



# Evaluation Of Drinking Water From Selected Regions Of Coimbatore District

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**Abstract:** Samples of stored drinking water were received from two regions of Coimbatore District, Tamilnadu, India and the following physicochemical properties such as pH, dissolved oxygen, temperature, biological oxygen demand, alkalinity, turbidity, hardness, dissolved and suspended solids, were assessed using standard protocols along with the microbial examination. The outcomes of the study displayed that all the parameters analyzed were within the tolerable limits in the water stored in copper container when compared to other containers like plastic, silver, underground, overhead and filter. Hence, it shall be resolved that all the water samples collected from Siruvani and Athikadavu which is stored in copper container are more suitable for drinking when compared to other containers like plastic, silver, underground, overhead and filter.

**Keywords:** Dissolved oxygen, turbidity, tolerable, physico-chemical and hardness.

## I. INTRODUCTION

Drinking water is also called as potable water and is safe to drink or to use for food preparation. The drinking water required for each organism differs, and depends on the physical activity, age, health issues, and environmental factors. Most of the biological reactions occur only in water and it is the integrated system of biological metabolic reactions in an aqueous solution which is vital for the sustenance of life [1].

Water covers about 70% of the earth's surface, only 3% of it is fresh. Of this 3% about 75% is tied up in glaciers and polar icebergs, 24% in underground and 1% is available in the form of fresh water in rivers, lakes and ponds which are suitable for human consumption [2]. Globally by the year 2015, 89% of people have admittance to improved water source that is suitable for drinking. Nearly billion people worldwide had access to tap water, while another 2.4 billion had access to wells or public taps [3]. The World Health Organization (WHO) deliberates access to safe drinking water is an elementary human right [3].

Access to safe drinking water is one of the basic human rights and is essential to human health [4]. The quality of drinking water is an essential factor for better human health [5]. An adequate supply of safe drinking water is one of the most challenging tasks in many developing countries [6]. Many people must confront every day the situation of an inadequate supply of water and the very serious consequences [7].

According to The Federal Emergency Management Agency, the water from tap should be stored in sterile vessels. The quality of drinking water is measured as Physical, Chemical and Microbiological [8, 9].

Physical and Chemical parameters include heavy alloys, trace carbon-based complexes, suspended solids and turbidity. Microbiological parameters include Coliform bacteria, and pathogenic bacteria, viruses and protozoan parasites. Chemical parameters result in chronic health risk. Physical parameters affect the aesthetics and taste of the drinking water and may severe the removal of microbial pathogens.

At present situation, the drinking water is highly becoming dangerous by industrial contamination and population explosion. Hence, the need of water supply had been increased enormously. Furthermore, significant part of this limited quantity of water is poisoned by sewage, industrial waste and a extensive range of synthetic chemicals.

This study was based on two aspects of water quality: one is the microbial load and the other is the physical and chemical features. The First is predominantly due to waterborne pathogens, particularly of Enterobacteriaceae. Mostly, waterborne transmission is happening through contaminated drinking water [10]. Contaminated drinking water aids as a vital cause for transmitting both chemical and microbial agents that cause diseases in humans [11]. Hence, this mode of transmission has converted as a public health problem around the world [12].

The primary objective of this research work was to find out the physical and chemical properties along with the pathogenic microorganisms of drinking water samples collected from Coimbatore district.

## II. METHODOLOGY

### Study Area:

Coimbatore is the largest city next to Chennai in the state of Tamil Nadu. It is known for its commercial and industrial centers. It is within  $10.8^{\circ}$  and  $11.13^{\circ}$  (northern latitude) and  $76.87^{\circ}$  and  $77.11^{\circ}$  (eastern longitude). It is with an altitude of 432 meters from msl. On the west, the city is enclosed by mountains, on the east by dry area and on the north by conserved forests and rivers. The city is highly advantageous by receiving rains from the south-west monsoon during June to August which drains into 2 sources viz. Siruvani and Athikadavu.

### 1. Copper container water



### 2. Silver container water



### 3. Plastic container water



### 4. Underground stored water



### 5. Overhead stored water



### 6. Aqua Purified stored water



Fig. 1: Samples of stored drinking water

### Water Sample Collection

Water samples (Fig.1 and Table 1) were collected from five homes getting their drinking water from two water dams namely Siruvani and Athikadavu belonging to Coimbatore District. The water samples were preserved in sealed bottles from the areas of Kanuvai, Perur, Cheranmanagar and Gandhimanagar.

Sample No.	Water Samples
1	Copper Container Water
2	Silver Container Water
3	Plastic Container Water
4	Underground Stored Water
5	Overhead Stored Water
6	Aqua Purified Stored Water

**Table 1: List of Collected Water Samples**

### Sample Preservation and Handling:

The water samples were kept in an icebox to avoid unwanted biological action, deterioration, and taken to the lab for further study and examination.

### Physico-Chemical parameters:

The collected water samples were examined for their pH, Temperature, Suspended and dissolved solids, etc., and also the presence of heavy metals such as Zn, Fe, Cu, Cd and Cr following the standard analytical methods [13 and 14].

### Microbial Examination:

The samples were kept in clean sterilized test tubes. Aseptically, 1 millilitre of each water sample was transferred into test tube containing 9 ml of distilled water that gives  $10^{-1}$  dilution. After which, the samples were blown out over the NA medium and kept at  $35^{\circ}\text{C}$  for 24 hours. After 24 hours the bacterial cultures were studied for their morphology and their load were calculated as colony forming unit using,

$$\text{Colony forming Units / millilitre} = \frac{(\text{no. of cultures} \times \text{dilution factor})}{\text{Volume of culture plate}}$$

## III. RESULTS AND DISCUSSION

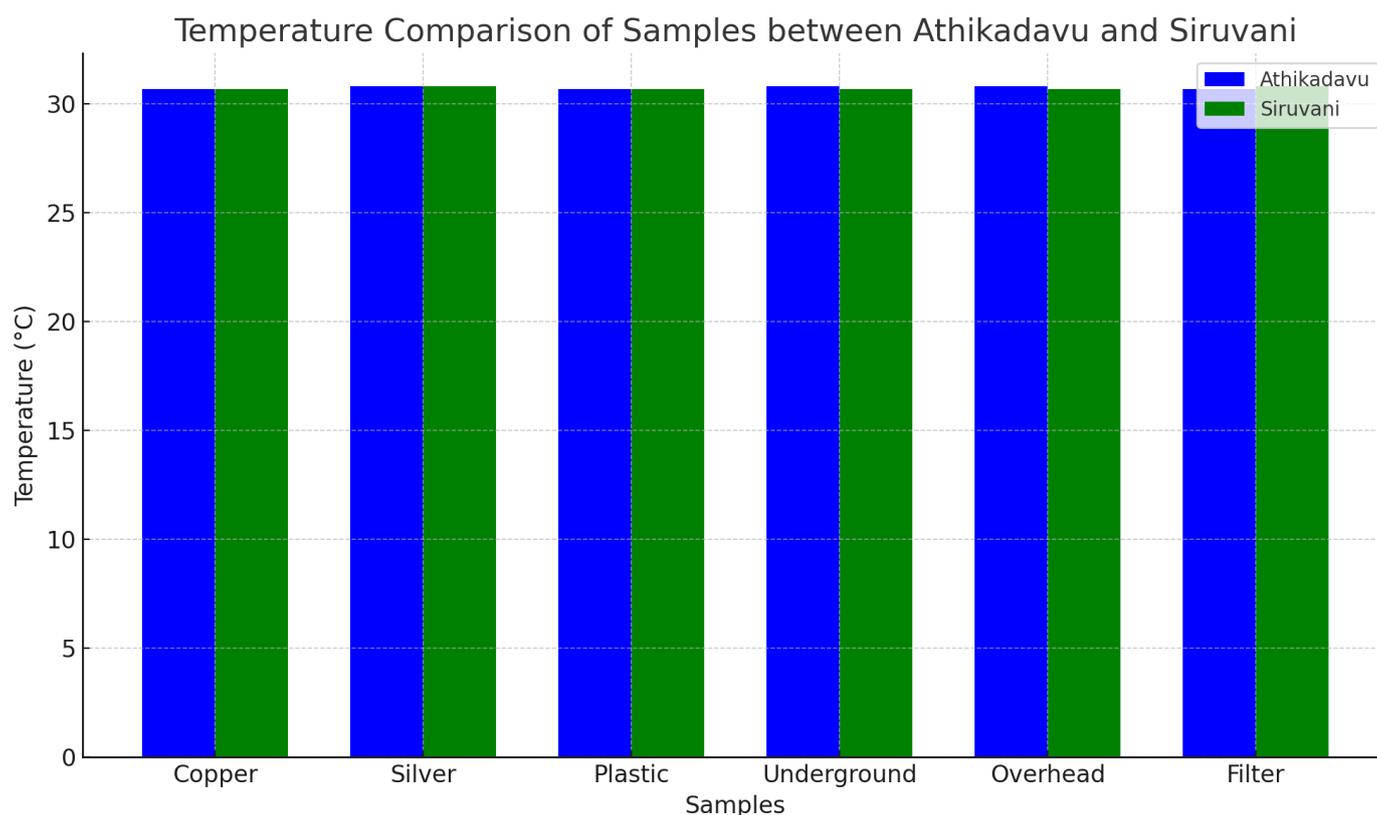
The current work was commenced to study the physical and chemical properties, presence of heavy metals and microbial population in the collected drinking water stored in containers such as silver, copper, plastic, underground tank, overhead tank, Aqua purifier with essential precautions from several regions of Coimbatore district. Standard protocol of World Health Organization was adopted to evade unwanted changes in the characteristics of the samples [3]. The collected samples were under refrigeration and then brought to the laboratory for the examination of the physico-chemical properties and heavy metals. Only the graded chemicals and double distilled water for solution preparation were used.

**PHYSICO-CHEMICAL PARAMETERS:****Temperature:**

Temperature of water always has its direct and indirect effects. The oxygen required for dissolving in water is controlled by temperature. The water solubility and its organic activity are highly influenced by temperature [16]. Temperature of the samples was reasonable i.e. 30°C (Table 2, Fig. 2).

Samples	1	2	3	4	5	6
<b>Athikadavu</b>	30.7°C	30.8°C	30.7°C	30.8°C	30.8°C	30.7°C
<b>Siruvani</b>	30.7°C	30.8°C	30.7°C	30.7°C	30.7°C	30.8°C

**Table 2: Temperature of the water samples**



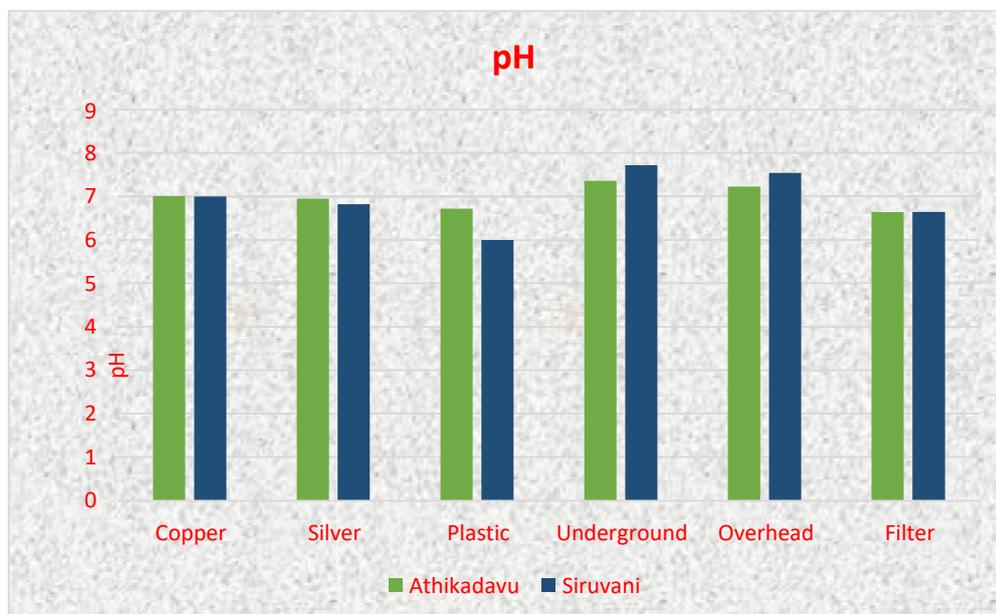
**Fig. 2: Temperature of the water samples**

**pH:**

The steadiness between the absorption of hydrogen and hydroxyl ion in water is defined as pH. Though human health is not affected by pH directly, it is closely related to other water characteristics which are extremely dangerous to human health [17]. The studied drinking water was slightly acidic as well as basic in nature (Table 3) (Fig. 3) which is within the guidelines given by WHO [18] and NEQS [19], i.e. is 6.5–8.5.

Samples	Athikadavu		Siruvani	
	pH observed	Nature (Acidic/Neutral/Basic)	pH observed	Nature (Acidic/Neutral/Basic)
1	7.01	Neutral	7.00	Neutral
2	6.95	Slightly Acidic	6.83	Slightly Acidic
3	6.72	Slightly Acidic	6.00	Slightly Acidic
4	7.36	Slightly Basic	7.72	Slightly Basic
5	7.23	Slightly Basic	7.55	Slightly Basic
6	6.64	Slightly Acidic	6.65	Slightly Acidic

**Table 3: pH of the water samples**



**Fig. 3: pH of the water samples**

### Colour:

The colour of the water samples was clear as crystal (Table 4).

Samples	Athikadavu	Siruvani
1	Clear as crystal	Clear as crystal
2	Clear as crystal	Clear as crystal
3	Clear as crystal	Clear as crystal
4	Clear as crystal	Clear as crystal
5	Clear as crystal	Clear as crystal
6	Clear as crystal	Clear as crystal

**Table 4: Colour of the water samples**

### Aroma:

There was no distinctive aroma in the water samples (Table 5).

Samples	Athikadavu	Siruvani
1	No distinctive smell	No distinctive smell
2	No distinctive smell	No distinctive smell
3	No distinctive smell	No distinctive smell
4	No distinctive smell	No distinctive smell
5	No distinctive smell	No distinctive smell
6	No distinctive smell	No distinctive smell

**Table 5: Aroma of water samples**

### Total Suspended Solids (TSS):

TSS provides the actual weight of the undissolved material in the samples. The TSS of the water samples ranged from 1 gram / litre to 4g/l. The maximum TSS level was observed in Athikadavu (3g) and Siruvani (4g). In Samples 1 and 6, no suspended solids were observed (Table 6 and Fig. 4).

Samples	Athikadavu		Amount of Suspended Solids in 10 ml	Total Suspended Solids	Siruvani		Amount of Suspended Solids in 10 ml	Total Suspended Solids
	Initial Wt	Final Wt			Initial Wt	Final Wt		
1	0.77	0.77	0g	0g/l	1.01	1.01	0g	0g/l
2	0.78	0.79	0.01g	1g/l	0.78	0.79	0.01g	1g/l
3	0.90	0.93	0.03g	3g/l	0.70	0.71	0.01g	1g/l
4	0.83	0.85	0.02g	2g/l	0.85	0.89	0.04g	4g/l
5	0.75	0.76	0.01g	1g/l	1	1.1	0.01g	1g/l
6	0.90	0.90	0g	0g/l	0.80	0.80	0	0g/l

Table 6a: Total Suspended Solids in the water samples

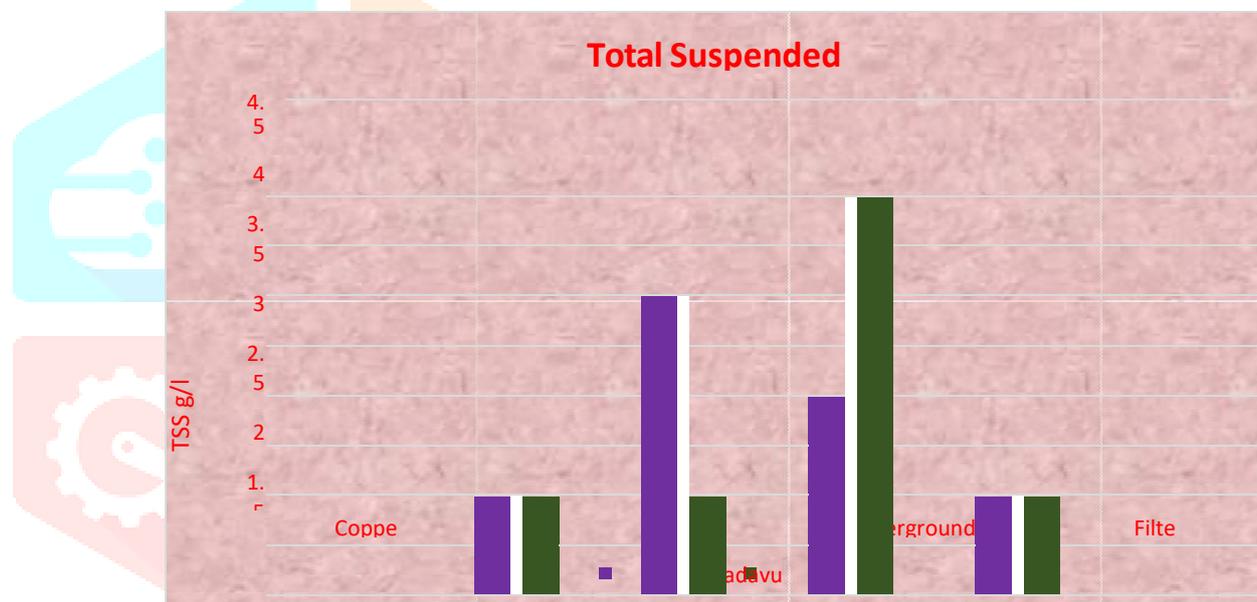


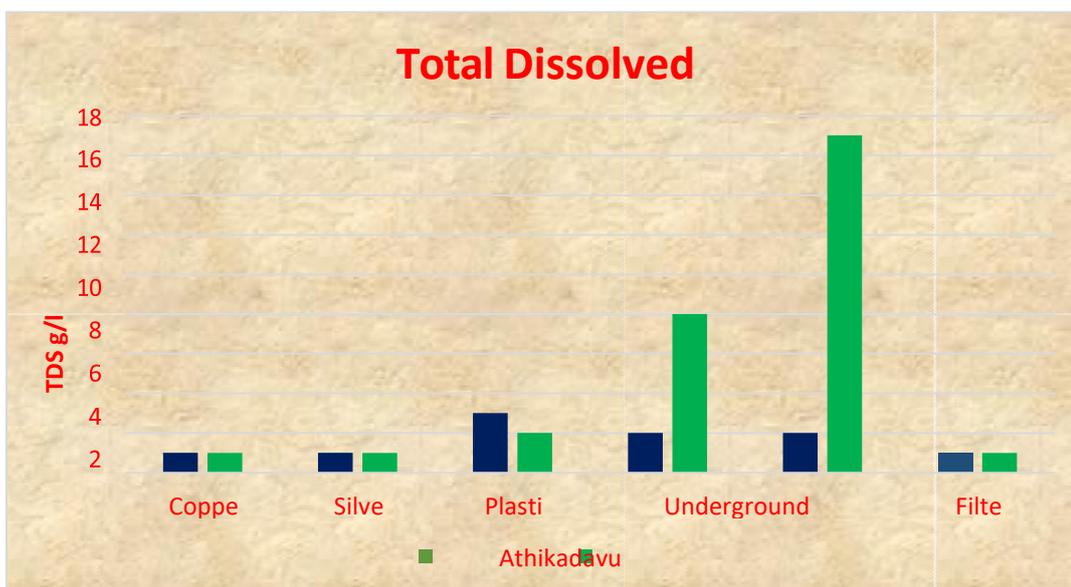
Fig. 4: Total Suspended Solids in the water samples

### Total Dissolved Solids (TDS):

Total Dissolved Solids is defined as the concentration of all diffused minerals in water that states the salinity nature of water. The TDS in the water samples ranged from 6g/l to 9g/l. The maximum TDS was observed in Athikadavu (3g/l) and Siruvani (17g/l) (Table 7 and Fig. 5). As per the guidelines of World Health Organization, Total Dissolved Solids in drinking water should be between 100–600 ppm [20]. The results showed the TDS range within the recommended limit.

Samples	Athikadavu		Amount of Dissolved Solids in 10 ml	Total Dissolved Solids	Siruvani		Amount of Dissolved Solids in 10 ml	Total Dissolved Solids
	Initial weight	Final Weight			Initial Wt	Final Wt		
1	49.62	49.63	0.01g	1g/l	43.06	43.16	0.01g	1g/l
2	44.20	44.21	0.01g	1g/l	50.13	50.23	0.01g	1g/l
3	49.13	49.16	0.03g	3g/l	49.63	49.83	0.02g	2g/l
4	43.03	43.05	0.02g	2g/l	50.63	51.43	0.08g	8g/l
5	50.70	50.72	0.02g	2g/l	48.34	48.51	0.17g	17g/l
6	44.20	44.21	0.01g	1g/l	42.98	43.10	0.01g	1g/l

Table 7: Total Dissolved Solids in the water samples



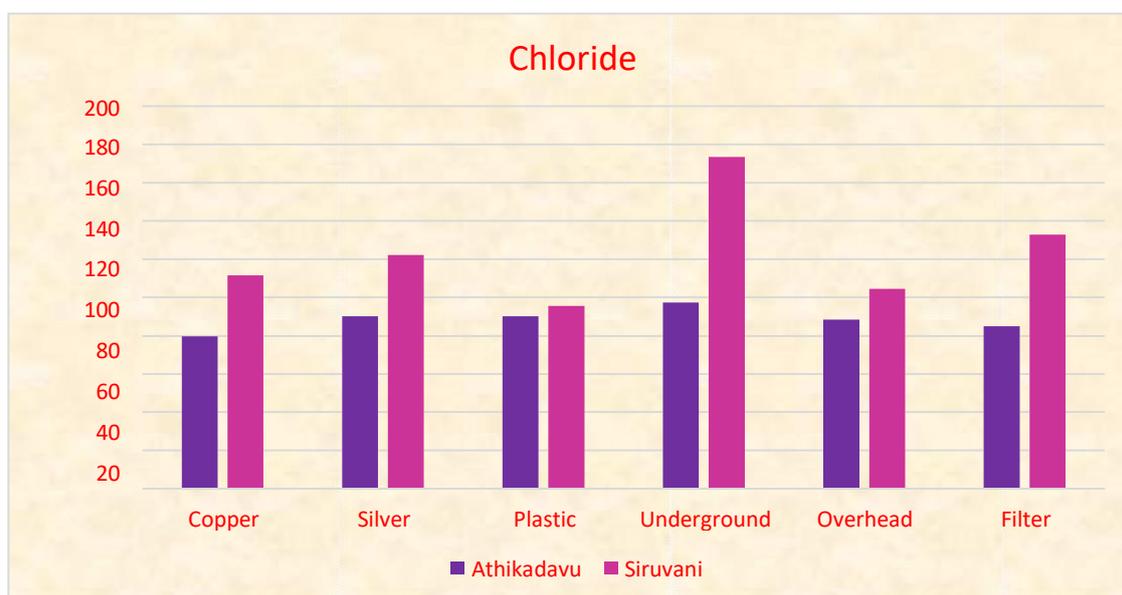
**Fig. 5: Total Dissolved Solids in the water samples**

**Chloride:**

Excess of 250mg/litre of Chloride concentrations shall increase detectable taste in water, but the overall concentration is dependent on the associated cation. Hence, consumers shall, become adapted to excess of 250 mg/litre concentration. The maximum chloride content was observed in underground water from both Athikadavu and Siruvani and minimum chloride content was observed in copper container water of Athikadavu (79.65 mg/l) and Plastic container water of Siruvani (95.58 mg/l) (Table 8, Fig. 6). Chloride concentration above 250 ppm in water disturbs the taste of drinking water [21]. But in the present study, the chloride concentration is within the acceptable limit.

Samples	Athikadavu (mg/l)	Siruvani (mg/l)
1	79.65	111.51
2	90.27	122.13
3	90.27	95.58
4	97.35	173.46
5	88.50	104.43
6	84.96	132.75

**Table 8: Chloride content in the water samples**



**Fig. 6: Chloride content in the water samples**

### Total Hardness:

The total quantity of salts of calcium and magnesium fixes the water hardness. Higher the calcium and magnesium in water, harder the water. It is expressed as milligrams of Calcium Carbonate per liter, also known as ppm. Calcium carbonate concentrations between 60 to 120 ppm makes water moderately hard, 120 to 180 ppm being hard, and 180 ppm very hard. In drinking water, the maximum hardness level is between 40 to 80 ppm whereas the minimum level is between 20-30 ppm. The maximum hardness was seen in Overhead tank from Athikadavu and Siruvani and the minimum hardness in silver container from Siruvani i.e. 360 ppm (Table 9, Fig. 7). From the study, it can be noted that the Water hardness is more than the specified limit in the water stored in Overhead tank both in Athikadavu and Siruvani.

Samples	Athikadavu (in ppm)	Siruvani (in ppm)
1	680	440
2	600	360
3	720	600
4	1120	3320
5	760	720
6	760	720

Table 9: Total hardness of the water samples

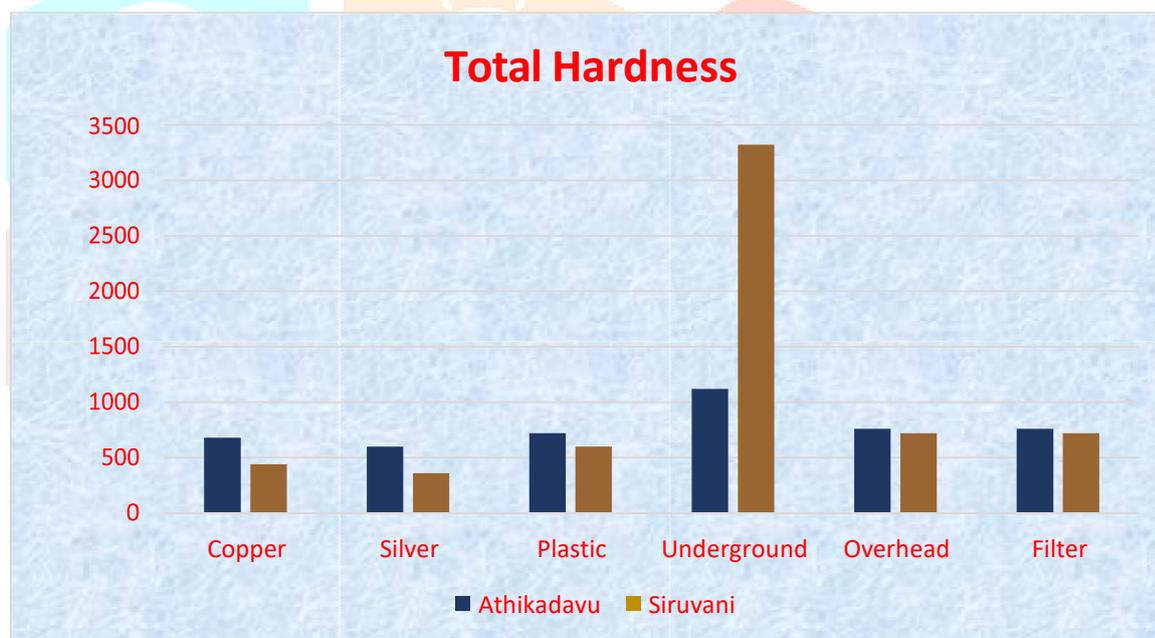


Fig. 7: Total Hardness of the water samples

### Free Carbon dioxide:

The maximum free carbon dioxide was tabulated in Underground water in Athikadavu and Overhead tank in Siruvani. The free carbon dioxide was low in Silver and Plastic containers (Table 10, Fig.8).

Samples	1	2	3	4	5	6
Athikadavu	8mg/l	4mg/l	4mg/l	20mg/l	16mg/l	6mg/l
Siruvani	6mg/l	10mg/l	24mg/l	20mg/l	70mg/l	18mg/l

Table 10: Free carbon dioxide content in the water samples

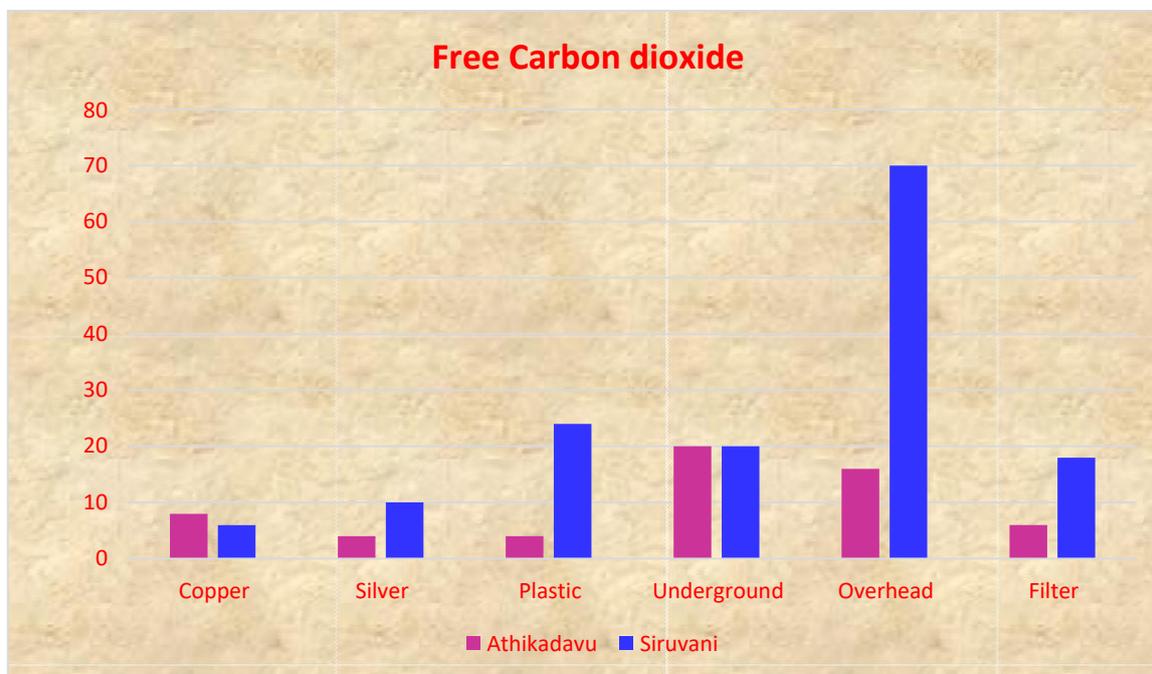


Fig. 8: Free Carbon dioxide content in the water samples

**Chemical Oxygen Demand (COD):**

The Chemical Oxygen Demand is the quantity of oxygen expended from chemically oxidized contaminated water to inorganic end products. Highest Chemical Oxygen Demand was seen in Plastic Container and Overhead tank and the lowest COD was in Filter water (Table 11, Fig. 9).

Samples	1	2	3	4	5	6
Athikadavu (mg/l)	207	0.77	365	236	231	0.65
Siruvani (mg/l)	236	232	196	339	514	249

Table 11: Chemical Oxygen Demand in the samples

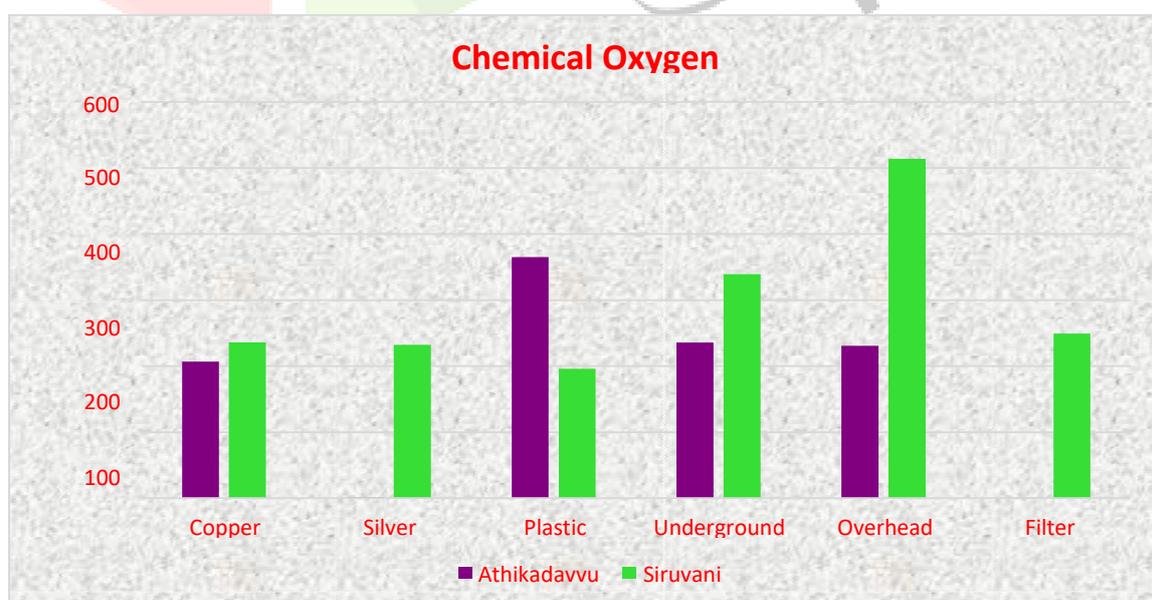


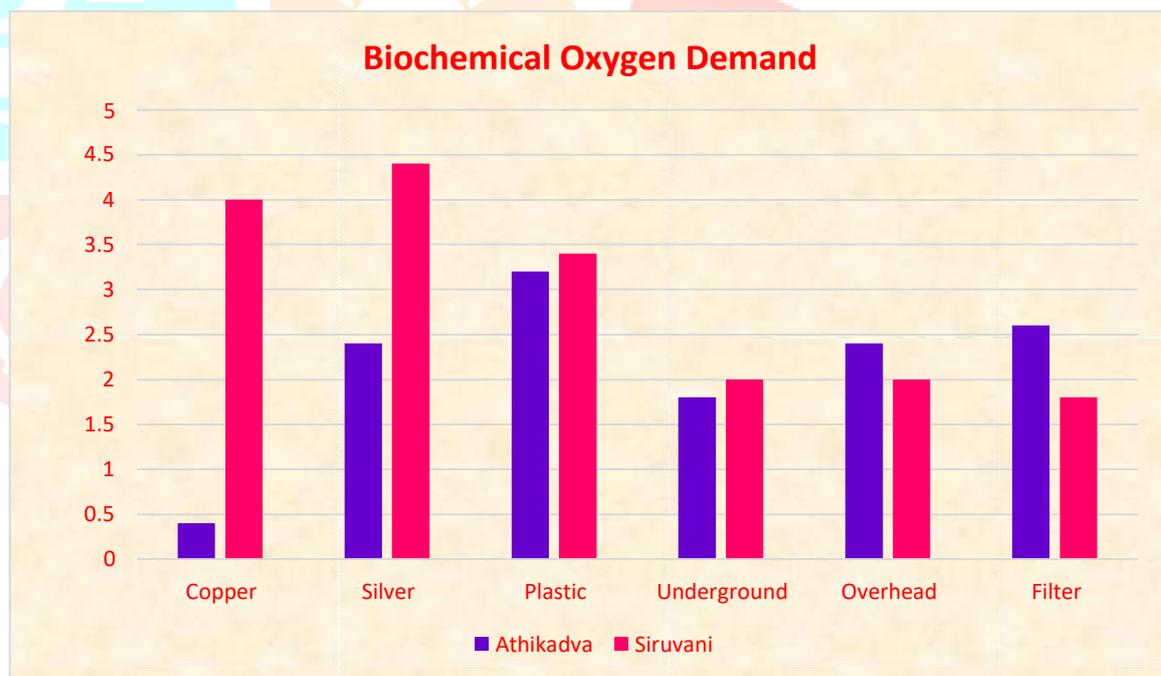
Fig. 9: Chemical Oxygen Demand in the samples

**BIOCHEMICAL OXYGEN DEMAND (BOD):**

Biochemical oxygen demand is the amount of dissolved oxygen required by aerophilic organisms to convert organic matter in water at a given temperature and stipulated time period. Maximum of BOD i.e. 3.2mg O<sub>2</sub>/l was noticed in Plastic container from Athikadavu and 4mg O<sub>2</sub>/l in copper container from Siruvani. The minimum amount of BOD was seen in copper container from Athikadavu (0.4 mg O<sub>2</sub>/l) and Filter water from Siruvani (1.8 mg O<sub>2</sub>/l). (Table 12, Fig. 10)

Samples	Athikadavu		BOD Value (O <sub>2</sub> /l) (3 days)	Siruvani		BOD Value (O <sub>2</sub> /l) (3 days)
	Initial Value	Final Value		Initial Value	Final Value	
1	2.7	2.6	0.4 mg	3.5	2.5	4 mg
2	2.75	2.15	2.4 mg	3.35	2.25	4.4mg
3	3.15	3.35	3.2 mg	3.35	2.5	3.4 mg
4	2.8	2.35	1.8 mg	3.1	2.6	2 mg
5	3.25	2.65	2.4 mg	2.7	2.2	2 mg
6	3.1	2.45	2.6 mg	2.7	2.25	1.8 mg

**Table 12: Biochemical Oxygen Demand in the water samples**



**Fig. 10: Biochemical Oxygen Demand of the water samples**

**HEAVY METAL ANALYSIS:**

The results of the heavy alloys present in the stored water are depicted in Tables 13a and 13b. The concentration of heavy alloys in the analyzed water samples was found to be in the order of Overhead tank >Silver, Plastic, Underground, Filter > Copper container.

The data exhibited that the heavy metals' concentrations were found to be high in copper container (Cd), (Cu), (Fe), silver container (Cr), (Fe), plastic container (Cd), (Fe), underground tank (Cr), (Fe), overhead tank (Fe) and filter water (Cr), (Fe). All the water samples found to contain high Fe concentration when compared to that of World Health Organization data.

Heavy Metals	Athikadavu						Acceptable concentration (ppm) [15]
	Samples						
	1	2	3	4	5	6	
Cadmium	0.004	-0.001	0.008	-0.003	0.002	-0.002	0.003
Chromium	0.01	0.06	0.03	0.09	-0.03	0.22	0.05
Copper	3.05	0.80	0.98	0.91	0.94	1.01	2.00
Zinc	0.67	0.22	0.29	0.26	0.27	0.25	3.0
Iron	0.87	0.69	0.51	0.68	0.96	0.70	0.2

**Table 13 a: Heavy metal concentration in the samples of Athikadavu**

The data (Table 13 b) displayed that the heavy metals' concentrations were found to be high in copper container (Fe), silver container (Cr), (Fe), plastic container (Fe), underground tank (Fe), overhead tank (Cr)(Fe) and filter water (Fe) when compared with that of the guidelines suggested by the World Health Organization. The iron content of the water samples obtained in the present study is in line with the previous works [22, 23].

Metals	Siruvani						Acceptable concentration (ppm) [15]
	Samples						
	1	2	3	4	5	6	
Cadmium	-0.00	-0.00	-0.00	-0.01	-0.00	-0.01	0.003
Chromium	0.04	0.08	0.03	0.05	0.06	0.03	0.05
Copper	1.64	0.92	0.97	0.84	0.89	1.14	2.00
Zinc	0.34	0.25	0.26	0.45	0.30	0.31	3.0
Iron	0.99	1.13	0.91	1.19	0.90	0.88	0.2

**Table 13 b: Heavy metal concentration in the samples of Siruvani**

#### MICROBIAL CONTAMINATION:

From the present study, it has been noted that the bacteria *Escherichia coli*, *Streptomyces sps* were present in the stored water samples.

#### COUNT OF THE BACTERIAL COLONIES:

The maximum number of bacteria was found in **plastic containers** from Siruvani, Athikadavu and the minimum number of bacteria was found in **copper containers** from Siruvani, Athikadavu.

Samples	Athikadavu	Siruvani
Copper	0	0
Silver	2	0
Plastic	150	200
Underground	1	2
Overhead	2	3
Filter	1	2

**Table 14: Count of Bacterial Colonies**

Samples	Athikadavu		Siruvani	
	Dilution factor $10^{-4}$	Dilution factor $10^{-5}$	Dilution factor $10^{-4}$	Dilution factor $10^{-5}$
Copper	0	0	0	0
Silver	0.0004	0.00004	0	0
Plastic	0.03	0.0003	0.04	0.004
Underground	0.0002	0.00002	0.0004	0.00004
Overhead	0.0004	0.00004	0.0006	0.00006
Filter	0.0002	0.00002	0.0004	0.00004

**Table 15: Colony Forming Unit in the water samples**

From the above table 15, it is clear that plastic has high colony formation (0.03/0.5ml). The results of the current work indicates that the drinking water stored in copper containers are safe to drink as copper acts as natural purifier and hence safer than filters.

#### IV. CONCLUSION

From the results of our study, it can be resolved that all the water samples collected from Siruvani and Athikadavu stored in copper container are more suitable for drinking when compared to the rest of the containers namely plastic, silver, underground, overhead and filter.

#### Credit authorship contribution statement

**Dr. Rehana banu Haroon** was responsible for conceptualization, data curation, formal analysis, drafting communication, reviewing and editing the manuscript. **Ms. Tharani Santhi Ramasamy** was responsible for conceptualization, data curation, formal analysis, validating, reviewing and editing the manuscript. **Ms. Navena Vetriselvan** was responsible for conceptualization, data curation, formal analysis, drafting, supervising, validating, reviewing and editing the manuscript.

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