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Physio-Chemical Properties and Quality Assessment of Tap Water at selected Railway Stations in South India

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Abstract

Water is essential to life. The availability of safe drinking water is a fundamental amenity for passengers at railway stations in India. The Indian railway network is the fourth largest network in the world, spanning 65,000km with 7,083 railway stations, after the USA (250,000 km), China (100,000 km), and Russia (85,500 km). As the number of people choosing railways as a mode of transport has increased significantly in recent days, it is crucial to evaluate the tap water quality at railway stations. Therefore, the objective is to evaluate the physiochemical parameters of drinking water provided at railway stations between Thiruvananthapuram and Nagercoil and to determine its suitability for consumption.

Keywords: drinking water, railway stations, tap water quality, South India, Thiruvananthapuram, Nagercoil.

INTRODUCTION

The rapid growth of population, industrialisation, and anthropogenic activities have resulted in poor drinking water quality (Ramapriya and Elango 2022; Darko et al. 2021; Faroque and South 2021). In the fiscal year 2021, it has been reported that 1.3 billion passengers travelled across India Passengers' perceptions of safety, security, comfortability, and higher speed compared to other modes of transportation; cost-effectiveness leads a considerable number of passengers to travel by train in India (Akiyama and Okushima 2009). In 2018, during a public interest litigation (PIL) hearing, Delhi High Court was told to provide drinkable water to the railway passengers (Press Trust of India 2018).

The primary source of drinking water at railway stations in India is groundwater). The groundwater quality varies from region to region due to the geological structure, location, extension and quality of ground water table, the leaching of minerals, contamination of water due to agriculture, and other anthropogenic activities (Sahni et al. 2010).

` Land use and land cover (LULC) of an area significantly control the water quality (Zeinalzadeh and Rezaei 2017). Physiography and climatic factors also affected the ground water quality. The main objective of the study was to assess the quality of drinking water of the railway station

The physical and chemical quality of water vary according to the basis of shape ,size, depth, light penetration, precipitation, temperature, chemical, nature of surrounding soil and dissolved minerals, p^H. The biological components of habitats depends on them if all the physical and chemical parameters are in optimum condition, maintaining balance between them (Tambekar et al. 2012).Hydrogen ion concentration (pH) is an important factor in water analysis. Water hardness above 200mg/litre may lead to scale deposition in distribution system. While containing water total 500mg/litre is considered harmful to human health. If chloride level exceeds 300mg/litre there is risk of change in taste of water. If chloride concentration increases, it will be impart salty taste to water (Rajkumar, N. and Gowri,S. 2005). Total dissolved solid values were used to determine whether water is suitable for drinking, agriculture and industrial purpose. TDS (Total Dissolved Solid) mainly from salt water contamination and industrial pollution. It also causes increase in level of alkalinity. The higher values of alkalinity indicate presence of bicarbonate, carbonate and hydroxide in water body. Too much of fluoride concentration leads to destruction of enamel and causes fluorosis leading to decalcification, dental disorder, mineralization of tendons, digestive and nervous system. According to WHO (World Health Organization) approximately 80% of all the disease of human being are caused by water.

This principle source of drinking water in India is ground water source. Due to the bad condition of the water quality, now a day's mineral water is being used. Different mineral nutrients available in drinking water include magnesium, chloride, sulphate, calcium, sodium, potassium, nitrate, fluoride and even bicarbonates. The mineral content may vary according to source. Calcium and magnesium content are the major drinking water quality. The hardness of the water is determined by calcium and magnesium (Chun-Yuh Yang et al,2006). The quality of drinking water and their associated health problems varies throughout the world. The basis on which drinking water safety is judged is national standards or international guidelines. The most important of these are the WHO Guidelines for Drinking – Water Quality.

Railway stations are the main sources of drinking water for railway travel and the analysis of water is very important in evaluating these supplies. A large number of railway passengers consume this drinking water on the railway platform and this contaminated water may be the vehicle of transmission of waterborne diseases (Tambekar, p et al.2012). Drinking water at railway stations is mainly supplied from bore wells. Most of the railway stations in India rarely have the much needed purifying technology (Magudeswaran, P .N. and Ramachandran, T.2007). Water quality assessment helps in identify any contaminants and checking the quality of water. As one of the essential amenities local government authorities provide drinking water to passengers at all the stations. But many times apathy has been

observed towards the quality maintenance of water storage tanks and particular areas (Sahni, A. et al.2010). Water quality assessment helps in identification of any contaminants and checks the quality of water. This work seeks to check the quality of water made available at the public transport stations on various railway stations between Thiruvananthapuram to Nagercoil.

REVIEW OF LITERATURE

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Sahni A *et al*. (2010) explained the Assessment of drinking water quality of Jaipur main and its suburb railway stations with special mention to fluoride. Shefali Nandan (2010) reported the Assessment of cleanliness of main platform areas at railway stations in India. Ahmad Shahezad (2013) investigated the Evaluation of drinking water quality of railway stations from Amravati to Mumbai. D.H. Tambekar *et al*.(2007) studied the Public drinking water:how safe is railway station water in india ?A study.

Chonde Sonal G *et al*.(2014) explained the Study on drinking water quality at public transport stations from Kholpur and Sangli city. Monika Sharma and Mahendra Pratap Choudhary(2017) explained the Assessment of drinking water quality at public amenities in Kota City. Nithin JosepH*et al*.(2018) studied the Bacteriological assessment of bottled drinking water available at major trasit places in Manglore City of South India.

S. Suthar and Sharma(2009) explained the Water quality assessment of river Hindon at Ghaziabad, India: impact of industrial and urban wastewater. Maria Susana Fortunato *et al*.(2020) studied the Evaluation of bottled water quality by determining nitrite concentration.

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Jinzhu Ma *et al*. (2009) studied the Sources of water pollution and evolution of water quality in the Wuwei basin of Shiyang river, Northwest China . R kaur et al.(2014) reported the A study on physiochemical analysis of road and railway track side soil samples of Amritsar (Punjab) and their genotoxic effects.

MATERIALS AND METHODS

Study area

Thiruvananthapuram is the southernmost district of Kerala and Nagercoil is the southernmost district of Tamil Nadu. The water sample (Tap water) for the present investigation was collected from six stations namely Kottar, Vettoornimadam, Kuzhithurai, Parassala, Neyyatinkara, Thiruvananthapuram as fresh and used immediately.

Collection of water samples

The water samples selected from different Railway Stations of Thiruvananthapuram and Nagercoil. The total of six water samples were analysed for their physio-chemical analysis of water samples. White plastic Jerry cans were used for sample collection. The water sample were brought to the District Water Testing Laboratory (Asaripallam) for analysis and quality check.

Physiochemical analysis

A total of 25 physio- chemical parameters were analysed including pH, Total hardness as $CaCO_3$, Total Alkalinity, Chloride, Sulphate, Nitrate, Fluoride, Appearance, Colour, Odour, Turbidity, Total Dissolved Soil, Conductivity, P- Alkalinity, Calcium, Magnesium, Sodium, Potassium, Iron, Manganese, Ammonia, Nitrite, Total Phosphate , tidys and Residual Chlorine.

Physical Examination – Colour o**f the water samples were** compared with known colour standards and recorded value in Pt/ Co scale.

The water samples were analysed for Turbidity, Total Dissolved Solids, pH and Total amount of Hardness, Chloride, Alkalinity,Sulphate, Nitrate, Nitrite, Fluoride, Calcium, Sodium & Potassium, Iron, Manganese, Ammonia, Phosphate, Tidy's as per standard procedures.

RESULTS

The results of the physical and chemical analysis were presented in tables 1 and 2. The samples in drinking water sample A to F, were colourless. The total dissolved solids ranged from 33 mg/L to 812 mg/L.

The pH of the water samples ranged from 6.36 mg/L to 8.16 mg/L. The total Hardness of the samples ranged from12 mg/L to 260 mg/L respectively. The total Alkalinity ranged from 10 mg/L to 288 mg/L within acceptable limits. The chloride of the sample F was 206 mg/L is high, while sample A was 7 mg/L is considered low. The Fluoride of the water samples A to

F was 0.2 mg/L respectively. The appearance of all the water samples are clear. The total conductivity of the sample E was 1230 mg/L is high value sample A as 50 mg/L is low value respectively.

Calcium of the water sample ranged from 5 mg/L to 64 mg/L is acceptable. The Magnesium of the water sample is ranged from 3 mg/L to 19 mg/L is respectively. There is no presence of sodium in this water samples. The iron of the water samples ranged from 0.12 mg/L to 0.35 mg/L. There is no presence of manganese in this water sample. The ammonia of the water samples ranged from 0.01 mg/L to 0.08 mg/L is acceptable. There is no presence of potassium in this water samples. There is no presence of any odour in this water sample. The presence of sulphate in the first three samples are <5 mg/L and the last three samples are ranged from 8 mg/L to 26 mg/L is respectively.

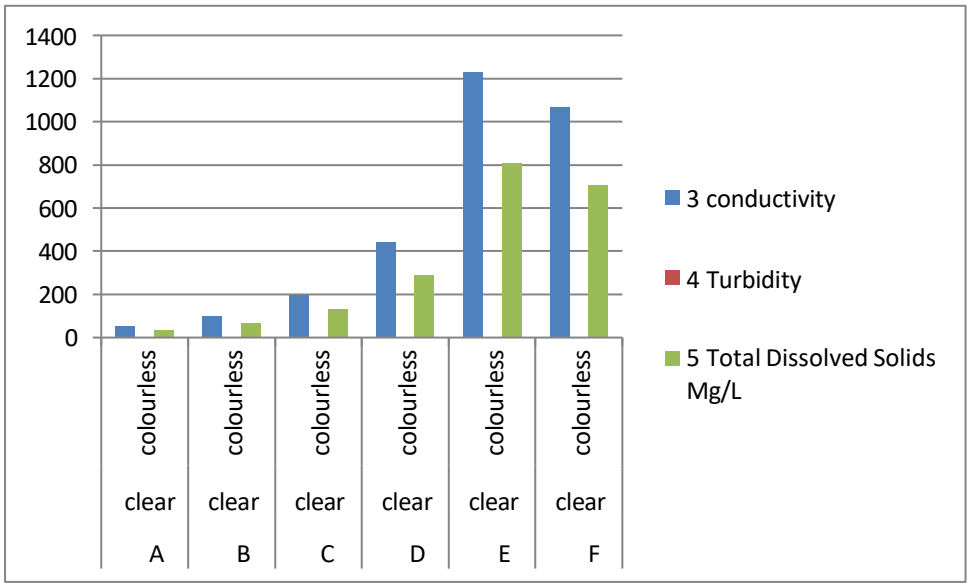
The presence of Nitrate in the first three samples are <2 mg/L and the last three samples are ranged from 2 mg/L to 4 mg/L. Their is no presence of turbidity in this water sample. The total phosphate of the sample D is 0.05 mg/L to sample B is 0.15 mg/L is acceptable. The presence of nitrite in the first three samples are ranged from 0.01 mg/L to 0.03 mg/L and the last three samples are 0.01 mg/L is acceptable. Their is no presence of Residual chlorine in this water sample. The Tidys test for 4 hours of the sample E was 0.36 mg/L is high value and sample A and C was 0.24 mg/L is low value respectively.

PHYSICAL EXAMINATION

Table:1. Physical examination of water samples in different Railway stations

sl. No	Physical examination	A	B	C	D	E	F
1	Appearance	Clear	Clear	Clear	Clear	Clear	Clear
2	Colour	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
3	Conductivity	50	103	198	442	1230	1070
4	Turbidity	0	0	0	0	0	0
5	Total Dissolved Solids Mg/L	33	68	131	292	812	706

Figure 1 : The level of Physical Examination value of water samples collected from various Railway Stations.



CHEMICAL EXAMINATION

Table: 2. Chemical examination of water samples in different

Railway stations

SL.NO	Chemical Examination	A	B	C	D	E	F
1	pH	**6.98**	**6.75**	**6.36**	**7.43**	**8.16**	**7.85**
2	Total Hardness	**12**	**40**	**56**	**156**	**224**	**260**
3	Total Alkalinity	**10**	**20**	**44**	**140**	**288**	**180**
4	Chloride	**7**	**18**	**32**	**60**	**172**	**206**
5	Sulphate	**<5**	**<5**	**<5**	**8**	**22**	**26**
6	Nitrate	**<2**	**<2**	**<2**	**2**	**4**	**3**
7	Fluoride	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
8	Conductivity	**50**	**103**	**198**	**442**	**1230**	**1070**
9	P –Alkalinity	**0**	**0**	**0**	**0**	**0**	**0**
10	Calcium	**5**	**16**	**18**	**37**	**50**	**64**
11	Magnesium	**0**	**0**	**3**	**9**	**18**	**19**
12	Sodium	**-**	**-**	**-**	**-**	**-**	**-**
13	Potassium	**-**	**-**	**-**	**-**	**-**	**-**
14	Iron	**0.24**	**0.12**	**0.24**	**0.24**	**0.24**	**0.35**
15	Manganese	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
16	Ammonia	**0.04**	**0.08**	**0.08**	**0.04**	**0.08**	**0.01**
17	Nitrite	**0.01**	**0.03**	**0.03**	**0.01**	**0.01**	**0.01**
18	Total Phosphate	**0.10**	**0.15**	**0.10**	**0.05**	**0.10**	**0.10**
19	Tidys	**0.24**	**0.28**	**0.24**	**0.28**	**0.36**	**0.32**
20	Residual Chlorine	**0**	**0**	**0**	**0**	**0**	**0**

Figure 2 & 3 : The level of Chemical Examination value of water samples collected from various Railway stations

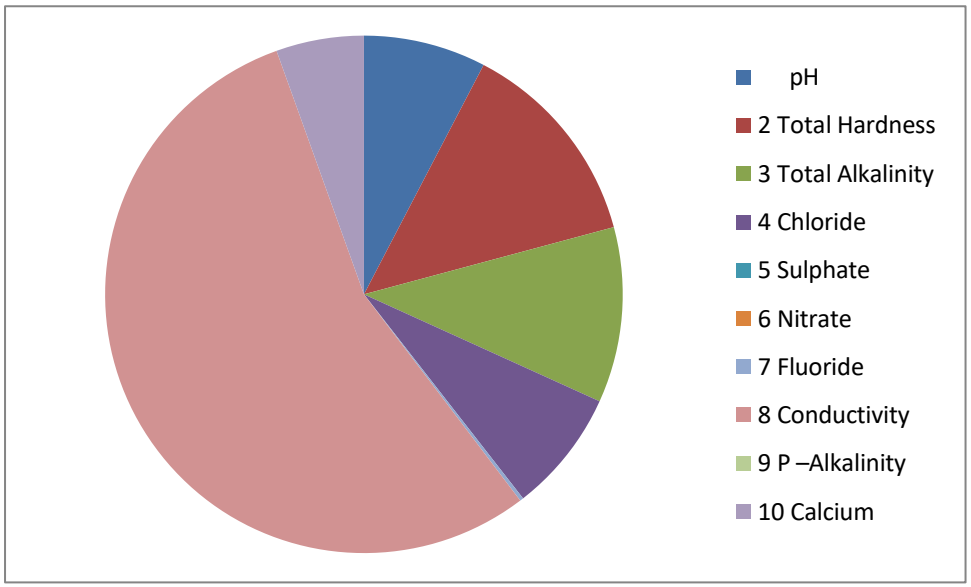


Fig :2

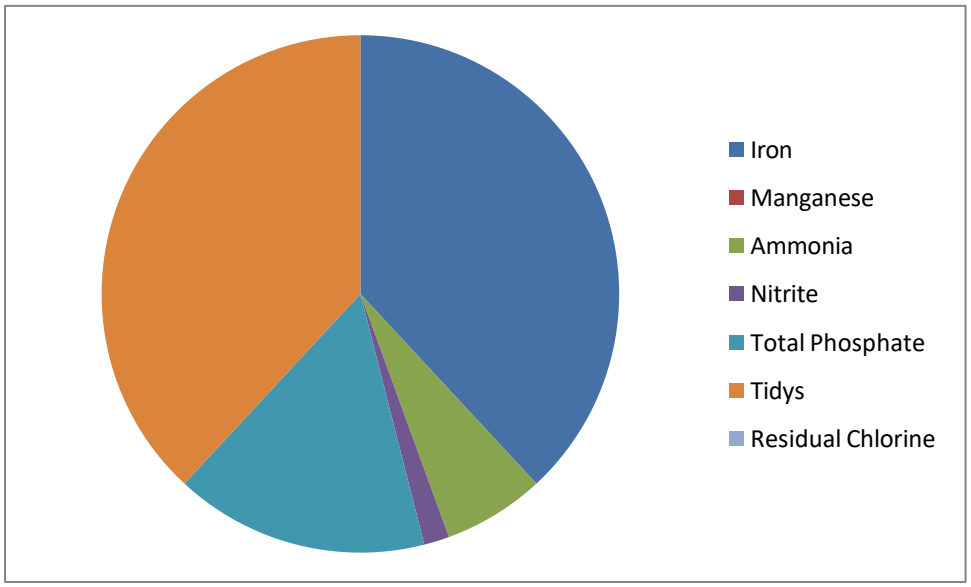


Fig :3

DISCUSSION

Increase in human population has exerted an enormous pressure on the provision of safe drinking water especially in developing countries (Umeh et al.,2005) unsafe water is global public health threat, placing persons at rest for a hosts diarrheal and other disease as well as chemical intoxication (Hughes and koplam,2005). Therefore , it becomes imperative to evaluate the physical, chemical qualities of these sachet water sold in the market to ascertain whether they conform to recommended standards for portable water (Taiwo et al., 2012).

The physical and chemical water analysis such as p^H, Total hardness, Total alkalinity, chloride, sulphate, nitrate, fluoride, appearance, colour, odour, turbidity, Total dissolved solids, conductivity, alkalinity, calcium, magnesium, sodium, potassium, iron, manganese, ammonia, nitrite, phosphate, tidy's, residual chlorine were analysed.

The quality of water is an important aspect as the poor quality of water will adversely influence the normal functions in all the systems (Glarson, 2002). Both surface and groundwater contain a lot of dissolved impurities and suspended materials.

The temperature ranged between 26.5 C and 29.5 C. This parameter is one of the most imported parameters for aquatic environment because almost all the physical, chemical and biochemical parameter of water are temperature depended (Edema et al.,2001).

The presence of solid particles in water indicated the level of contamination (Oinam et al., 2006). pH used to express the intensity of acidic or alkaline condition of a solution (Bhudhathoki., 2010). The pH values observed for the water samples were between 6.36 to 8.16 P of the sample C and E, a below the range of 6.5 -8.5 specified by WHO (6.5 to 8.5).

Electrical conductivity is the measure of the capacity of water to conduct electric current (Bhudhahoki 2010). In the present study for conductivity sample E has the maximum value of 93 micro mho/ cm. High value of conductance indicate high dissolved gas and other chemical in water (Bhudhathoki 2016).

The calcium and magnesium are the most abundant elements in the groundwater . Calcium is an essential nutritional element for human being and aids in maintaining the structure of plant cells and soils. Magnesium is constituent of bones and is essential for normal metabolism of calcium. Its deficiency may lead to protein energy malnutrition. The acceptable limits of calcium and magnesium are 75 mg/L and 30 mg/L respectively lower concentration of calcium and magnesium were observed in certain location.

The hardness is mainly contributed by bicarbonates, carbonates, sulphates and chlorides of calcium and magnesium. The highest value of total water hardness of water sample F is 240 mg/L as CaCO3. If these components are present in high concentration than this leads to encrustation in water supply structure and adversely affect use of water (Durfor and Becker 1964).

The highest concentration of sodium ion in drinking may cause heart problems. The permissible limit of drinking water as prescribed by BIS is 50 mg/L. In this water sample there is no presence of sodium. Potassium is an important caution and plays a vital role in intermediate metabolism. Potassium is an essential nutrient for both plants and human life. However , ingestion of excessive amounts may prove determined to human beings.

Alkalinity of water is its acid neutralizing capacity. The acceptable limits of alkalinity is 200 mg/L and in the absence of alkalinity up to 600 mg/L is acceptable for drinking. The range of Total Alkalinity of water sample E is 288 mg/L.

The maximum permissible limit of chloride in potable water is 250 mg/L (Trivedy and Goel, 1984). In the analysed water samples, the concentration of chloride varied from 7 to 206 mg/L. The chloride content of water sample when compared with in BIS standard then it was found that all samples showed concentration with the permissible limit.

Fluoride concentration in all these samples found to be within permissible limit.

The acceptable limit of sulphate is 200 mg/L. The sulphate content in analysed water samples varied from <5 to 26 mg/L. The iron content of water A, B and C showed same value and the water sample E and F is relatively low value.

CONCLUSION

The Physio – chemical parameters of the drinking water sample taken from different Railway stations were assessed.The physical characters like appearance, colour, odour, turbidity, dissolved solids and electrical conductivity were evaluated and it was found that the appearance was almost clear in six samples (A, B, C, D,E & F).While evaluating the chemical parameters of various samples (A, B, C, D, E &F), it was found that almost agreeable with the permitted limit in all the samples. Hence concerned authorities must follow WHO standards for providing healthy and hygienic drinking water in their Railway stations premises. This type of study should be conducted from time to time to ensure quality of drinking water.

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