Physico-Chemical and Microbial analysis of various drinking water sources in Chengalpattu District (Tamilnadu) India

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Abstract- This study investigates the physicochemical and Microbiological properties of various drinking water sources in Chengalpattu District. Standard methods were employed for the physicochemical analysis of the water samples, while microbial isolation was conducted using the streak plate method on nutrient agar and selective media for identification purposes. The physicochemical characteristics of all water samples were found to be within the recommended permissible levels set by the WHO. However ,the total plate count exceeded WHO guideline values in five of the water samples, with the highest count observed in tank water. Three bacterial isolates, namely Escherichia coli, Pseudomonas aeruginosa, and Bacillus cereus, were identified, all of which are highly pathogenic. These findings suggest that water in Chengalpattu District is heavily contaminated and not safe for drinking or utility purposes. This study underscores the urgent need for pollution control measures in water bodies.

***KeyWords*:** Water, Chengalpattu, Microbiological, Physicochemical.

1. INTRODUCTION

Water is a vital resource with multifaceted uses encompassing hydroelectric power generation, domestic, industrial, transportation, and commercial applications. Despite covering over three-quarters of the Earth's surface, only a mere 2.8% is suitable for human consumption. Its significance extends beyond sustenance to supporting health, lifestyle, and economic activities [1]. Unfortunately, more than a third of the global population faces moderate to severe water stress due to its limited availability, exacerbated by population growth [2].

Rapid industrialization, mining, agricultural, and urbanization activities have led to widespread contamination of river water with wastewater and hazardous substances. Approximately 70% of water bodies worldwide are polluted by domestic sewage and industrial effluents discharged into natural water sources such as rivers, streams, and lakes [3]. Rivers, in particular, serve as conduits for industrial wastewater and agricultural runoff, perpetuating a cycle of pollution [4].

Freshwater, essential for human existence and agriculture, is finite. Without sustainable access to quality freshwater, healthy living and development are unattainable [5].

The scarcity and degradation of water pose serious challenges due to inadequate water management systems [6]. Given the intimate relationship between water quality and human health, microbial analysis is imperative to ensure water safety. Physicochemical and microbiological assessments are crucial to as certain the portability of water before consumption [7]. Natural water sources are susceptible to contamination from various pollutants [8], leading to the proliferation of infectious diseases, particularly among children, caused by enteric pathogens such as enterotoxigenic Escherichia coli, Shigella spp., and Vibrio cholerae O1 [9].

A diverse array of microbes , including bacteria, fungi, protozoa, algae, and viruses, inhabit water ecosystems, forming intricate dynamics that are often challenging to comprehend [10]. The presence of fecal coli forms indicates potential pathogenic microorganisms, posing a risk of waterborne diseases [11]. Groundwater resources are especially vulnerable to pollution, with quality fluctuating seasonally [12,13]. Pollution stems from natural processes as well as human activities, including chemical and microbial contamination through surface runoff and direct waste injection [14].

A comprehensive assessment of water quality necessitates the survey of all potential pathogens posing a risk to human health [15]. The World Health Organization (WHO) has established essential parameters for drinking water quality, including fecal coli forms, chlorine residual, turbidity, pH, dissolved oxygen, and temperature [16]. Water contaminated with agricultural, industrial, or sewage waste poses significant hazards to human consumption [17].

Potable drinking water adheres to WHO guidelines or national standards in terms of physical, chemical, and microbiological characteristics, ensuring its safety for cooking and drinking purposes [17].

Attaining pathogen-free water involves selecting uncontaminated water sources, implementing efficient treatment, and disinfection measures [18][19][20]. Regular monitoring of water quality is crucial for microbiological safety, disease prevention, and socioeconomic development [21]. Therefore, this study aims to conduct a comparative analysis of the physico-chemical and microbiological properties of water samples from rivers, ponds, tanks, and pumps in Chengalpattu District using standardized methods.

The Investigation revealed that the total plate count exceeded WHO guidelines in five water samples, with the highest count observed in tank water. Additionally, three bacterial isolates— Escherichia coli, Pseudomonas aeruginosa, and Bacillus cereus—were identified, highlighting the contamination of water sources in Chengalpattu District.

2. MATERIALS & METHODOLOGYS

Sample Collection:

Water samples were collected from various sources including rivers, lakes, and ponds in Chengalpattu District, TamilNadu, India, between November 2019 and January 2020. Samples were collected in sterile screw-cap bottles and transported to the laboratory in containers filled with a freezing mixture.

Physico-Chemical Characterization:

Physicochemical analysis involves investigating the Interactions between components of a system by studying the relations between physical properties and composition [22].

Biological Oxygen Demand(BOD):

Diluted samples were prepared and filled into BOD bottles, along with dilution water. Additional BOD bottles containing only dilution water were prepared as controls. Initial dissolved oxygen(DO)levels were measured, and the BOD bottles were incubated at 20°C for 5 days. Subsequently, DO content was determined.

Chemical Oxygen Demand(COD):

Samples were diluted and mixed with reagents including Mercury Sulphate, Silver Nitrate, Potassium Dichromate, and concentrated Sulfuric acid. The solution was heated, cooled, and titrated against Ferrous Ammonium Sulphate, with Ferrion used as an indicator. COD in the sample was calculated based on the titration results.

Turbidity:

Samples were poured into graduated glass tubes, and turbidity was determined by observing the disappearance of a candle Flame through the suspension. The reading of the glass tube against the suspension surface provided turbidity measurements in parts per million (ppm).

Total Hardness:

Samples were mixed with Ammonia buffer solution and Eriochrome Black Tindicator, titrated against EDTA solution, and the appearance of blue color indicated the end point. Permanent Hardness:

Samples were boiled to remove carbonates and bicarbonates, and titration against EDTA solution was repeated to obtain consistent values.

pH Measurement:

The pH meter was calibrate dusing standard buffer solutions, rinsed with distilled water, dipped into the sample solution, and readings were recorded after stabilization.

Micro biological Characterization:

Micro biological analysis involves estimating bacterial concentrations in water samples [23].

Sterilization:

Test tubes and pipette tips were sterilize dusing wet sterilizationinanautoclaveat121°Cfor15minutes.The laminar airflow chamber was sanitized with ethanol and irradiated with UV light. Distilled water-filled test tubes were also autoclaved for serial dilution.

Media Preparation:

Nutrient agar medium was prepared in conical flasks and autoclaved for the growth of microorganisms.

Serial Dilution:

Serial dilution was performed by transferring water samples into sterile water and progressively diluting them to achieve concentrations from 10-1 to 10-10.

Spread Plate Technique:

Diluted samples were spread plated on petri plates containing nutrient media using an L-rod and incubated at 37°C.

Isolation of Pure Colonies:

After incubation, colonies were observed, and pure cultures were obtained by quadrant streaking on nutrient plates

Biochemical Characterization of Microorganisms:

Gram staining was performed to differentiate between gram-positive and gram-negative bacteria using crystal violet, iodine solution, decolorizer, and safranin solution.

Overall, the materials and methods described above were Employed to analyze the physico-chemical and microbiological properties of water samples collected from Chengalpattu District.

3. RESULT

TABLE-1: Physico-Chemical Parameters of the Water Samples

S.No	Parameters	Venbakkam	Well water	Kolavai	River water	Tank water
1	pH @ 25°C	7.3	7.1	8.1	7.9	7.9
2	Turbidity (NTU)	<1	<1	32	<1	<1
3	BOD (3 days) @ 27°C (mg/L)	6	<2	46	<2	<2
4	COD (mg/L)	24	<4	184	<4	<4
5	TDS	434	992	1050	396	1388
6	Total hardness as $CaCO_3$ (mg/L)	259	356	248	137	632

TABLE-2: Lists of Bacterial Species and Protozoan Presented in Water Samples

Name of the bacteria	Gram staining	Indole test	Citrate Utilisation test	Catalase test	Methyl red test	Voges-proskaeur test
Escherichia coli	-	+	-	+	+	-
Pseudomonas aeruginosa	-	-	+	+	-	-
Bacillus cereus	+	-	+	+	+	+

Escherichia coli

Escherichia coli is a gram negative bacteria, it is rod shaped and anaerobic. It is found in the lower intestine of warm blooded organisms. *E.coli* causes food poisoning. It can lives together with hydrogen consuming organisms. It is an uropathogenic. Mostly *E.coli* strains do not cause disease. The virulent gene strains causes gastroenteritis, urinary tract infections and neonatal meningitis. It also cause severe abdominal cramps, diarrhoea turns bloody with24hrs.

Uropathogenic *E.coli* mainly cause urinary tract infection. It can lead to faecal contamination of the urogenital orifices. It also cause food borne disease. Antibiotic used for the *E.coli* is azithromycin with an emerging role for rifaximin. Rifaximin is effective in patient with *E.coli* predominant traveller's diarrhoea.

In our present study water analysis collected from various area of Chengalpattu town. The samples were collected from tap water, Kolavai and well water. It has presence in this water samples. The opaque colonies with entire marginal growth on nutrient agar. The water samples are polluted from faecal Contamination in water resource and it cause water borne pathogen. It cause through drinking impure water, livestock waste dumped near to water bodies. Before having food, we have to wash our hands cleanly and consumption of hygienic food and water.

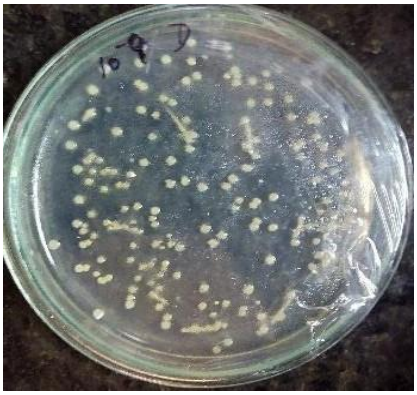

Figure: 1 Escherichia *coli*

Pseudomonas Aeruginosa

It is a common gram negative bacterium. It can cause disease in animals. It is an aerobic bacterium. It is a cocco bacillus bacterium with unipolar motility. It is an opportunistic human pathogens and also for plants. It is rod shape. Pseudomon as exposes a variety of pigments, pyocyanin (blue-green), pyoverdine (yellow-green) and pyorubin (red-brown). It identify preliminarily odour like grape (or) tortilla. It can grow at 42°C also and capable of growth in diesel and jet fuel. It is known as hydrocarbon using microbial corrosion. *Pseudomonas aeruginosa* population is characterized by a few dominant clones wide spread in disease and environment habitat. It will cause infections like septic shock, urinary tract infections, gastrointestinal infection, skin and soft tissue infections haemorrhage and necrosis. It is most common cause of infections of burninjuries. It is found in soil and water. Antibiotics used for infections are ciprofloxacin. Probiotic prophylaxis may prevent colonization.

In our present study water analysis collected from various area of Chengalpattu town. The samples were collected from well water, kolavai and Venbakkam Lake. It has presence of pseudomonas aeruginosa identified on nutrient agar which gives blue green colonies and streak pure colonies of Pseudomonas aeruginosa. It causes water borne pathogen [24].

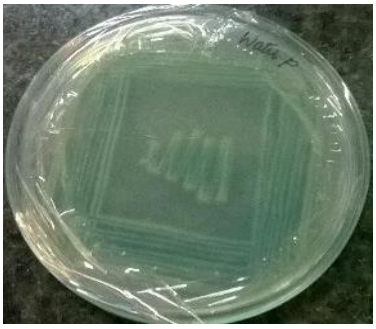

Figure: 2 Pseudomonas *aeruginosa*

Bacillus cereus

It is a gram positive. It is rod shaped and aerobic bacteria. It is mesophilic and growing optimally at temperature between 20°C and 40°C. It can adapt to a wide range of environmental conditions. It is found in soil and wood and also in rhizosphere of some plants.It is mainly spread in foods like, eggs, meat and dairy products. It is causing food borne intoxications. It is source of food poisoning. It is an opportunistic human pathogens and occasionally more serious infections. The waste food is dumped near the water bodies. Waste foods are mixed in the water and also soya waste. People are using contaminated water for defecation. It cause diarrhoea and gastrointestinal tract.

In our present study the water samples are collected from well water samples are collected from well water and venbakkam. *Bacillus cereus* presence identified by nutrient agar, yellowish colonies were observed. It causes food borne pathogens.

Figure:3 *Bacillus cereus*

TABLE: 3 The Major Diseases by Bacterial Species Isolated from Water Samples

Name of Bacteria	Gram Positive (or) Negative	Major Diseases
Escherichia coli	Negative	Urinary tract infection, food borne disease, vomiting, enterotoxin, diarrhoea.
Pseudomonas aeruginosa	Negative	Opportunistic infection in man, Inflammation of middle ear.
Bacillus cereus	Positive	Diarrhoea , vomiting, food borne Disease.

4. DISCUSSION

In this study, various samples were collected from in and around Chengalpattu District. Physical and chemical characterization were analyzed, such as biochemical oxygen demand, chemical oxygen demand, turbidity, total hardness, total dissolved solids, and pH. Microbiological analysis was performed, and various organisms were isolated [25]. The BOD estimated the highest value for Venbakkam Pond(6) and Kolavai Lake(46),showing the highest value compared with other samples. This study creates social awareness for people in and around Chengalpattu District about the pollution levels of water bodies caused by industrial waste and man-made activities.

In the microbiological analysis, the presence of Escherichia coli, Pseudo monasa eruginosa, and Bacillus cereus was isolated [26]. The study also analyzed various samples of bottled drinking water for total hetero trophic bacterial (THB) load and coliforms. This study characterized the physical, chemical, and microbiological analysis in Chengalpattu District [27].

The quality of water was analyzed using physicochemical parameters in Karnataka state. This present study monitored monthly changes in physical and chemical parameters such as turbidity, dissolved oxygen, pH, free carbon dioxide, total hardness, chlorides, alkalinity, phosphate, and nitrates.

5.Conclusion

This experimental investigation was done according to the material properties based on IS specifications and its physical which are obtained through various tests conducted. The

Design mix for M20 grade of concrete was done and verified with the reference of IS code. The compressive strength of Plastic Waste replaced concrete with 10% replacement; it gives acceptable strengthof29.83N/mm2.

Also the compressive strength of Plastic Waste replaced concrete with 10% replacement and Brick Waste replaced concrete with 4% gives an optimum result for casting interlocking Block; it gives acceptable strength of 31.63 N/mm2.

From the test results the interlocking blocks are casted and the Compressive Strength was evaluated and thus we are concluding that the Interlocking concrete block with 10% replacement of Plastic waste with 4% replacement of Brick Waste shows an evident result.

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