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A Review on Physico-Chemical Parameters of the Quality of Water

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ABSTRACT
On this planet, water is one of the natural resources that are considered to be the most valuable. All living things, the majority of natural systems, human health, the production of food, and the growth of the economy all benefit from its presence. Water is becoming extremely polluted with a wide variety of toxins as a result of the rapid growth of the world's population, the spread of industry and improved agricultural methods, and other activities caused by humans. In the current scenario, the water from the river has turned into wastewater as a result of the removal of the garbage from the area through which it flows. Water is an essential resource for the continued existence of humans. The integrity of the water supply is critical to the maintenance of good health. A wide variety of pollutants, both chemical and microbiological, can compromise the quality of drinking water and make it unsafe to consume. These pollutants are the root of many significant health issues. Having access to clean water is crucial in the fight against disease and in the pursuit of improved personal satisfaction. This review paper discusses a variety of physicochemical parameters such as pH, Electrical conductivity, Total Hardness, Turbidity, BOD, COD, Total alkalinity, Chloride, Sulphate, Phosphate and DO. that are relevant to thinking about the quality of water.

Keywords: Physio-chemical parameters, Electrical conductivity, BOD, COD

INTRODUCTION

Almost 70% of India's surface water resources and an increasing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic contaminants, making water pollution a severe issue in India. In many instances, these sources are no longer fit for human consumption or other uses, including as irrigation or industrial purposes. This demonstrates that decreased water quality can lead to water scarcity by reducing its availability for human and ecological usage [1, 2]. In recent years, the need for residential water has multiplied due to population growth, agricultural expansion, and industrial expansion. Not only has improper waste disposal and excessive resource extraction harmed the quality of tap water, but also ground water. There is a wide range of causes for water contamination. The sewage from cities and industrial waste from factories are the two biggest polluters of rivers. There is not a single city in India with sufficient sewage treatment facilities. Almost 10% of our wastewater is treated before being released into local waterways. The result is the contamination of subterranean water supplies, surface water systems, and aquatic ecosystems [3, 4]. The water that flows through these pipes and into our homes is typically highly contaminated and hosts disease-causing microorganism. Another important source of water pollution is agricultural run-off, or water from fields that flows into rivers and carries with it harmful chemicals like fertilisers and pesticides. Fertilizers have a negative knock-on effect on water supplies [5, 6].

Water is not only a necessary component for life itself, but it is also a significant factor in the nation's overall economic development, which makes it a vital resource. Although though water is a renewable resource, there is a finite amount of water that can be used in the natural world. So, it is absolutely necessary to preserve the availability of water by implementing an appropriate water management approach in its use. The quality of ground water is determined by several chemical constituents and their concentrations, which are primarily derived from geological data specific to the location. Industrial and municipal solid wastes have emerged as major sources of contamination in surface and ground water. Because to the presence of heavy metals in excess, available water in many sections of the country is made unfit for human consumption [7, 8].

In fact, fertilisers promote the proliferation of organisms by enhancing the nutrient content of waterways. These organisms could be pathogens or algae. The expansion of algae may delay the flow of waterways, leading to an increase in the number of organisms and sedimentation. Agricultural land usage and farming practises significantly affect groundwater quality [6, 9]. Leaching is the process by which chemicals from fertilisers (such as nitrate) and pesticides leach into the groundwater as a result of intensive crop cultivation. Agriculture's routine use of fertilisers and pesticides, as well as the indiscriminate disposal of industrial and residential wastes, are increasingly recognised as major drivers of water contamination. The human population suffers from a variety of water-borne diseases due to the consumption of contaminated drinking water; hence, it is essential that the quality of drinking water be evaluated at regular intervals [10].

There is a trend in developing nations to use sewage effluent as fertiliser, as it is seen as a source of organic matter and plant nutrients and is an effective fertiliser. Farmers are primarily interested in general benefits, such as increased agriculture production, a low-cost water source, an efficient method of effluent disposal, a source of nutrients, organic matter, etc., but they are unaware of its negative effects, such as heavy metal contamination of soils and crops and health-related quality issues [11]. Long-term usage of this sewage effluent for irrigation has been shown to pollute soil and crops to the point where it becomes poisonous to plants and causes soil degradation. This contains a substantial number of potentially hazardous compounds, such as soluble salts and heavy metals such as Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+}, Ni^{2+}, and Pb^{+}. These heavy metal additions are unwanted. Plants can accumulate heavy metals in their tissues at concentrations above the permissible levels, which is considered to be a threat to the lives of humans and animals consuming these crops and may lead to contamination of the food chain, as it was observed that the soil and plants that received irrigation water containing industrial effluent contained numerous toxic metals [12, 13].

Over the entire summer, the situation is made worse by the lack of available water and the runoff of rainwater. The contamination of water resources that can be used for residential and drinking purposes with heavy elements, metal ions, and dangerous bacteria is one of the most critical main health challenges that are currently facing the world today. The majority of the rivers that can be found in the metropolitan regions of emerging nations are the destinations of the effluents that are discharged from the factories [14, 15]. Some nations in Africa and Asia are in the midst of a period of rapid industrialization; as a result, efforts to preserve their natural environments are proving challenging. Trace metals can be found in relatively high numbers but at extremely low concentrations in seawater. Because of the extremely low concentrations of a great number of essential trace metals, this matrix presents a significant challenge to analytical chemists.

Physico-Chemical Parameters and Assessment

The physicochemical parameters of water quality will be analysed using APHA (American Public Health Association) approved procedures [16, 17]. The work was done along the following lines: (a) Physicochemical evaluation of river, ground, and surface water, including pH, Hardness, total alkalinity, phosphate, chloride, Calcium, Magnesium, and Nitrate values, C.O.D., B.O.D., total alkalinity, Temperature, pH, dissolved oxygen (DO), total dissolved solid (T.D.S.), and so on. (b) Data processing in preparation for statistical analysis. Different analytical water quality parameters with their analytical technique are depicted in Table 1[18].

Table 1: Different analytical water quality parameters with their analytical technique

S.No.	Studied Parameter	Method used
1	pH	Recorded by pH meter
2	Electrical conductivity	Conductivity meter / Water analysis kit
3	Total Hardness	Complexometric titration
4	Turbidity	Turbiditymetry
5	BOD	Titrometric
6	COD.	Titrometric
7	Total alkalinity	Neutralizing with Std. HCl
8	Chloride	Mohrs method
9	Sulphate	Spectrophotometric
10	Phosphate	Spectophotometric
11	DO	Titrometric

It is critical to analyse water before it is used for drinking, residential, agricultural, or industrial purposes. Water must be examined using various physicochemical criteria. The parameters used for water testing are purely determined by the purpose for which the water will be used and the degree to which its quality and purity are required. The physio-chemical parameters for analysing water quality as shown in figure1.

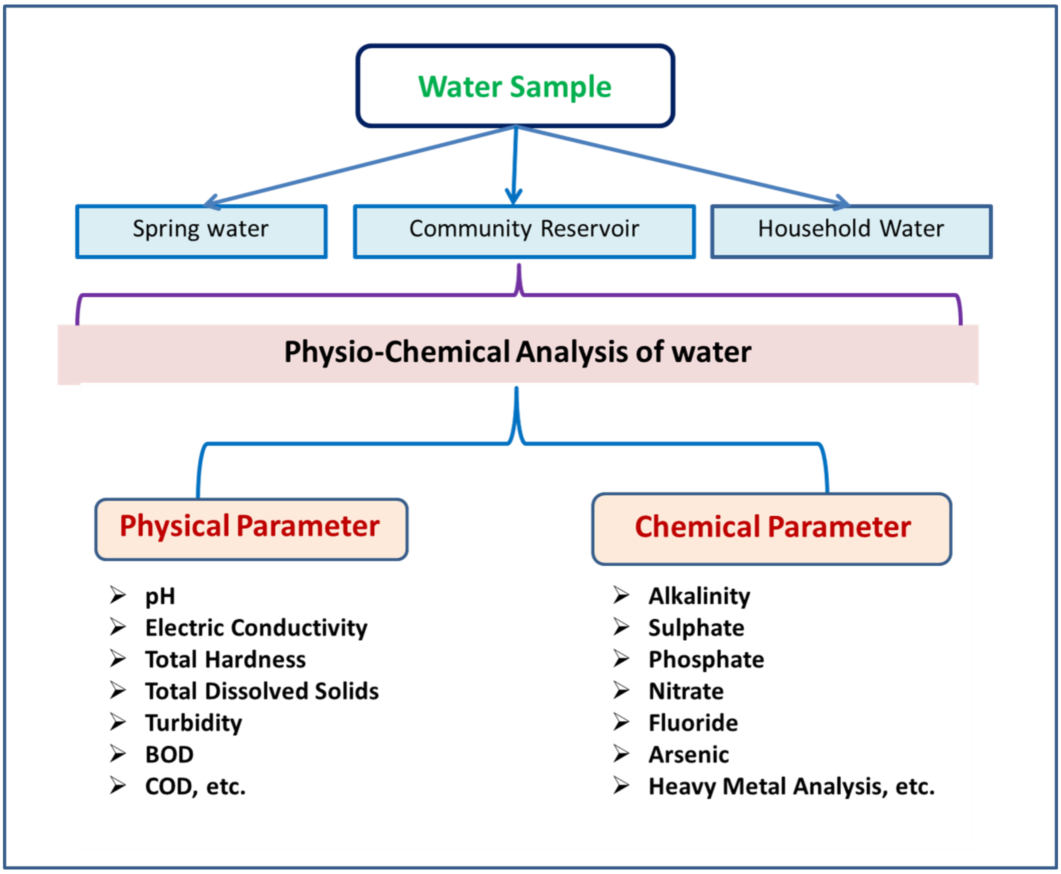

Fig.1. Physio-Chemical parameters for analysing water quality

Water contains a variety of impurities, including floating, dissolved, suspended, microbiological, and bacteriological pollutants. Temperature, colour, odour, pH, turbidity, TDS, and other physical tests should be undertaken, while chemical tests should be performed for BOD, COD, dissolved oxygen, alkalinity, hardness, and other characteristics. Water should be tested for trace metals, heavy metals, and organic contaminants, such as pesticide residue, in order to attain higher and higher quality and purity. It is evident that drinking water must pass all of these tests and contain the required amount of minerals. Only developed nations check all these parameters. Owing to water's low heavy metal and organic pesticide contaminants, advanced testing instruments and well-trained staff are needed. To evaluate water quality, the following physic chemical parameters are examined periodically.

pH (Negative log of H^+ ion concentration):

pH is an indicator of the existence of biological life. pH of water ranges from 0 to 14. pH value 7 to 14 is alkaline, pH value 0 to 7 is acidic and pH value 7 is neutral. The pH value was measured by pH meter. A pH metre measures pH value. The pH range for drinking water is 6.5 to 8.5 [19].

Electrical Conductivity (EC):

Electrical Conductivity (EC) is a numerical value. The total amount of dissolved ions (TDS) in the water, are estimated using electrical conductivity (EC). The purity of water is estimate by EC and therefore it is a useful tool to check the purity of water [20, 21]. An apparatus known as an electrical conductivity metre is used to measure EC.

Total Hardness (TH):

Whether water is being used for domestic, commercial, or agricultural purposes, Total Hardness is a crucial indicator of its quality however it is to be used for agricultural, domestic, and/or industrial purposes. It is due to the presence of excess of Calcium, magnesium and Iron salts. Ethylene diamine tetraacetic acid (EDTA) technique is used to determine overall hardness. Maximum total hardness was measured at 297 mg/l in a residential area, while minimum total hardness was measured at 228 mg/l in a mining region [21]. According to equivalent CaCO3 content, the degree of hardness of drinkable water has been categorised as follows: Soft: 0–60 mg/l, Medium: 60–120 mg/l, Hard: 120–180 mg/l, and extremely hard: > 180 mg/l [22, 23].

Total Dissolved Solid (TDS):

Solids may negatively affect water quality in a variety of ways. Total dissolved solids are a measure of the many types of minerals that are present in water (TDS). The amount of TDS is closely related to how pure and high-quality the water is. Additionally, we can assert that TDS is equal to the total of the cation and anion concentrations. A TDS metre can calculate TDS. The acceptable limit is 500 mg/l, and the allowed maximum is 2000 mg/l, according to IS: 10500-2012. [23, 20].

Turbidity:

Turbidity is a metric used to determine a liquid's relative clarity mainly for suspended particles in water that block the path of light. Both organic and inorganic substances can cause turbidity. Microorganisms may be present in organic particles. As a result, turbidity may raise the risk of waterborne illness. However, inorganic components have no discernible negative consequences on health. Turbiditymetry is used to quantify it. According to IS: 10500-2012, the acceptable level is 1 NTU, while the allowed limit is 5 NTU [22, 23].

Chemical Oxygen Demand (COD):

COD testing is frequently used to assess the organic content of municipal and industrial waste. Dissolved oxygen may completely disappear from the system if too many organics are added. The entire aquatic community is at danger if there isn't enough oxygen. BOD and COD are closely linked. BOD, measures the quantity of organic matter that can be biologically oxidised whereas COD required dissolved oxygen for oxidation of organic and inorganic constitution both. COD is evaluated quickly, taking only 3 to 4 hours while BOD takes 5 days. The carbonaceous portion of organic matter is evaluated using it.

Biological Oxygen Demand (BOD):

BOD is a measure for organic contamination in both surface water and waste. Poor water quality is indicated by high BOD levels. Any garbage discharged into the waterways would have an impact on downstream users and the water quality for this tree plantation operation.

Total Alkalinity:

Carbonates and bicarbonates are the cause of alkalinity. Silicates, phosphates, and borates also contribute to the alkalinity of water in contaminated waters. Alkalinity could be a chemical process that explains how water can neutralise acids. The allowable level of alkalinity in drinking water is 120 mg/l. [24]. The Standard Values of water quality by BIS and WHO parameters are depicted in table 2 [25].

Table 2: Standard Values of water quality by BIS and WHO parameters

S.No.	Parameters	Bureau of Indian Standards (BIS)	World Health Organization (WHO)
1	pH	6.5-8.5	7-8
2	Total Dissolved Solids	500	300-1200
3	Total Alkalinity	200	-
4	Total Hardness	200	500
5	Magnesium	30	150
6	Calcium	75	200
7	Chlorides	250	250
8	Sulphates	200	250
9	Fluoride	1	1.5
10	Iron	0.3	0.3

Chloride:

The quantity of chloride varies greatly in all forms of natural waters. The amount of chloride in water will automatically grow as the mineral concentration does. The high concentration of chloride is caused by human activity. The acceptable level of chloride is 250 mg/l, while the allowed limit is 1000 mg/l, according to IS: 10500-2012.

Sulphate:

Sulfate ions are prevalent in natural water, and the majority of these ions are soluble in water. The ultraviolet spectrophotometer is used to measure it. According to IS: 10500-2012, the acceptable and allowed limits for sulphate are 200 and 400 mg/l, respectively.

Dissolved Oxygen:

DO association with water bodies indicates bacterial activity, photosynthesis, nutrition availability, stratification, and more. Summer temperatures and microbial activity lowered dissolved oxygen. During Summer's high DO is caused by rising temperatures and intense sunlight that bright sunlight speed phytoplankton photosynthesis, using CO^2 and releasing O^2 [26, 27]. Winkler's titrimetric method is used to quantify DO in samples. The quantity of oxygen used by the bacteria throughout this time period is represented by the disparity between the DO values at the beginning and end of the experiment.

CONCLUSION

Water is a vital resource for human survival. The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Water quality refers to its chemical, physical, and biological qualities, usually in connection to its suitability for a particular use. Due to increase population, advanced agricultural practices, industrialization, man- made activity, water is being highly polluted with different contaminants which severe consequences on all forms of life, including humans, animals, fish, and birds, and ultimately leads to the extinction or drastic reduction in reproduction capacity of aquatic organisms. To minimize the pollution in drinking water we can use modern technologies such as reverse osmosis and ozonation in large scale, which are effective in the treatment of water but their feasibility in a rural setting needs to be worked out. The current review paper examined various physicochemical parameters of water quality in order to raise public awareness about water quality. The individual and the community can help to reduce water pollution by practising simple housekeeping and waste management practises.

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