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Physicochemical Analysis of Drinking Water Quality in Kallakurichi, Cuddalore, and Salem Districts of Tamil Nadu: A Comparative Study with BIS: 10500 Standards

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Abstract - Water is one of the most fundamental natural resources essential for sustaining all forms of life on Earth. Drinking water quality holds paramount importance as it directly influences human health, socioeconomic development, and public well-being. This study presents a physicochemical analysis of drinking water collected from three districts of Tamil Nadu — Kallakurichi, Cuddalore, and Salem — each characterized by distinct contamination sources such as agricultural runoff, salinity intrusion, and industrial discharge, respectively. Groundwater samples were tested for physical parameters including temperature, colour, odour, and turbidity, and chemical parameters including pH, TDS, total hardness, and chloride. Results were compared against BIS: 10500 permissible limits to assess potability. Salem and Kallakurichi showed elevated TDS and hardness beyond permissible limits, while Cuddalore exhibited objectionable odour. The findings highlight regional water quality variations and provide a scientific basis for water treatment interventions.

Keywords **- Drinking water, physicochemical parameters, BIS: 10500, water quality index, Tamil Nadu, TDS, turbidity, hardness, chloride.**

I. INTRODUCTION

Water is an essential natural resource, and ensuring its quality for human consumption is of paramount importance. Tamil Nadu, one of the most industrially and agriculturally active states in southern India, faces significant challenges in maintaining adequate drinking water quality across its districts.

The three districts under study — Kallakurichi, Cuddalore, and Salem — represent a diverse spectrum of geographical, demographic, and industrial characteristics. Cuddalore is known for heavy industrial activity including chemical and petrochemical manufacturing. Salem is recognized for its steel industries and agricultural practices. Kallakurichi is a predominantly agricultural district with a rural population largely dependent on groundwater.

Physicochemical parameters including pH, TDS, total hardness, alkalinity, DO, BOD, turbidity, chloride, fluoride, nitrate, and heavy metals serve as critical indicators of water potability. Deviations from acceptable ranges can lead to gastrointestinal disorders, dental and skeletal fluorosis, methemoglobinemia, cardiovascular ailments, and chronic heavy metal toxicity.

The Bureau of Indian Standards (BIS) has established IS: 10500 as the national benchmark for drinking water quality. This study systematically collects, analyzes, and compares water samples against BIS: 10500 standards to assess potability and recommend appropriate interventions.

Table I: BIS: 10500 Standard Values

II. LITERATURE REVIEW

Parameter	Acceptable Limit	Permissible Limit
Temperature	25°C (ambient)	—
Colour	5 TCU	15 TCU
Odour	Unobjectionable	Unobjectionable
Turbidity	1 NTU	5 NTU
pH	6.5 – 8.5	No relaxation
TDS	500 mg/L	2000 mg/L
Total Hardness	200 mg/L	600 mg/L
Chloride	250 mg/L	1000 mg/L

A. Ravikumar et al. (2011)

Conducted a comprehensive study on physicochemical characteristics of groundwater in Salem district. A significant proportion of samples exceeded BIS: 10500 limits for fluoride and TDS, attributed to dissolution of fluoride-bearing minerals in granite and gneissic rock formations. Defluoridation treatment was recommended as an urgent public health intervention.

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B. Subramani et al. (2005)

Investigated hydrogeochemical characteristics of groundwater in hard rock terrain of Tamil Nadu. Weathering of silicate minerals and ion exchange processes were dominant controls on groundwater chemistry. Several samples showed TDS values exceeding 1500 mg/L, rendering them unsuitable for drinking without treatment.

C. Deepali and Gangwar (2010)

Examined physicochemical deterioration of water bodies near industrial zones. Their findings are directly relevant to Cuddalore, which hosts the SIPCOT industrial complex. Elevated concentrations of heavy metals and high BOD/COD values were documented, consistently exceeding BIS: 10500 permissible limits.

D. Vasanthavigar et al. (2010)

Conducted a WQI-based groundwater quality assessment in the Thirumanimuttar sub-basin, Tamil Nadu. Approximately 30% of samples fell under the poor to very poor water quality category, primarily due to elevated hardness, chloride, and nitrate concentrations from agricultural runoff.

E. Annapoorna and Janardhana (2015)

Evaluated groundwater quality in rural segments of Cuddalore district. Iron, chloride, and TDS concentrations in several samples exceeded BIS: 10500 limits. Coastal proximity contributed to saline intrusion, elevating sodium and chloride levels in groundwater.

F. Pazhanivel and Bhaskaran (2018)

Investigated seasonal fluctuations in physicochemical parameters of drinking water sources across Kallakurichi. Turbidity and microbial load peaked during monsoon season. Post-monsoon samples showed elevated nitrate from agricultural leaching. Approximately 38% of water sources were unfit for direct consumption without treatment.

G. WHO (2017)

The WHO Guidelines for Drinking Water Quality (4th Edition) serve as the global benchmark complementing national standards. Health-based guideline values include fluoride (1.5 mg/L), nitrate (50 mg/L), arsenic (0.01 mg/L), and lead (0.01 mg/L). The guidelines provide Water Safety Plans (WSPs) as a proactive risk management framework for water supply systems.

III. METHODOLOGY

Sample Collection
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Sample Preservation & Transport
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Physicochemical Parameter Testing (Lab)
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Data Recording & Tabulation
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Comparison with BIS: 10500 Standards
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Water Quality Index (WQI) Calculation
↓
Statistical Analysis
↓
Results & Interpretation

Table II: Ground Water Test Methods

Parameter	Method
Total Hardness (as $CaCO_3$)	Titrimetric Method
Chloride (as Cl)	Argentometric Method
pH (at 25°C)	Electrometric Method
Total Dissolved Solids	Gravimetric Method
Temperature	Thermometric Method
Colour	Platinum Cobalt Method
Odour	Threshold Method
Turbidity	Nephelometric Method

The pH meter was calibrated with standard buffer solutions (pH 4, 7, 9). The glass electrode was immersed in the sample and reading was stabilized before recording. Expressed on scale 0–14 using Electrometric Method.

V. RESULTS AND DISCUSSION

Table III presents the physicochemical test results for the three districts compared against BIS: 10500 standards. Salem and Kallakurichi showed significantly elevated TDS (1309 mg/L and 1208 mg/L respectively), both exceeding the acceptable limit of 500 mg/L though within the permissible limit of 2000 mg/L. Total hardness in Salem (768 mg/L) and Kallakurichi (676 mg/L) exceeded both acceptable (200 mg/L) and permissible (600 mg/L) limits, indicating unsuitability for direct consumption.

Chloride levels in Salem (444.8 mg/L) and Kallakurichi (349.9 mg/L) exceeded the acceptable limit of 250 mg/L but remained within the permissible limit of 1000 mg/L. Cuddalore showed odour classified as Not Agreeable, indicating potential organic or industrial contamination.

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Salem turbidity (1.1 NTU) slightly exceeded the acceptable limit of 1 NTU but remained within the permissible limit of 5 NTU. pH values for all three districts remained within the acceptable range of 6.5–8.5.

Table III: Comparative Results vs BIS: 10500 Standards

S.No	Parameter	Kallakurichi	Cuddalore	Salem
1	Total Hardness	676 mg/L	212 mg/L	768 mg/L
2	Chloride	349.9 mg/L	92 mg/L	444.8 mg/L
3	pH	7.04	7.18	6.95
4	TDS	1208 mg/L	509 mg/L	1309 mg/L
5	Temperature	27.2°C	26.9°C	27.4°C
6	Colour	0 Hazen	0 Hazen	0 Hazen
7	Odour	Agreeable	Not Agreeable	Agreeable
8	Turbidity	0.6 NTU	0.8 NTU	1.1 NTU

VI. CONCLUSION

The physicochemical analysis of drinking water from Kallakurichi, Cuddalore, and Salem districts reveals significant regional variations in water quality. Salem and Kallakurichi exhibit the most critical non-compliance, particularly for total hardness and TDS, likely attributed to geological and agricultural factors. Cuddalore's objectionable odour reflects industrial contamination.

All districts require appropriate treatment interventions before the water is safe for human consumption. The study recommends installation of reverse osmosis systems in high-TDS zones, regular monitoring by TWAD Board, community-level awareness programs, and stringent industrial effluent treatment norms in Cuddalore. Future studies should incorporate seasonal variation, microbiological parameters, and heavy metal analysis for a comprehensive assessment.

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