Comparative Study of PH Value, Alkalinity, Acidity, Hardness of Different Water Samples

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ABSTRACT

Water is a very important part of our life. It is one of precious gifts of nature. Water quality is important factor for human, animals and environmental sustainability. Studying pH value, alkalinity, acidity and hardness of different water samples. pH indicates the acid content of water. pH value of water indicates the hydrogen ion concentration in water and it is determined by pH meter while alkalinity and acidity determined by acid-base titration. Hardness of water is one of important parameter of water quality and it is determined by EDTA Complexometric titration method. Different water sources display distinct chemical characteristics. This investigatory project focuses on reviewing the pH, alkalinity, acidity, hardness of water collected from different sources using suitable indicators. The results obtained help in understanding water quality.

Keywords: Water quality, Hardness, PH value, Alkalinity, Acidity, Acid-base titration.

INTRODUCTION

Water is an indispensable resource essential for sustaining life and driving economic activities worldwide. Alkalinity of water refers to amount of acid consumed to neutralise a given water sample. We know that a sample has different capacities to react to addition of another substance.

Conducting a review study and analyze pH, alkalinity, acidity and hardness of water.

This study aim to provide a comprehensive review of pH-value, alkalinity, acidity and hardness in water sample. we endeavour address complex challenges posed by alkalinity, Acidity & hardness in water system. Water quality is an important factor that determines suitability for drinking and other domestic purposes.

Different sources of water, such as ground water, river water, pond water, lake water, tap water, RO water, and packaged drinking water, may have different chemical compositions due to variations in environmental factors, geological conditions, and dissolved minerals.

Various chemical parameters, pH, acidity, alkalinity, and hardness are important factors used for evaluating water quality. These parameters provide useful information about water quality.

If we measure pH, acidity and alkalinity then we know quality of water. pH, acidity and alkalinity are related to each other and sometimes they are confusing. The value of pH of water is intensity factor and acidity and alkalinity are known as capacity factors. For calculate pH-value of water we use digital pH meter and alkalinity and acidity determined by acid-base titration and hardness determined by EDTA titration. Knowledge of these parameters are necessary for all human being because alkalinity gives information about how Sensorial that water body become to acid inputs such as by acid rain and waste water. Alkalinity in water system derived from many sources like evaporation of minerals, reduction of strong acid anions, soil-ion exchange reactions, weathering of minerals and rocks and atmospheric dust-particle deposition (WHO, 2011).

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pH of water

The term pH was introduced by Sorenson (1909) and represents the negative logarithm (base 10) of hydrogen ion concentration present in solution.

pH indicates the acid content of water. The pH scale is measured from 0.0 – 14.0 pH units. Solutions with a pH higher than 7 are considered basic, and pH lower than 7 is acidic. If pH is 7, the solution is neutral. pH of water mostly affects biological and chemical processes. Most aquatic life prefers a pH range of 6.5 to 8.5. Highly alkaline or acidic pH levels can make toxic chemicals more dangerous.

The pH of water can be determined by the following methods:

Digital pH Meter: It is a costly but accurate method then other methods. It is very easy to determine pH by using this technique. Here we take a pH electrode whose we dipped into the water sample to directly and display the pH value on a digital screen.

PH indicator paper(Litmus/Universal Indicator Paper): it method is easy to determine the pH of water, in this technique we use a litmus paper. we take a litmus paper and dipped in water and this litmus paper changes to its color then we match this colour to a colour chart to determine the pH value.

Acidity of water

Acidity of water is its capacity to react with strong base of designated pH. Acidity indicates the capacity of water to neutralize bases. It is generally caused by carbon dioxide and some organic acids. High acidity may affect many factors in water like its taste and can cause corrosion of metal pipes.

Acidity of Water is an important factor for water. Acidity is the capacity of water to react with a strong base to a designated pH, indicated its capacity to neutralise base. It is generally caused by carbon dioxide and some organic acids.

The Acidity of water can be determined by the following methods:

Acid-Base Titration: This titration is very useful to determine the acidity of water. In this titration we use a standard strong base against the water sample. This standard strong base (like Sodium Hydroxide – NaOH) using suitable indicators like phenol phathallin or Methyl orange to observe the end-point colour change.

Alkalinity of water

Alkalinity of water is an important parameter of water quality. The word alkalinity, from Arabic ‘al-qali’, means ‘saltwort ashes’ (Dictionary.com, 2018) would make the water more acidic, alkalinity acts as buffer and help to maintain pH value of water. Alkalinity of water has a great importance in water quality parameters. It acts as a chemical “buffer” to protect aquatic ecosystems from sudden acidic shocks (like acid rain). It is determined by carbonates (CO_3^{2-}), bicarbonates (HCO_3^{-}), and hydroxides (OH^-).High alkalinity can impact a bitter or soda-like taste to drinking water.

The Alkalinity of water can be determined by the following methods:

Titration: This titration method has a very importance to determine the alkalinity of water. In this titration we use a standard solution (like Hydrochloric acid) using some indicators (phenol phthalein and Methyl orange) to calculate Carbonate, bicarbonate and hydroxide alkalinity values.

Hardness of water

The presence of dissolved calcium and magnesium salt caused for hardness in water. Hard water does not easily produce with soap. Hardness is categorized into temporary hardness and permanent hardness. It is expressed in milligrams per litre.

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The study of these four parameter is necessary for understanding chemical composition and quality of different water sources.

The objective of this review is to compare the pH, acidity, alkalinity, and hardness of different water types by analyzing existing scientific literature.

Here, we also discuss importance of these parameters in water .

Hardness of water is a big issue in this time, because of this issue our daily life affects in many ways. It does not produce with soap and causes the many problems of deposits in pipes, heaters and other household appliances.

Hardness of water is mainly caused by the presence of dissolved Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) ions in water.

The Hardness of water can be determined by the following methods:

Titration: In this titration, to determine the total calcium and magnesium hardness of water, in standard laboratory method using EDTA and EBT indicator.

Field Tests: Using a TDS meter or soap test (hardness of water produces less lather with soap).

Structure of water –

Water molecules is polar in nature, this is one side of molecule is positive, while the other side is negative.

H (δ+)
****
O (δ-)
/
H (δ+)

Studies on water quality

Srivastava et al. measure by to assess the quality of river water from source to plain of Allahabad, India. They are taken five samples in such a way that overall quality of the river is assessed properly and samples collected in post-monsoon and pre-monsoon for a year and also analyzed temperature, pH, Dissolved Oxygen (DO), Biological oxygen demand (BOD), chemical oxygen demand (COD), chloride and sulphate. It is find out that water was contamination more at samples which are take from river because disposal of large amount of sewage and effluents from tanneries. So we found that sewage and effluent should be treated.

Heinrich Glorian et al. analyzed the quality of water in Uttar Pradesh, Uttarakhand and New Delhi. They analyzed river bank titration sites at yamuna and ganga river. Chadetrik Rout and Arabinda sharma analysed ground water samples of ambale cantonment area, Haryana, India. Their findings showed groundwater was alkaline in study area.water is necessary for drinking, digestion, circulation of body and it help in removal of waste from the body. It help in to maintain good health.

Agriculture depends on water. Farmers use water for irrigation and growing crops.

Water also necessary for photosynthesis, nutrient absorption and growth in plants.

There are many factors which affect water quality.

Physical Factors

Temperature: The temperature of water affect dissolved oxygen levels and the survival of aquatic organisms. Where temperature is high generally oxygen dissolved in water reduced.

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Colour: If water colour is changed then its show presence of organic matter, minerals, industrial waste or other pollutants.

Turbidity: Cloudiness of water caused by suspended particles such as soil, clay and organic matter found due to turbidity.

Chemical Factors

Dissolved oxygen (DO): Dissolved oxygen is necessary for survival of fish and other aquatic organisms.

Biochemical Oxygen Demand (BOD): Oxygen required by microorganisms to decompose organic matter in water measure by bio chemical oxygen demand.

LITERATURE REVIEW

There is study on groundwater quality in Tonk District, Rajasthan, India and find groundwater in the region was slightly alkaline and hard. (Study published in Discover Water) Researchers takes approximately 321 groundwater samples for parameters such as pH, total alkalinity, total hardness, calcium magnesium and other dissolved ions. this study shows importance of monitoring pH, alkalinity and hardness to evaluate groundwater quality. The Bureau of Indian Standard (BIS) has give their guidelines for drinking-water quality under IS 10500:2012. This guidelines tells us, acceptable limit for total alkalinity and total hardness is 200 mg/L and acceptable pH range of drinking water is 6.5-8.5. These reference tells us standard of chemical Quality of drinking water.

D.k. Bharati and M.B. singh give their contribution to know quality of water “In Renukoot industrial area in district Sonbhadra, Uttar Pradesh. They studied about pH, total hardness, alkalinity, chloride and TDS. Their result showed that some samples have higher concentration of certain constituents and some samples were within permissible drinking water limits.

For a very long time ago, many researchers have attempted to determine and comparatively study of pH value, alkalinity and acidity and hardness of water of different water samples like tap water, ground water, RO water, packaged drinking water, hand pump water.

When people first started making predictions, they determine all factors by which people know quality of water and importance of all these factors.

They write many books and research papers explaining how pH value, alkalinity and acidity affect water quality.

The following researcher have given their research views as follows -

Malik G.M. and Raval V.H.(2010) conducted a study on impact of religious festivals on water quality of Kapildhara pond at Varanasi, India.

Quality characterization of groundwater using water quality index in Surat city, Gujarat, India.

In this study, this has been determined by collecting 125 groundwater sample from 39 area of Surat city and they do physiochemical analysis of total alkalinity, hardness and highlighted the importance of regular monitoring of ground water quality.

Arulbalaji and Gurugnanam conducted study on groundwater quality assessment in Salem District, Tamilnadu, India. They analyzed 57 groundwater samples from Salem District, Tamilnadu, India to evaluate suitability of domestic and irrigation. They studied different parameters like pH, alkalinity, hardness, calcium, magnesium and other dissolved ions.

Acharya and co-researchers studies quality of 150 groundwater samples for drinking and irrigation near Dwarka, New Delhi, India. They find that >44% of samples were affected by nitrates and very high TDS. They

studied different parameters including total hardness, pH etc.

Jaspal Singh Chauhan, Tarun Badwal and Neha Badola investigated the quality of spring water in a village in Uttarakhand, India. They studied different water parameters like conductivity, pH, TDS, alkalinity, hardness, calcium nitrates and chloride. In this study they emphasised the importance of examining different water sources to understand their quality.

Pryuttma and Abhay Prakash investigated a comparative study of underground water and surface water from Khagaria District, Bihar, India. Their research focused on investigated parameters such as pH, total hardness, alkalinity, iron, calcium and magnesium and focused on comparing chemical characteristic of ground water and pond water.

Radha Krishnan, Dharmaraj and Ranjitha kumari so doing a comparative study on physico-chemical and bacteriological characteristics of drinking water, bosewall water and sewage water in different areas of Sivakasi, India. Their study tells us importance of analysing different chemical parameters to determine quality of water from different sources. a study entitled Evaluation of selected physicochemical parameters to know assess quality status of drinking water in Delhi, India was published in 2023. The researchers have taken 31 water samples, including ground water, handpump, submersible and tap water. They are doing standard analytical procedures and find pH value, dissolved oxygen, free carbrbon dioxide, alkalinity, chloride and total as well Archana Aggarwal, Ram Gupta and their co-researchers concluded that water samples which are tested had physicochemical parameters within acceptable limits, while some samples showed higher values of T.D.S., alkalinity, chloride and hardness than the allowable limits.

Anandeep Kaur and co-researchers doing their research on a study entitled descriptive and correlation analysis of physicochemical properties of ground water of Delhi and NCR region, India. They collected 50 groundwater samples on different different area of Delhi and NCR region and analysed parameters such as pH, electrical conductivity, total hardness and total dissolved solids. The results showed that pH values ranged from 7.4 to 8.9 which show groundwater was neutral to slightly alkaline and total hardness 112 to 299 mg/L.

They also observed positive correlational between electrical conductivity and total hardness.

But In this research paper, we also study about acidity and alkalinity but their study not mention these parameters. Overall idea from the literature: After studying all these works, it is clear that many researchers have research about characteristics of groundwater, surface water and drinking water. Previous studies also focused on parameters such as pH, total dissolved solids, alkalinity and hardness, while acidity has received comparatively less attention in previous study.

Research gap: Many researchers have studied the physicochemical properties of water quality like pH value, alkalinity, acidity and hardness. We study many research on this topic but we found that they give useful information about chemical characteristics of water and its importance for drinking and domestic purpose while some researchers studies have focused on individual parameters or limited number of physicochemical properties. So here we need for combined understanding of these four important parameters and their role in determinining water quality.

This present review based study suggest us to address this gap by bringing together and analysing previous research findings related to pH, alkalinity, acidity and hardness of different water sources. In this review based study also focuses on chemical principles, significance of these parameters in water quality assessment. This study provide us a better understanding of importance of these parameters in evaluating water quality for different-different areas.

CONCLUSION

Water quality may vary depending on its different sources, geological conditions and environmental factors. It can be concluded that study of pH, acidity, alkalinity and hardness gives useful information about water quality. The comparative study indicates that different water sources show different chemical properties. Groundwater generally has a higher amount of dissolved minerals, which are increases its hardness and

alkalinity. Rainwater has fewer dissolved minerals and lower hardness. River water, pond water and tap water show different-different chemical properties depending on environmental conditions, dissolved substances and treatment processes.

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