundwater. Samples were collected from six different sites, including both mining areas and urban regions, with three samples taken at various distances from the mine, which is located 10 km from Jhansi city. The study analyzed several physicochemical parameters, including pH, dissolved oxygen (D.O.), electrical conductivity (E.C.) and total dissolved solids (T.D.S.).**

**MATERIAL AND METHODS**:

 **Sampling sites:**

A total of 100 water samples, each with a capacity of 1–2 liters, were randomly collected from different sources like tap water and bore wells across the poultry farms in and around the Warangal district of Telangana state. The samples were collected for a period of 6 months from September 2023- February 2024.

**Processing of samples:**

Water samples were collected in 1-liter stoppered polythene bottles. Each bottle was first cleaned with diluted hydrochloric acid, then freshwater, and finally, distilled water was added. The bottles were then tightly sealed, neatly labelled, and transported to the laboratory for analysis.

The following parameters were analyzed using a digital water analysis kit (Fig 1)

**pH**: pH is a measure of a solution's acidity in water. The pH scale typically ranges from 0 to 14 and operates on a logarithmic scale, not a linear one. For instance, a solution with a pH of 6 is ten times more acidic than one with a pH of 7. Pure water is regarded as neutral, having a pH of 7. Water with a pH below 7.0 is classified as acidic, while water with a pH above 7.0 is considered basic or alkaline.

**Temperature**: The temperature is an important factor affecting the growth of microorganisms and redox reactions affecting the ionic distribution. It is measured using the thermometer and is expressed on a scale ranging from 0-100ºC

**Electrical Conductivity**: It is a measure of an aqueous solution's ability to carry an electrical current. It depends on the presence of ions (cations and anions) in the water, their total concentration, mobility and temperature of the water. The results are expressed in µScm-1.

**Total Dissolved Solids**: **The difference between total solids and suspended solids helps to determine the number of solids small enough to pass through a filter (filterable solids). This can be measured using filtrate obtained through a specific procedure. Additionally, in a water sample, the conductivity measurement can offer an indirect estimation of total dissolved solids (a component of total solids). The acceptable limit for total dissolved solids in drinking water, as per the Indian Standard IS: 10500-2012, is 500 mg/L, while the permissible limit is 2000 mg/L.**

**Salinity:** Salinity refers to the concentration of dissolved salts in water. It is typically measured in parts per thousand (ppt) or practical salinity units (PSU). For seawater, the average salinity is about 35 ppt or 35 PSU. This means that for every liter of seawater, there are about 35 grams of dissolved salts. Salinity affects water density and circulation, which can influence ocean currents and weather patterns. It also impacts marine life, as different species are adapted to specific salinity levels. In freshwater environments like rivers and lakes, salinity is usually much lower, often less than 0.5 ppt.

**Redox potential:** Redox reactions play an important role in the chemistry of natural water systems and influence the mobility and availability of many nutrients of biological importance as well as inorganic and organic species. Redox reactions in natural aqueous systems have been the focus of many geochemical studies including ground water contamination. The extent of redox reactions is defined and measured by a potential. An electrode potential measurement, most commonly carried out with a Pt electrode, does not respond to the activity of aqueous electrons in solution but rather to electron transfer between redox sensitive species. (Arnorsson, 2003).

**Hardness:** Hardness of water is the concentration of dissolved minerals, primarily calcium (Ca²⁺) and magnesium (Mg²⁺) ions, in the water. These minerals can form scale deposits in pipes, appliances and water systems. Hard water is typically measured in terms of calcium carbonate (CaCO₃) equivalents.



**Fig 1: Digital water analyzer kit**

Data collected for all the water quality parameters were arranged and was subjected to descriptive statistical analysis. Correlation analysis was done among different water quality parameters and Karl Pearson's Coefficient of Correlation (r) were obtained.

**RESULTS AND DISCUSSION**

The samples were analyzed, and a summary of the results is presented in Table 1 and Figure 2.

**pH:**

The average pH level was 6.62, which indicates that the water is slightly acidic but close to neutral. With a standard deviation of 1.07, this suggests there are noticeable fluctuations in acidity or alkalinity among the samples. Most samples with pH values below 7 were acidic, likely due to contamination from industrial waste or agricultural runoff. Conversely, samples with pH values above 7 were alkaline, probably because of the presence of carbonate and bicarbonate ions. These variations indicate that water quality across the sampled locations is affected by both natural factors and human activities.

 **Temperature**

The average water temperature is 27.13°C, with a standard deviation of 2.96°C, indicating moderate variations. Higher temperatures were recorded in samples taken from shallow sources, likely due to the influence of surrounding environmental conditions. Temperature is a crucial factor in regulating the solubility of gases and the metabolic rates of aquatic organisms, making it an essential parameter for assessing water quality.

 **Electrical Conductivity (EC)**

Conductivity measures the ability of water to conduct electricity, which is influenced by the presence of dissolved ions. The average conductivity value is 476.68 µS/cm, but a high standard deviation of 272.44 µS/cm indicates significant variability in ion concentration. Higher conductivity values suggest a greater concentration of dissolved salts, which can result from natural mineral deposits or pollution from agricultural runoff. Conductivity is an important indicator of water’s ability to conduct electricity, and it directly correlates with the total ionic content in the water. (Satheesh,2016)

 **Total Dissolved Solids (TDS)**

The average concentration of Total Dissolved Solids (TDS) in the water is 402.08 mg/L, indicating the amount of dissolved substances present. However, the standard deviation is 329.49 mg/L, which shows significant variation in the dissolved content across the samples. Several samples in this study exceeded the recommended limit, suggesting that the water may not be safe for direct consumption without treatment. High TDS levels are often linked to the presence of minerals, salts, and organic matter, which can impact the taste, hardness, and overall potability of the water.

 **Salinity**

The average salinity of the water is 0.52 ppt, indicating that the salt content is relatively low. A standard deviation of 0.41 ppt suggests moderate fluctuations in salinity levels. Higher salinity was observed in areas near industrial zones or agricultural fields, likely due to runoff that increases the salt content in the water. Salinity is an important factor in assessing the suitability of water for agricultural and drinking purposes, as elevated salinity can negatively impact crop growth and human health. (Corwin and Yemoto, 2020)

 **Redox Potential (mV)**

The Redox Potential (ORP), which indicates the oxidation-reduction characteristics of water, has an average value of 112.6 mV. A standard deviation of 46.50 mV suggests moderate variation in oxidation levels. The differences in mV values across the samples highlight variations in the oxidative or reductive environments of the water sources. These variations may be influenced by factors such as organic matter, microbial activity, and chemical contaminants.

**Hardness**

Water hardness, which indicates the concentration of calcium and magnesium, has an average value of 248.71 mg/L. The high standard deviation of 177.59 mg/L points to significant variability in water hardness. Some samples are classified as soft (0–60 mg/L) and moderately hard (61–120 mg/L), while many samples exceed 180 mg/L, categorizing them as very hard . Overall, the data demonstrates considerable variation in water hardness across different samples.

**Discussion**

The recorded mean temperature is 27.13°C, while the mean pH is 6.6174, indicating that the water is slightly acidic to neutral. Mohammad et al. (2017) studied groundwater in Khammam, Telangana, and found pH levels ranging from 6.5 to 8.5, which aligns with our findings of slightly acidic to neutral pH. However, Sunitha *et al.* (2005) reported that the groundwater exhibited alkaline conditions, with pH values ranging from 7.8 to 8.7, suggesting a tendency towards oxidizing conditions that contrast with our results.

The conductivity measured was 476.68 µS/cm, and the total dissolved solids (TDS) were 402.08 mg/L, indicating the presence of dissolved ions. Rajkumar et al. (2024), in their study conducted in the Medchal-Malkajgiri District of Telangana, observed higher values of TDS and electrical conductivity (EC), suggesting that agricultural activities may be negatively impacting groundwater quality. This contrasts with our findings. On the other hand, Satyanarayana *et al.* (2016) reported EC values that align with our current results.

The salinity recorded at 0.51866 ppt indicates a moderate salt content. According to Adimalla and Venkatayogi (2018), research in semi-arid regions like Basara in Telangana has shown groundwater salinity levels ranging from 0.2 to 1.2 ppt, which suggests that our findings fall within the expected range for such areas. Additionally, Chanapathi *et al*. (2019) evaluated water resources in the Warangal district and emphasized the importance of salinity for irrigation purposes.

The redox potential of 112.6 mV indicates the oxidation-reduction balance in the water. Additionally, the hardness measured at 248.71 mg/L suggests that the water is predominantly hard. Sunitha *et al*. (2005) reported total hardness values ranging from 23 to 184 mg/L, with a median value of 92 mg/L, indicating that the groundwater generally falls into the moderately hard category. Our sample's hardness level is higher than this median value. This variation in hardness may be attributed to differences in the dissolution of minerals, such as calcium and magnesium, from aquifer materials. Factors influencing this process include rock type, the residence time of the water, and recharge sources. Narsimha *et al*. (2018) reported total hardness values ranging from 80 to 720 mg/L, with a mean value of 294 mg/L. This finding indicates that groundwater in the MRB varies from moderately hard to very hard. The values observed in our sample fall within this reported range.

The standard deviation values indicate variability in the data, with Total Dissolved Solids (TDS) and hardness showing the highest deviations at 329.49 and 177.59, respectively. This suggests significant fluctuations between different samples. Çadraku *et al*. (2016) analysed water quality variations across various regions of the Blinaja catchment in Kosovo, which aligns with our findings.

According to Table 2, there is a weak positive correlation between temperature and both pH and conductivity. This implies that slight increases in temperature are associated with higher levels of pH and conductivity. Additionally, TDS demonstrates a moderate correlation with both conductivity and pH. Salinity shows a strong positive relationship with TDS, indicating that dissolved solids significantly contribute to salinity levels. There is also a strong positive correlation between conductivity and redox potential, suggesting that higher ion concentrations may influence oxidation-reduction reactions. In contrast, temperature has a weak negative correlation with redox potential, indicating that as temperature rises, the oxidation-reduction potential slightly decreases. Furthermore, there is no significant relationship between salinity and redox potential, as reflected by their near-zero correlation.

The study reveals substantial variability in water quality across the sampled locations, with several samples showing concerning levels of acidity, TDS, and salinity. These findings emphasize the necessity for regular monitoring and targeted water treatment strategies to ensure the safety and usability of water resources. The variation in physiochemical parameters suggests that both natural geological factors and human activities are contributing to the observed water quality issues. Addressing these challenges requires a comprehensive approach that includes pollution control, sustainable water management practices, and public awareness initiatives.

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **COMPONENT** | **TEMPERATURE** | **pH** | **CONDUCTIVITY** | **TDS** | **SALINITY** | **REDOX POTENTIAL** | **HARDNESS** |
| **MEAN** | 27.13 | 6.6174 | 476.68 | 402.08 | 0.51866 | 112.6 | 248.708 |
| **STANDARD DEVIATION** | 2.962680332 | 1.072214 | 272.4446336 | 329.4935 | 0.410799 | 46.50317682 | 177.592176 |
| **STANDARD ERROR** | 0.296268033 | 0.107221 | 27.24446336 | 32.94935 | 0.04108 | 4.650317682 | 17.7592176 |

 This study reveals significant variations in water quality throughout Warangal district of Telangana, highlighting important issues such as pH levels, total dissolved solids (TDS), and hardness that exceed permissible limits. Addressing these concerns requires a comprehensive approach that includes technological advancements, regulatory measures, and public awareness campaigns.

 **Table 1: Summary of water quality parameters**

**Fig 2: Graphical representation of results**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Temperature** | **pH** | **Conductivity** | **TDS** | **Salinity** | **Redox Potential** |
| **Temperature** | 1 |  |  |  |  |  |
| **pH** | 0.282\* | 1 |  |  |  |  |
| **Conductivity** | 0.343\* | 0.111 | 1 |  |  |  |
| **TDS** | 0.231 | 0.346\* | 0.407\*\* | 1 |  |  |
| **Salinity** | 0.168 | 0.040 | 0.232 | 0.627\*\* | 1 |  |
| **Redox Potential** | -0.123 | 0.053 | 0.614\*\* | 0.337\* | -0.003 | 1 |
| \*Correlation significant at 0.05 (2-tailed), \*\*Correlation significant at 0.01 (2-tailed). |

**Table 2: Correlation coefficients (r) of water quality parameters**

**CONCLUSION**

Water quality varies significantly among collected samples, with some sources showing unsafe levels of acidity, dissolved solids, and hardness. Factors like industrial waste and agricultural runoff contribute to these fluctuations, affecting both human health and farming. Regular monitoring, proper treatment and stricter pollution control are essential to safeguard water resources. Raising awareness among communities can further help in ensuring clean and safe water for future generations.

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