



Research article

Evaluation of water quality for drinking purpose from various zones of southern part of tamilnadu, chennai, india

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ABSTRACT

The objective of this study was to assess the drinking water quality from North, Central, South, and West regions of Chennai. The samples for analysis included metro water, ground water, Reverse Osmosis water, packaged drinking water, mineral water, boiled water, and rainwater. Analysis of sixteen physicochemical parameters such as pH, turbidity, Electrical conductivity, Total dissolved solids, Total suspended solids, major cations like calcium (Ca^{2+}), sodium (Na^{+}), and potassium (K^{+}) and anions like chloride (Cl^{-}), fluoride (F^{-}), nitrate (NO_3^{-}) and sulphate (SO_4^{2-}) and heavy metals such as Copper (Cu), Zinc (Zn^{2+}), magnesium (Mg), and Iron (Fe) are all measured using American Public Health Association (APHA) standard methods of analysis. The results were compared with standard values established by agencies such as World Health Organization (WHO), the Bureau of Indian Standards (BIS) and National Drinking Water Quality Standard (NDWQS). The Water Quality Index ranged from 11.66 to 147.11. The results indicate that about 52.9% of the water samples investigated in this study is excellent.

Keywords: Drinking water, Chennai city, Physico-chemical parameters, Water quality index (WQI).

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INTRODUCTION

About 78% of Earth's surface is covered by water, yet the source of clean water for human consumption is limited. A safe and excellent quality of drinking water is considered as a fundamental human right of individuals^[1]. Fresh water is a natural resource that is not only necessary for human existence but is also most important for agriculture, industry, and for the consumption of animals and birds. Water, unlike many other raw materials, cannot be replaced in many of its uses.

Water consists of many essential elements for human existence and if found contaminated it could be a source of toxins to human health. In the current scenario, the contamination of drinking water quality is rapidly increasing due to components such as rapid industrialization, urbanization, and changes in lifestyle. The different types of contamination in water resources include organic and inorganic substances, radionuclides, microorganisms, and disinfectants^[2]. In comparison to the organic pollutants, the heavy metals contamination plays a greater role in water pollution^[3]. It is reported that approximately 1.1 billion people in the world lack access to clear and safe drinking water^[4]. The ill effects of consumption of contaminated drinking water along with improper hygiene and sanitation includes most of the diarrhoeal disease around the world that affects approximately 6-8 million people found to be diagnosed

drying from water-related disease^[5]. According to the World Health Organization (WHO), water is responsible for causing around 80% of all human illnesses.

A drinking water is described as the water having appropriate physical, chemical, and bacteriological quality that is safe to drink and cook. Therefore, it is necessary to evaluate the quality of surface water and groundwater for the required quality parameters making it compatible for consumption. In the evaluation for detection of water contamination, several scientific methodologies and instruments have been developed over the course of time. This includes the analysis of physicochemical properties such as pH (determination of acidity/ basicity), EC (Electrical Conductivity), TDS (Total Dissolved Solids), TSS (Total Suspended Solids), turbidity, heavy metals, and major ions^[6].

In the study of the drinking water quality in regions of Chennai, Chennai Metro Water Supply and Sewage Board (CMWSSB) assures the supply of potable water in adequate amount and appropriate quality. Apart from Chennai metro water and ground water, nearly 80% of residents in Chennai drink packaged water. The city sells around 20 million litres of packaged drinking water on a daily basis^[7]. Although Chennai has reservoirs of lakes, rivers and dams, groundwater resources have always played an important role in

meeting additional demand^[8]. The quality of groundwater can vary depending on the physical, chemical, and microbiological properties of the source rock due to weathering and anthropogenic activities^[9-10]. Our study intends to discuss the quality of Chennai water supply system, since the city's population continues to grow, and the demand for water supply continues to increase.

The samples considered for analysis included Tap water or metro water, Ground water, RO water, Boiled water, packaged drinking water and mineral water from different zones of Chennai. The quality of the water could be estimated by the Water Quality Index as proposed by Horten^[11]. Along with the WQI, analysis of sixteen physico-chemical parameters such as pH, turbidity, electrical conductivity, TSS, TDS, Cl, F, NO₃, SO₄, Na, Ca, K, and heavy metals like Cu, Mg, Zn and Fe were carried out. It was further compared with the standards set by agencies such as WHO, BIS and NDWQS. The quality of the water is affected if these values exceed the standard limit set by WHO and other regulatory bodies^[12-14].

MATERIALS AND METHODS

Study Area

The present study was carried out in Chennai; the capital of Tamil Nadu which is located on the south-eastern coast of India. The latitudinal and longitudinal axes include 13° 04' N to 13.067° N and 80° 17' E to 80.237° E respectively at a height of 60 metres (200 ft) with a mean elevation of approximately 6.7 metres (22 ft). The city is divided into four major zones: North, Central, South and West. The climatic conditions around the city remain tropical, wet and dry with an annual rainfall of around 140 cm. From mid-October to mid-December, Chennai receives majority of its rainfall from the north-east monsoon winds. The reservoirs supplying water to the regions of Chennai include Red Hills, Cholavaram, Poondi and Chembarambakkam, with a total carrying capacity of 11,057 mcf^[15]. The Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) is a statutory board of the Tamil Nadu government in charge of supplying water to the city and its surrounding areas. CMWSSB has established multiple well fields, totalling 74 deep bore wells, and has executed water purchase agreements with private agricultural owners. CMWSSB currently produces around 100 million litres per day^[16-17].

Sample Collection

A total of seventeen samples were collected for the assessment of water quality during the southwest monsoon period of August 2021. For the study purpose, the city was divided into 3 different regions as north, south, and central Chennai and one zone from each region was chosen to analyse the water samples. The samples were collected in a precleaned, sanitised, one-litre polyethylene bottles. The collected water samples included, Tap/ Metro water, Ground Water, Packaged Drinking Water, Boiled Water

(S1-S12), Rainwater, RO water, Water stored in Copper Bottle, Bottled Mineral water 1, Bottled Mineral water 2 (S13-M2) (Table-1). The water samples collected were differentiated based on the different types of water consumption by people living in the city. The bottled mineral water was selected based on the market distribution and the selected mineral waters represented a share of more than 40%^[18].

Table 1: Details of Sample locations, number, and source

Location	Sample	Source
North Chennai (Royapuram)	S1	Tap/ Metro water
	S2	Ground Water
	S3	Packaged Drinking Water
	S4	Boiled Water
South Chennai (Adyar)	S5	Tap/ Metro water
	S6	Ground Water
	S7	Packaged Drinking Water
	S8	Boiled Water
Central Chennai (Anna Nagar)	S9	Tap/ Metro water
	S10	Ground Water
	S11	Packaged Drinking Water
	S12	Boiled Water
Other	S13	Rainwater
	S14	RO water
	S15	Water stored in Copper Bottle
Marketed products	M1	Bottled Mineral water 1
	M2	Bottled Mineral water 2

Analytical methods

The drinking water quality is determined by a variety of physicochemical parameters and their concentrations. Analytical methods were performed in the Analytical Chemistry Laboratory, SRM College of Pharmacy (SRMIST, Kattankulathur), in accordance with all standard procedures for water quality monitoring as stipulated by the American Health Organization (APHA)^[19] and Indian Drinking Water Standards (IS 10500: 2012)^[20]. On-site analysis (pH, EC, and turbidity) and laboratory analysis (Total dissolved solids and Total suspended solids), both are part of chemical analysis. 16 physicochemical parameters were selected and analysed to assess water quality.

Onsite Analysis for testing the pH, Electrical conductivity and Turbidity

pH, electrical conductivity, and turbidity was performed at the time of sampling according to standard protocols. A pH metre was used to measure the pH of the water samples. Before performing the measurements, standard buffer solutions were prepared and used for calibration of the instrument. After obtaining a steady recording, the pH probe was placed in a beaker containing a water sample, and the value was recorded. To eliminate cross contamination across samples, the probe was cleaned with deionized water after each measurement (IS: 3025 Part2). Similarly, Conductivity was performed using conductivity metre and Turbidity using digital Nephelo-turbidity meter and the value of turbidity is measured as nephelometric turbidity units (NTU).

Laboratory Analysis for assessment of TDS and TSS

Assessments of TDS and TSS in water samples were determined using the standard approach given by APHA and BIS.

Before starting filtration, a certain amount of water sample was poured into a pre-weighed Whatman filter paper. The samples were then filtered using vacuum filtration. After filtering, the filter paper was dried at 100° C for 2 to 3 hours and weighed. The increase in the weight of the filter paper indicates the TSS content.

Gravimetric technique was used to determine the total dissolved solids (TDS) in the collected water samples. The filtrate left after the TSS analysis, was boiled above 100 °C in a water bath until all water gets evaporated completely. The remaining residue weight is the amount of TDS present in the sample. Both TDS and TSS are expressed as mass per volume of filtered sample (mg/L).

TDS has a correlation with conductivity or electrical conductivity (EC) ^[21]. Both the TDS and EC are water quality parameter used to indicate the salinity level. The correlation between TDS and conductivity can be expressed by equation

$$\text{TDS (mg/L)} = 0.5 \times 1000 \times \text{EC (mS/cm)}$$

$$\text{Or TDS (mg/L)} = k \times \text{EC (}\mu\text{S/cm)}$$

Where, k= 0.5 to 0.75.

Concentrations of Heavy metals, anions, and cations

Water samples are analysed for four heavy metals: copper, magnesium, zinc, and iron. In addition to heavy metals, other parameters such as chloride, fluoride, sulfate, nitrate, sodium, potassium, and calcium were calculated using standard methods. Copper was measured using Neocuproine method (IS:3025 P-42), EDTA titration for calcium and magnesium (IS: 3025 P40 and P46), Zincon method (IS: 3025 P49) for zinc, Sodium and potassium were determined using flame photometry, Sulphate was calculated using turbidimetry (IS:3025 P-24), chloride using an argentometric method (IS: 3025 P32), while iron, nitrite, fluoride, and phosphate were assessed using spectrophotometric methods(model UV-VIS Spectrophotometer 3092, LABINDIA Analytical, Thane).

Water Quality Index (WQI)

Water Quality Index (WQI) is a simple technique that reflects the cumulative effect of various water quality parameters on overall water quality and converts massive dataset into a single numerical, usually dimensionless, in a simple and repeatable manner ^[22]. WQI is calculated by comparing the 17 water quality parameters measured in this study using the approach described in previous literature ^[23,24].

WQI is computed in five steps:

Step 1: Each of the 17 parameters was given a weight (wi) based on its relative value in determining the overall quality of drinking water [Table 2]. The TDS parameter was assigned a maximum weight of 4.6 owing to its relevance in assessing water quality.

Step 2: The relative weight (Wi) is determined using the following equation and Table 2 shows the measured relative weight (Wi) for each parameter.

$$\text{Relative weight, } W_i = \frac{W_i}{\sum W_i}$$

Where, wi is the weight of each parameter

Step 3 Each parameter is assigned a quality rating scale (qi) by dividing its concentration in each water sample by its corresponding standard as per BIS, WHO, and NDWQS guidelines and multiplying the result by 100. The more contaminated the water ^[25], the greater the Qi value.

$$q_i = (C_i/S_i) \times 100$$

Where, Ci is the concentration of each parameter in each water sample and

Si is the drinking water standard for each parameter.

Step 4 The following equation is used to calculate the water quality sub-index (SI) for each chemical parameter

$$SI_i = W_i \times q_i$$

Step 5 Finally, the total water quality index (WQI) is determined by adding the individual sub-index values (SIi) of each water sample according to the equation.

$$WQI = \sum SI_i$$

Table 2: The assigned weight (wi), Relative weight (Wi) and drinking water standard of each parameter

Parameter	Standard(Si)	Assigned weight (wi)	Relative weight (wi)
pH	6.5-8.5 (7.5)	2.7	0.062790698
Conductivity	300	2.9	0.06744186
Turbidity	5	2.9	0.06744186
TSS	25	2	0.046511628
TDS	500	4.6	0.106976744
Copper (Cu)	1.5	2	0.046511628
Magnesium (Mg)	30	2	0.046511628
Iron (Fe)	0.3	3	0.069767442
Calcium (Ca)	75	2	0.046511628
Sodium (Na)	200	2.5	0.058139535
Potassium(K)	22.5	1.5	0.034883721
Chloride (Cl)	250	4.5	0.104651163
Fluoride(F)	1	4	0.093023256
Nitrate (NO3)	45	3.1	0.072093023
Sulphate (SO4)	200	3.3	0.076744186
		$\sum w_i = 43$	$\sum W_i = 1$

RESULTS AND DISCUSSION

The physio-chemical parameters such as pH, Conductivity (EC), total suspended solids (TSS), total dissolved solids (TDS), Copper (Cu), Zinc (Zn), Iron (Fe), calcium (Ca), magnesium (Mg), sulphate (SO4), chloride (Cl), nitrite (NO3) and Turbidity were measured in each water samples. Table 3 shows the experimental results in comparison with the norms and standards as per the WHO, NDWQS and Indian standards listed in Table 4.

pH

pH is a measure of hydrogen ion concentration in water. It is the most prevalent method for determining water quality. A pH of 6.5 to 8.5 is typically regarded as acceptable for drinking, as per the standards. In the present study, the pH ranges from 7.01 to 8.15, except for rainwater, which has a pH of 5.74 and is somewhat acidic due to the presence of carbonic acid (H₂CO₃). The measured pH for bottled mineral water (M1 and M2) is 7.2 and 7.5, which is approximately the pH indicated on the container label. This indicates

that the label did not include any misleading information. The pH value of sample S14(water stored in a copper pan) is almost neutral,

indicating the importance of drinking water from a copper bottle Figure 1(a).

Table 3: The Experimental results of all physico-chemical parameters of Chennai city

Sample Unit	pH	Conductivity $\mu\text{S/cm}$	Turbidity NTU	TSS mg/L	TDS mg/L	Cu mg/L	Zn mg/L	Mg mg/L	Fe mg/L	Ca mg/L	Na mg/L	K mg/L	Cl mg/L	F mg/L	NO ₃ mg/L	SO ₄ mg/L
S1	6.95	637.3	2.3	2.5	242	BDL	BDL	15.4	0.03	20.4	28.4	10.2	125.7	0.12	3.4	15.4
S2	8.04	1136	2.5	3.2	761.12	BDL	BDL	25.7	0.54	164.3	184	2.56	239.9	0.45	7.1	80.2
S3	7.12	228.07	1	0.5	120	BDL	BDL	2.32	0.12	27.77	17.8	3.9	17.24	BDL	0.98	45.86
S4	7.49	220	1.9	1.4	110	BDL	BDL	15	0.01	26	12.5	2.1	22	BDL	2	32.3
S5	7.68	1040	2.6	2.3	512	BDL	BDL	21	0.04	91	39.5	9.71	158	0.24	2.7	121
S6	7.9	1962	4.2	2.5	1104	BDL	BDL	26.47	1.01	162	126	26	248.9	0.41	9.92	143
S7	6.89	170	1.1	0.5	95	BDL	BDL	3.36	0.12	19.83	11	3.2	13.97	BDL	1.07	35.78
S8	7.95	330	1.5	1	154	BDL	BDL	2.1	BDL	35	17.3	4	28	BDL	1.7	55
S9	7.61	370	3.07	3.7	420	BDL	BDL	20	0.21	67	109.1	10.6	80	0.11	7.8	60
S10	7.52	1447	2.9	2.7	926	BDL	BDL	13.25	0.16	54.3	173	7.2	242.1	0.25	22	145
S11	6.79	200.2	1	0.4	118	BDL	BDL	12.6	0.08	26.07	14.2	1.58	31.9	BDL	6.9	15.5
S12	8.15	205	3.3	1.2	102.5	BDL	BDL	6	0.03	38.71	20.8	2.12	18.15	BDL	1.14	14
S13	5.74	81.3	3	4	35	BDL	BDL	3.2	BDL	4	2.2	1	9.7	BDL	BDL	11
S14	6.67	78.76	1.3	0.6	33	BDL	BDL	3.3	BDL	7	2.5	2.2	3.6	BDL	1.4	BDL
S15	7.01	320	1.2	0.9	140	0.097	BDL	12.4	BDL	24	37.4	5.4	27.96	BDL	0	22.7
M1	7.5	127.2	0.3	0.1	71	BDL	BDL	12	BDL	25	7.9	6.23	6.12	BDL	1.2	3.2
M2	7.2	89.65	0.2	0	52	BDL	BDL	10	BDL	21	4.5	4.21	4.55	BDL	1.4	2.7
Average	7.3065	508.381176	1.96294	1.6	293.86	0.097	-	12.01	0.214	47.846	47.535	6.01	75.164	0.263	4.419	50.17

BDL- Below the detection limit

Table 4: Standard limits of water parameters for determining drinking water quality as per WHO, BIS and NQWQS

Parameters	Units	BIS Standards IS 10500		WHO limits (2005)		NDWQS limits
		Desirable limit	Maximum limit	Desirable limit	Maximum limit	
pH	No unit	6.5-8.5	no relaxation	6.5-8.5	9.2	6.5-9
Conductivity	$\mu\text{S/cm}$	none	none	300	1000	1000
Turbidity	NTU	1	5	5	none	-
TSS	mg/L	none	none	none	none	25
TDS	mg/L	500	2000	500	1500	1000
Copper (Cu)	mg/L	0.05	1.5	2	-	1
Zinc (Zn)	mg/L	5	15	none	none	3
Magnesium (Mg)	mg/L	30	100	50	150	150
Iron (Fe)	mg/L	0.3	no relaxation	0.3	-	0.3
Calcium (Ca)	mg/L	75	200	75	200	-
Sulphate (SO ₄)	mg/L	200	400	200	400	250
Chloride (Cl)	mg/L	250	1000	200	600	250
Fluoride(F)	mg/L	1	1.5	1	1.5	1.5
Nitrate (NO ₃)	mg/L	45	no relaxation	45	100	10
Sodium (Na)	mg/L	none	none	-	200	-
Potassium (K)	mg/L	20-25	-	12	-	-

Electrical Conductivity

The presence of dissolved particles in water samples, like Ca^{2+} , Cl^- , and Mg^{2+} , conducts the electric current through the water. The measured conductivity of all samples was in the range of 78.76 $\mu\text{S/cm}$ (S6) to 1962 $\mu\text{S/cm}$ (S14), with an average conductivity of 508.38 $\mu\text{S/cm}$ Figure 1(b).

Turbidity

Turbidity is the amount of cloudiness in water due to intense light scattering by fine particles suspended in it. The average turbidity value is 1.96. According to BIS and WHO guidelines, the maximum allowable turbidity limit for potable water is 5 Nephelometric units (NTU). Sample M2 has the lowest turbidity value of 0.2 and the maximum value of 4.2 is found in sample S6. Bottled mineral water showed the lowest turbidity value compared to other samples Figure 1(c).

Total Suspended Solids (TSS)

NDWQS recommends a maximum TSS level of 25 mg/L. Figure 1(d) shows the TSS level of all the samples collected, ranging from 0 to 3.7, with a mean value of 1.6 mg/L.

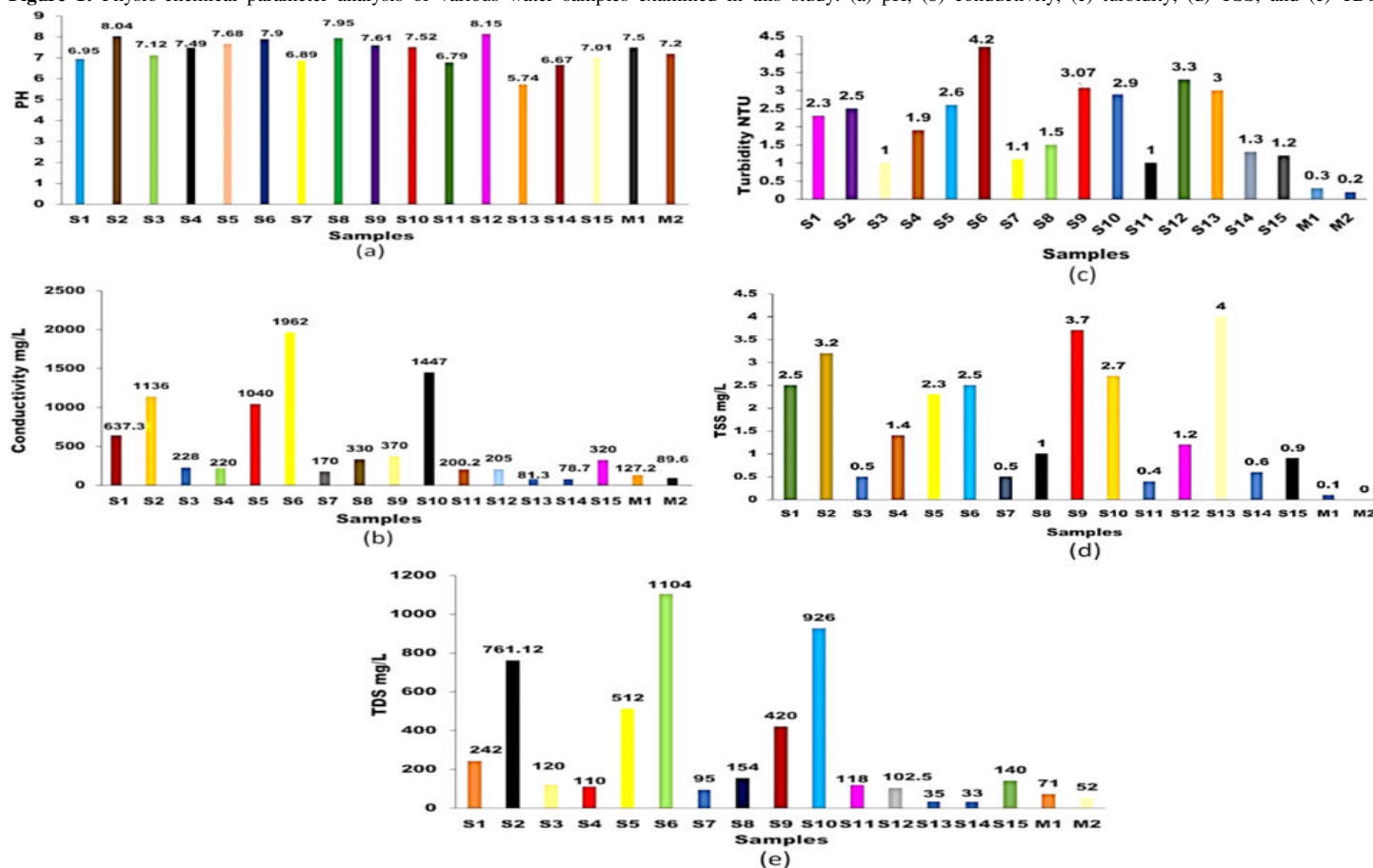
Total Dissolved Solids (TDS)

The amount of organic and inorganic particles present in

water is referred to as TDS, and it determines its acceptability for usage. High concentrations of TDS can adversely affect taste. Water with a TDS above 500 mg/L is not considered suitable for drinking. However, in the absence of potable water, the permissible limit is up to 2000 mg/L. According to the WHO, water may be classified in terms of palatability based on the amount of TDS value. Figure 1(e) depicts the TDS level of all 17 water samples. Sample S6 has the greatest TDS level of 1104mg/L and sample S14 has the minimum TDS values of 33 mg/L.

Concentration of Heavy metals

The detection limits of the 4 heavy metals analysed are 0.02 mg/L for Cu, 0.01 mg/L for Fe, and 0.05 mg/L for Zn and Mg. Results indicate that zinc is absent or below the detection limit (BDL). Only one sample, S14, shows evidence of copper. This is due to the Oligodynamic effect, which results when water is stored in a copper vessel or bottle for more than eight hours. The amount of iron present in samples S2 and S6 was found to exceed the acceptable limit of 0.3 mg/L according to standard recommendations. The Mg concentration in all study areas ranged from 2.1 to 26.4 mg/L, with an average value of 12.01 mg/Which is well below the standard limit.

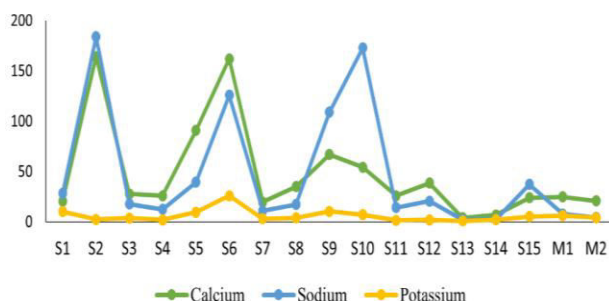
Figure 1: Physio-chemical parameter analysis of various water samples examined in this study. (a) pH, (b) conductivity, (c) turbidity, (d) TSS, and (e) TDS

Calcium

According to BIS and WHO, the allowable limit for calcium is 75-200 mg/L. Calcium content ranges from 4 to 164.3 mg/L, with the highest concentration observed in ground water sample S2 (Figure 2). The lowest calcium level is found in sample S13 (rainwater).

Sodium and Potassium

The concentrations of Na⁺ and K⁺ vary between 2.2 mg/L and 184 mg/L and 1 mg/L and 10.6 mg/L respectively. Excess potassium in water samples can cause nervous disorder and indigestion.

Figure 2: Concentration of major cations like Na⁺, K⁺, Ca²⁺ present in all the water samples examined in the study.

Chloride

Chloride concentrations were detected in the range of 3.6 mg/L to 248.9 mg/L (Figure 3). The maximum permissible amount of Cl as BIS and NDWQS is 250 mg /L. Chloride levels in all the

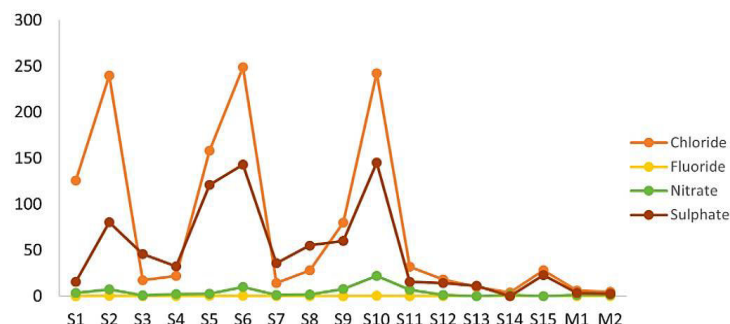
samples were determined to be within the acceptable range.

Fluoride

Fluoride content in drinking water has a major effect on fluorosis prevalence [26]. In this study, the fluoride content ranges between 0.12 and 0.45 mg/L (Figure 3). In samples S3, S4, S7, S8, S11, S12, S13, S14, M1 and M2, fluoride is either absent or below the detection limits.

Nitrate and Sulphates

The nitrate concentration varies between 0 to 9.92 mg/L. The WHO set a permissible limit of 100 mg/L for nitrate. Sulphate is found in water in the form of inorganic sulphate salts and dissolved gas (H₂S). The concentration of sulphate ions varies from 2.7 mg/L to 145 mg/which is below the acceptable limit of 200 mg/L according to BIS, WHO and NDWQS standards

Figure 3: Concentration of major anions like Cl⁻, F⁻, NO₃⁻, SO₄²⁻, present in all the water samples examined in the study

Water Quality Index

The range of calculated WQI values is 11.66 to 147.11 and is listed in Table 6. The higher levels of EC, TDS, chloride, and sulphates in samples S2, S5, S6 and S10 have been proven to be primarily responsible for the high WQI values. Table 5 shows the standard ranges of water quality classification according to WQI values. About 52.9% of the water samples are classified as “Excellent”, and 17.6% of the water samples are of good quality (Figure 4). Only one sample is rated as extremely poor quality, while two others are of poor quality. S2 and S6 are in the category of non-potable water.

Table 5: Water quality parameter based on WQI value

WQI Value	Water Quality
0-24	Excellent
25-49	Good
50-74	Poor
75-100	Very poor
>100	Not potable water

Figure 4: The ranges of water quality index for all the water samples examined in this study

Figure 4 (a): WQI values

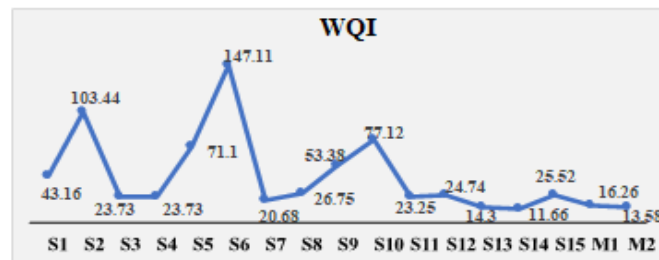


Figure 4 (b): % of samples falling in different water quality category

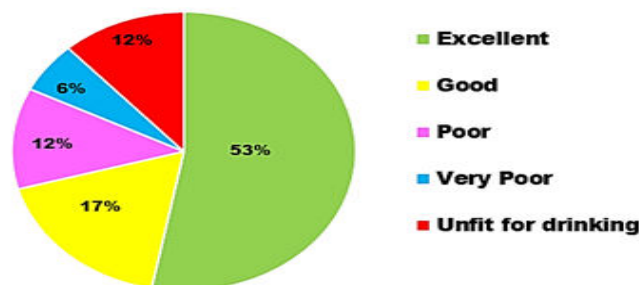


Table 6: Quality rating (qi), Sub Index (SI) and Water Quality Index of each Samples of Study area

Parameter	S1		S2		S3		S4		S5		S6		S7		S8		S9	
	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi
pH	92.67	5.82	107.2	6.731	94.93	5.96	99.87	6.27	102.4	6.43	105.3	6.614	91.87	5.77	106	6.66	101.5	6.371
Conductivity	212.4	14.3	378.7	25.54	76.02	5.13	73.33	4.95	346.7	23.4	654	44.11	56.67	3.82	110	7.42	123.3	8.318
Turbidity	46	3.1	50	3.372	20	1.35	38	2.56	52	3.51	84	5.665	22	1.48	30	2.02	61.4	4.141
TSS	10	0.47	12.8	0.595	2	0.09	5.6	0.26	9.2	0.43	10	0.465	2	0.09	4	0.19	14.8	0.688
TDS	48.4	5.18	152.2	16.28	24	2.57	22	2.35	102.4	11	220.8	23.62	19	2.03	30.8	3.29	84	8.986
Copper (Cu)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	51.33	2.39	85.67	3.984	7.733	0.36	50	2.33	70	3.26	88.23	4.104	11.2	0.52	7	0.33	66.67	3.101
Iron (Fe)	10	0.7	180	12.56	40	2.79	3.333	0.23	13.33	0.93	336.7	23.49	40	2.79	0	0	70	4.884
Calcium (Ca)	27.2	1.27	219.1	10.19	37.03	1.72	34.67	1.61	121.3	5.64	216	10.05	26.44	1.23	46.67	2.17	89.33	4.155
Sodium (Na)	14.2	0.83	92	5.349	8.9	0.52	6.25	0.36	19.75	1.15	63	3.663	5.5	0.32	8.65	0.5	54.55	3.172
Potassium(K)	45.33	1.58	11.38	0.397	17.33	0.6	9.333	0.33	43.16	1.51	115.6	4.031	14.22	0.5	17.78	0.62	47.11	1.643
Chloride (Cl)	50.28	5.26	95.96	10.04	6.896	0.72	8.8	0.92	63.2	6.61	99.56	10.42	5.588	0.58	11.2	1.17	32	3.349
Fluoride(F)	12	1.12	45	4.186	0	0	0	0	24	2.23	41	3.814	0	0	0	0	11	1.023
Nitrate (NO3)	7.556	0.54	15.78	1.137	2.178	0.16	4.444	0.32	6	0.43	22.04	1.589	2.378	0.17	3.778	0.27	17.33	1.25
Sulphate (SO4)	7.7	0.59	40.1	3.077	22.93	1.76	16.15	1.24	60.5	4.64	71.5	5.487	17.89	1.37	27.5	2.11	30	2.302
WQI	43.2		103.4		23.7		23.7		71.1		147.1		20.7		26.8		53.38	

Parameter	S10		S11		S12		S13		S14		S15		M1		M2	
	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi	qi	Wiqi
pH	100.3	6.296	90.53	5.68	108.7	6.823	82	5.149	88.93	5.584	93.47	5.869	100	6.279	96	6.028
Conductivity	144.7	9.759	66.73	4.5	68.33	4.609	27.1	1.828	26.25	1.771	106.7	7.194	42.4	2.86	29.88	2.015
Turbidity	58	3.912	20	1.35	66	4.451	60	4.047	26	1.753	24	1.619	6	0.405	4	0.27
TSS	10.8	0.502	1.6	0.07	4.8	0.223	16	0.744	2.4	0.112	3.6	0.167	0.4	0.019	0	0
TDS	185.2	19.81	23.6	2.52	20.5	2.193	7	0.749	6.6	0.706	28	2.995	14.2	1.519	10.4	1.113
Copper (Cu)	0	0	0	0	0	0	0	0	0	0	6.467	0.301	0	0	0	0
Magnesium (Mg)	44.17	2.054	42	1.95	20	0.93	10.67	0.496	11	0.512	41.33	1.922	40	1.86	33.33	1.55
Iron (Fe)	53.33	3.721	26.67	1.86	10	0.698	0	0	0	0	0	0	0	0	0	0
Calcium (Ca)	72.4	3.367	34.76	1.62	51.61	2.401	5.333	0.248	9.333	0.434	32	1.488	33.33	1.55	28	1.302
Sodium (Na)	86.5	5.029	7.1	0.41	10.4	0.605	1.1	0.064	1.25	0.073	18.7	1.087	3.95	0.23	2.25	0.131
Potassium(K)	32	1.116	7.022	0.24	9.422	0.329	4.444	0.155	9.778	0.341	24	0.837	27.69	0.966	18.71	0.653
Chloride (Cl)	96.84	10.13	12.76	1.34	7.26	0.76	3.88	0.406	1.44	0.151	11.18	1.17	2.448	0.256	1.82	0.19
Fluoride(F)	25	2.326	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrate (NO3)	48.89	3.525	15.33	1.11	2.533	0.183	0	0	3.111	0.224	0	0	2.667	0.192	3.111	0.224
Sulphate (SO4)	72.5	5.564	7.75	0.59	7	0.537	5.5	0.422	0	0	11.35	0.871	1.6	0.123	1.35	0.104
WQI	77.12		23.3		24.74		14.31		11.66		25.52		16.26		13.58	

CONCLUSIONS

This study demonstrates that calculating WQI is a valuable method for measuring overall water quality. Water quality is excellent in almost all packaged drinking water, boiled water, and

bottled mineral water. Drinking water stored in copper vessels has also proven to be very important, with a WQI of 25.52, which is close to the excellent category. This is because of the oligodynamic effect

which destroys bacteria and other micro-organisms making it safe for drinking. Rainwater has the lowest WQI rating of 11.66, indicating that it is as pure as distilled water. However, it lacks the majority of essential minerals and is quickly contaminated by microbes and pathogens that are potentially harmful to human health. Groundwater samples obtained in Chennai's Royapuram and Adyar zones show a high WQI value of above 100 and are thus unfit for drinking. This is due to the high concentration of dissolved solids in it. This poor-quality water consumption can be harmful to one's health over time and must be treated before being used for drinking. Several techniques like ion exchange, precipitation, RO, UV, UF, nanofiltration, electrocoagulation etc may be employed to improve the quality of water particularly when the TDS and EC levels are high. Further other parameters like microbial and radiological studies should be performed to know about the overall safety of the water in Chennai.

REFERENCES

1. UNICEF, WHO, 2005. Water for life: making it happen, Jt Monit Progr Water Sanit. 3:2006.
2. Nollet LM, De Gelder LS, 2000. Handbook of water analysis (Eds.), CRC press.
3. Rahmanian N, Ali SHB, Homayoonfard M, 2015. Analysis of physiochemical parameters to evaluate the drinking water quality in the State of Perak, Malays J Chem. 10 pages.
4. Khyade VB, Swaminathan MS, 2016. Water: The pacemaker for life of earth, World Sci News. 44, 93–125.
5. Water UN, 2013. Water security and the global water agenda: The UN-water analytical brief, J Chem Inf Model. 53, 1689–1699.
6. Daud MK, Nafees M, Ali S, 2017. Drinking water quality status and contamination in Pakistan, Biomed Res Int. 18 pages.
7. Chennai: Kasturi & Sons, 2018. To tackle water crisis, Metrowater pitches in, The Hindu.
8. Packialakshmi S, Ambujam NK, Nelliya P, 2011. Groundwater market and its implications on water resources and agriculture in the southern peri-urban interface, Chennai, India, Environ Dev Sustain. 13, 423–438.
9. Bhandari NS, Nayal K, 2008. Correlation study on physico-chemical parameters and quality assessment of Kosi river water, Uttarakhand, J Chem. 5, 342–346.
10. Dorairaju SV, Rao CN, Raju MB, 2013. Analysis of Drinking Water Quality and its Impact on Human Health in Chandragiri, Near Tirupati, India, Biosci Biotechnol Res Asia. 10, 379-381.
11. Horton RK, 1965. An index number system for rating water quality, J Water Pollut Control Fed. 37(3), 300-306.
12. WHO, 2005. Guidelines for Drinking-Water Quality, World Health Organization, Geneva, Switzerland.
13. NDWQS, 2005. Implementation directives for national drinking water quality standards, Government of Nepal.
14. BIS, 2003. Indian standards specification for drinking water, New Delhi, 15:10500.
15. Krishnamurthy R, Desouza KC, 2015. Chennai, India, Cities. 42, 118-129.
16. Sujatha P, Janardhanam PVS, 2012. Water supply in Chennai city, 2nd int sym. pp. 364-365.
17. Anbazhagi M, Loganathan D, Tamilselvan S, 2007. Cryptosporidium oocysts in drinking water supply of Chennai City, southern India, Clean (Weinh). 35(2), 167-171.
18. Karavoltos S, Sakellari A, Mihopoulos N, 2008. Evaluation of the quality of drinking water in regions of Greece, Desalination. 224(1-3), 317-329.
19. APHA, 2005. Standard method for the examination of water and wastewater, 21st edn, American Public Health Association, Washington.
20. BIS. IS 10500, 2008. Drinking Water-Specification (First Revision).
21. Rusydi AF, 2018. Correlation between conductivity and total dissolved solid in various type of water: A review, IOP Conf Ser Earth Environ, Sci. 118, 012019.
22. Abbasi T, Abbasi SA, 2012. Water quality indices, 1st ed., Elsevier, Amsterdam, The Netherlands, 384 pages.
23. Gebrehiwot AB, Tadesse N, Jigar E, 2011. Application of water quality index to assess suitability of groundwater quality for drinking purposes in Hantebet watershed, Tigray, Northern Ethiopia, ISABB J Food Agric Sci. 1, 22–30.
24. Suneetha M, Sundar SB, Ravindhranath K, 2015. Calculation of water quality index (WQI) to assess the suitability of groundwater quality for drinking purposes in Vinukonda Mandal, Guntur District, Andhra Pradesh, India, J Chem Pharm Res. 7(9), 538–545.
25. Kothari V, Vij S, Sharma S, 2021. Correlation of various water quality parameters and water quality index of districts of Uttarakhand, Environ Sustain Indic. 9, 100093.
26. Kumar SP, Chaitanya P, Reddy Aditya G, 2013. Experimental Intervention to prevent fluoride exposure. J med P'ceutical Allied Sci. 5,14-23.

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