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Research Article

Effect of Treated and Untreated Domestic Sewage Water Irrigation on Tomato Plants

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Abstract

Background and Objectives: Agricultural cultivations in the world are suffering from water shortages. Water scarcity poses challenges in the economy and health of people all over the world. The present study aimed the cultivation of tomato plants using groundwater, treated and untreated domestic sewage water and tried to make a comparative study on the heavy metals present in the leaves and fruits of the tomato plants. **Materials and Methods:** The water samples were analyzed for various physicochemical parameters such as; pH, total hardness, chloride, total alkalinity, dissolved oxygen and heavy metal. Stomatal conductance was measured using porometer. The heavy metal analysis was conducted using Atomic Absorption Spectrometer. **Results:** All physicochemical parameters were found to be below the permissible level of standard values in the groundwater and treated domestic sewage water, but above the permissible level in untreated domestic sewage water. Stomatal conductance was found to be very low in the plants treated with untreated domestic waste water (296.33/428 in the ventral surface during the morning and noon, respectively) when compared to the leaves of the plants treated with other water samples. Untreated domestic sewage water showed a very high level of lead, i.e., 7.5354 ppm, whereas the treated sewage water contained 0.5650 ppm slightly above the permissible level. **Conclusion:** The present study has revealed that the treated domestic sewage water would be used for the irrigation of agricultural cultivation.

Key words: Domestic sewage water, alkalinity, chemical oxygen demand, porometer, hardness, stomatal conductance

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Water pollution is known to everyone. However, most of the people are unaware of how it affects the food chain itself, such as the plants and vegetables as a whole. The plants including vegetables and herbs, absorb the heavy metals in the water. Human beings ate many things without looking into the quality of the products. Recent trends of the people are to depend on the village food or homemade vegetables, which we think that they are perfectly pure. Not all those products may be cultivated in systematic and scientific methods. The farmers, especially those who are involved in the cultivation of vegetables and fruits commercially, may adopt the unscientific methods to increase productivity. Many of us are not aware of the type of water that is used in the cultivation. Due to the scarcity of water, especially in underdeveloped countries, the people are forced to use sewage water for the cultivation, which may invite severe health issues in the people. So, the underlying purpose of this study was to understand how contaminated water will affect the vegetables, especially the fruits. If it was affecting the fruits, it would directly affect the human body also[1]. Some physiological changes in the plants also have to be observed. Cultivations in the world are suffering from water shortages due to several factors, such as; climate change, surface and groundwater pollution[2]. Water scarcity poses serious economic, social and even political concerns all over the world. Under these circumstances, studies are going on the use of treated wastewater to mitigate the damaging effects of local water deficit[3]. So, the study of water bodies has gained immense importance in recent years because of their multiple uses for human consumption, agriculture and industry[4,5]. Freshwater has been of great importance to human beings and other organisms of the environment for the sustenance of life and maintaining the balance of nature, hence, water is the lifeblood of the earth[6]. Water is a prime natural resource and a basic human need. Wetlands, freshwater and its resources are economically important for the healthy survival of living beings on earth and so has become a cause of concern during this era of global warming[6,7]. The tomato plants are considered more adaptive to many kinds of stresses especially salt stress and metals[8]. So, in the present study the tomato plants were selected to know the extent of the adaptability of the plants to the sewage water.

The physicochemical and bacteriological methods are used to detect the effects of pollution on water quality[9]. The defilement of water and deterioration of aquatic system have become more challenging due to the industrialization, urbanization, developmental and agricultural activities. Unplanned and excessive exploitation and mounting anthropogenic influences in and around aquatic ecosystem have resulted in pollution problems[10]. To reuse the polluted and contaminated water after the treatment has become more common, but its safety parameters are not often tested. Physico-chemical analysis of water will help in this process. Therefore, this study focussed on the cultivation of tomato plants using groundwater, treated and untreated domestic sewage water and tried to make a comparative study on the heavy metals present in the leaves and fruits of the tomato plants. Moreover, this was conducted to establish the quality of the water that recycled through a Sewage Treatment Plant (STP) in CHRIST (Deemed to be University).

MATERIALS AND METHODS

Study area: The present study was carried out in the Life Science laboratory of Department of Life Sciences, CHRIST (Deemed to be University), Bangalore. The total duration of this study was from 15 June, 2019 to 10 March, 2020.

Water samples: The water samples were collected from treated and untreated domestic sewage water from the Sewage Treatment Plant (STP) of CHRIST (Deemed to be University) and the groundwater from the bore well. The water samples were collected in a sterilized plastic container of 1 L and were analyzed for various physicochemical parameters such as; pH, total hardness, chloride, total alkalinity, dissolved oxygen and the detection of different heavy metals was done using AAS. The procedure for analysis was followed as per standard methods of analysis of water.

Plant samples: Tomato seedlings were collected from Chandapura and planted in CHRIST (Deemed to be University) Campus. They were planted in different pots and filled with the same soil samples for the homogeneity. Nine tomato plants were arranged for each water samples. The experiment was conducted from June, 2019 to March, 2020.

Determination of pH: The pH of the water samples was determined using the pH meter following the standard protocol for the determination of pH.

Estimation of Dissolved Oxygen (DO)

Preparation of reagents: For the preparation of 40% $MnSO_4$ solution, 40 g of manganous sulphate crystals were dissolved in a little volume of distilled water and made the final volume to 100 mL. The standard alkaline iodide was prepared by dissolving 500 g of NaOH or 135 g of NaI or 150 g of KI in distilled water and dilute to one litre. For the 1% starch solution, 1 g of starch was dissolved in a little volume of distilled water and make the final volume to 100 mL. For the preparation of the standard sodium thiosulphate (0.025 N) 6.205 g of sodium. Thiosulphate was dissolved in freshly boiled and cooled distilled water and dilute[10,11] to 1 L.

Methodology: About 300 mL Biochemical Oxygen Demand (BOD) bottle was filled with the water sample and stoppered the bottle, so that extra water overflows and then added 1.5 mL of 40% manganous sulphate solution with a pipette, keeping its tip well below the surface of the water in the reagent bottle. Similarly added 1.5 mL of alkaline iodide to the sample, stoppered the bottle carefully without enclosing air bubble and then shaken the bottle well by inverting the bottle several times. Allowed the precipitate to settle down. After a few seconds added 1 mL of concentrated sulphuric acid. stoppered the bottle and shaken well. About 20 mL of the sample was poured into a conical flask and added five drops of the starch solution, the sample turned blue. Then it was titrated against the standard $NaHSO_4$ taken in the burette. Complete disappearance of blue was considered as the endpoint[10-12].

The DO was calculated as the amount of oxygen per litre of the sample using the following formula:

$$DO\ (mg\ L^{-1}) = V_1N\times8\times1000\times V_2/V_4\times V_2\text{-}V_3$$

Chemical Oxygen Demand (COD)

Indicator: Ferroin was used as indicator. Standard potassium dichromate solution: (0.0167 M), sulphuric acid reagent catalyst solution and standard ferrous ammonium sulphate solution (0.1 N) were used in the estimation COD. About 2.5 mL of the water samples were added to each of the two COD vials and the remaining COD vial was for the blank, this COD vial was added with distilled water. Then immersed the flask in cold water and slowly added 3.5 mL silver sulphate sulphuric acid reagent with continuous shaking through the open end of condenser attached. Then added 1.5 mL of $K_2Cr_2O_7$ to this solution and mixed the content of the flask. The COD vials were placed into the COD incubator at 150°C and heated for 2 h. After the incubation, the vials were removed from the digester and allowed it to cool to the room temperature. The prepared water samples were titrated against the ferrous ammonium sulphate solution and then performed a blank titration by using distilled water in place of sample solution exactly following the same steps[11,12].

Estimation of alkalinity: Almost 20 mL of water sample was pipetted out into a conical flask. Added 1-2 drops of phenolphthalein, rinsed and filled the burette with 0.02 N HCl. If pink colour was developed in the sample, it was titrated against 0.02 N HCl till the pink colour just disappeared. Noted down the reading and repeated to get three concordant readings. About 20 mL of the water sample was taken in a conical flask and added 2-3 drops of methyl orange indicator to it. Then it was titrated against 0.02 N HCl till a red colour is obtained. Recorded the observation and repeated to get three concordant readings[13].

Calculation: Using the following formula, the total alkalinity of water samples are calculated:

- Phenolphthalein alkalinity in terms of calcium carbonate equivalence:

Acid	=	Water sample
N1 V1	=	N2 V2
$0.02\times V1$	=	$N2\times20$
N2	=	$0.02\times V1/20$

Strength in terms of $CaCO_3$ equiv. = N2 x Equivalent weight of $CaCO_3$:

$$= N2\times50\ g\ L^{-1} = X\ g\ L^{-1}$$

Phenolphthalein alkalinity = X x 1000 mg L^{-1} = X x 1000 ppm

- Methyl orange alkalinity in terms of $CaCO_3$ equivalence

Acid	=	Water sample
N1V1	=	N2V2
$0.02\times V1$	=	$N2\times20$
N2	=	$0.02\times V1/20$

Strength in terms of $CaCO_3$ equiv = N2 x equivalent weight of $CaCO_3$:

$$= N2\times50\ g\ L^{-1} = Y\ g\ L^{-1}$$

Methyl orange alkalinity or total alkalinity of water sample = $Y\times1000$ mg L^{-1}

Estimation of the total hardness of the water samples: Total hardness was due to the presence of bicarbonates, chlorides and sulphates of calcium and magnesium ions. The total hardness of water was estimated by titrating the water sample against EDTA by using Eriochrome Black-T (EBT) indicator. About 20 mL of the given water sample was pipetted out into a clean conical flask. About 5 mL ammonia buffer and two drops of EBT indicator were added and titrated against EDTA from the burette. The end-point was determined when the colour was changed from wine red to steel blue. The titration was repeated to get concordant titre value[14,15]:

$$\text{Total hardness} = \frac{\text{Volume of EDTA solution consumed}}{\text{Volume of the hard water taken}} \times 1000 \text{ ppm}$$

Stomatal conductance using porometer: Stomatal conductance of the leaves of the treated plants were measured using SC-1 Leaf Porometer available in the Department of Life Science, CHRIST (Deemed to be University). A flag leaf that is clean, dry and free of disease and receiving sunlight to the adaxial surface was chosen and then placed the leaf into the chamber at the mid-point of the leaf and ensured that the selected area of the leaf completely covered the aperture of the sensor. During the measurement, care was taken to make sure that the white filter was facing upwards and in full sun (did not allow other plants to shade the filter). In order to start taking measurements, 'ENTER' key was pressed. The readings were saved to the instrument. It took approximately 30-120 sec to take the measurement. The readings were then transferred to the system and the mean of the values was calculated.

Heavy metal analysis

Preparation of samples: Water samples (500 mL) were filtered using Whatman No. 41 filter paper for estimation of dissolved metal content and preserved with 2 mL nitric acid to prevent the precipitation of metals. Fruits, stems and leaves of tomatoes treated with different water samples were collected and dried by keeping it in the oven. The dried plant samples were made into powder. To 0.1 g of each sample, added 5 mL of concentrated nitric acid and then incubated for one overnight[16-19].

Sample analysis for heavy metals: A Shimadzu type Atomic Absorption Spectrophotometer (AAS) 6880 model with Air-C_2H_2 flame type of an average fuel flow rate of between 0.8-4.0 L/min and the support gas flow rate between 13.5-17.5 L/min was used for sample analysis and operated as per the equipment manual. The single element hollow cathode lamps for respective metals were used in the test. The atomic absorption analysis standards for the given elements were made from the metal compounds. The reference standard for Cd, Cu, Cr, Hg and Fe were made from the 1000 ppm stock solution. Calibration curves for various elements obtained from these standards were of the first-order reaction. The samples were finally injected into the flame AAS and the readings were measured in ppm.

Daily intake of heavy metals:

$$\begin{array}{c}\text{Daily intake of}\\\text{heavy metals } (\mu g \text{ day}^{-1})\end{array} = \begin{array}{c}\text{Daily fruit or vegetable}\\\text{consumption}\end{array} \times \begin{array}{c}\text{Fruit or vegetable heavy}\\\text{metal concentration}\end{array}$$

Statistical analysis: The statistical analysis was carried out for the analysis of variance (ANOVA) considering $p<0.05$ as significant using the software SPSS[20]. Two dimensional response plots were generated by keeping the concentration of heavy metals as dependent variable and plotting it against factors i.e., different types of water samples and the parts of the plants as independent variables.

RESULTS

Water analysis (Determination of pH): In this study, all water bodies showed pH more than seven and so considered to be alkaline in nature. Groundwater was found to be slightly alkaline with a pH of 7.34 and the other two water bodies were found to be highly alkaline. So, from the result, it could say that groundwater was having pH 7.34, which was not harmful. Treated sewage water contained pH 8.45, which was considered suitable for irrigation (Table 1). The untreated sewage water cannot be used for any purpose like irrigation of agricultural products.

Dissolved Oxygen (OD): The amount of dissolved oxygen in the water is considered critical for life in water. In the present water analysis study, groundwater contained the adequate amount of DO, i.e., 7.8 mg L^{-1}, which was found to be between the standard value of DO (5.0-10 mg L^{-1} ppm). Untreated domestic sewage water contained shallow value of DO and cannot be even used for the irrigation purpose. Treated sewage water contained around 4.7 mg L^{-1} (Table 2), which may be used for irrigation purposes.

Table 1: pH of the water samples tested in the experiment

Water samples	pH values
Groundwater	7.34
Untreated domestic sewage water	10.3
Treated domestic sewage water	8.45

Table 2: Amount of dissolved oxygen in different water samples

Water samples	Dissolved oxygen (mg L^{-1})
Groundwater	7.8
Untreated domestic sewage water	0.03
Treated domestic sewage water	4.7

Chemical oxygen demand: The chemical oxygen demand of the groundwater and treated domestic sewage water was found to be 0.0544 and 72 ppm, while the untreated domestic water contained 483 ppm (Table 3).

Estimation of alkalinity: In the present study, it was observed that more amount of alkalinity was found to be in untreated domestic sewage water. The presence of alkalinity in groundwater was found to be nil. The presence of alkalinity in treated domestic sewage water was found to be 0.07 g L^{-1}, which was considered to be below permissible amount approved by WHO (0.5 g L^{-1}) (Table 4).

Hardness of the water samples: It was observed that treated sewage water had 109.43 mg L^{-1} (Table 5) hardness, which was considered the medium level of hardness. Groundwater, which was taken from bore well also showed hardness of 55.87 mg L^{-1}, which was considered to be in the soft category. Untreated domestic sewage water showed a high level of hardness, i.e., 874.90, (Table 5), which was above the very hard category, which cannot be used for any purpose (Table 6).

Table 3: Amount of Chemical Oxygen Demand (COD) measured in ppm for different water samples

Water samples	COD value (ppm)
Groundwater	0.0544
Untreated domestic sewage water	483
Treated domestic sewage water	72

Table 4: Amount of alkalinity in different water samples

Water samples	Alkalinity (g L^{-1})
Groundwater	0.00
Untreated domestic sewage water	0.53
Treated domestic sewage water	0.07

Table 5: Hardness of the water samples (mg L^{-1}) of $CaCO_3$ equivalent in grams of $CaCO_3$

Water samples	Hardness (mg L^{-1})
Groundwater	55.87
Untreated domestic sewage water	874.90
Treated domestic sewage water	109.43

Table 6: Hardness chart (for drinking water)

Type of hardness	Range (mg L^{-1})
Soft	0-60
Medium	60-120
Hard	120-180
Very hard	>180

Source: USGS[21]

Stomatal conductance: Ventral side of the tomato leaf had higher stomatal conductance than dorsal side of the leaf because more stomatal openings were there in the ventral side. Low stomatal conductance was observed in the morning, but high stomatal conductance was observed at noon (Table 7). Stomatal conductance was found to be very low in the plants treated with untreated domestic wage water (296.33/428 in the ventral surface during the morning and noon, respectively) when compared to the leaves of the plants treated with other water samples.

Heavy metals analysis in water: The analysis of heavy metals like Cu, Zn, Cr and Pb of groundwater, untreated domestic sewage wastewater and treated domestic sewage wastewater were carried out using AAS. The metal analysis was compared with the standard parameters. The copper content in both ground water and treated domestic sewage wastewater was low. However, in the untreated wastewater, there was a higher level of copper above the permissible level. Chromium level in the groundwater showed low concentration. However, in the treated domestic sewage water and untreated domestic sewage water, chromium contained above the desired and permissible level of drinking water quality. Lead, a very toxic metal element in nature was found to be very low in groundwater. However, the treated domestic sewage water and the untreated domestic sewage water contained the lead above the desired and permissible range. Untreated domestic sewage water showed a very high level of lead, i.e., 7.5354 ppm, whereas the treated sewage water contained 0.5650 ppm slightly above the permissible level (Table 8).

Heavy metal analysis in tomato fruit, leaf and stem: Heavy metal analysis of leaves, stems and fruits of the tomato plants treated with groundwater, untreated and treated domestic sewage water was given in the Table 9-11. In the case of Cu, the fruit had low concentration. Copper was shown in the increasing order of Fruit<Leaves<Stem (Table 9-11). So,

Table 7: Stomatal conductance of the leaves of the tomato plants treated with different water samples

	Morning (9-10 am)		Noon (12.00-1.00 pm)	
Water samples	Ventral	Dorsal	Ventral	Dorsal
Groundwater	385.43±17.180	163.67±13.05	915.33±23.459	478.47±18.54
Untreated domestic sewage water	296.33±13.65	130.33±11.97	711.00±9.54	428.00±23.06
Treated domestic sewage	335.66±13.05	114.96±5.58	744.67±17.47	310.33±19.50

Table 8: Heavy metal analysis conducted in different water samples used in the treatment of the plant samples

Water samples	Cu (ppm)	Zn (ppm)	Cr (ppm)	Pb (ppm)
Groundwater	0.2560	0.0394	0.1205	0.0153
Untreated domestic sewage water	1.6651	2.1742	1.1349	7.5354
Treated domestic sewage water	0.1552	1.0606	0.1510	0.5650
BIS desired level[14]	0.05	1	0.05	0.05
BIS permissible level[14]	1.5	2.5	0.05	0.05
WHO[9]	2	3	0.05	0.01

Table 9: Heavy metal analysis conducted in the leaves of the tomato plants treated with different water samples

Water samples	Cu	Zn	Cr	Pb
Groundwater	0.02564	0.00542	0.0342	0.0006
Untreated domestic sewage water	0.33	2.565	1.5655	1.2565
Treated domestic sewage water	0.0339	1.7669	0.1241	0.8665

Table 10: Heavy metal analysis conducted in the stems of the tomato plants treated with different water samples

Water samples	Cu	Zn	Cr	Pb
Groundwater	0.01256	0.3265	0.09876	0.0089
Untreated domestic sewage water	0.0164	1.8762	4.6546	0.2098
Treated domestic sewage water	0.0914	1.3282	0.1475	0.1260

Table 11: Heavy metal analysis conducted in the tomato fruits from the plants treated with different water samples

Water samples	Cu	Zn	Cr	Pb
Groundwater	0.0293	0.0657	0.0343	0.0003
Untreated domestic sewage water	0.0419	2.2747	6.1228	0.4543
Treated domestic sewage water	0.01039	1.0071	0.4316	0.0496

Table 12: ANOVA showing the F-value of heavy metals tested between the different water samples

Parameters	Sum of squares	Df	Mean square	F-value	Sig.
Cu					
Between Groups	0.873	3	0.291	1.593	0.266[a]
Within Groups	1.462	8	0.183		
Total	2.336	11			
Zn					
Between Groups	0.566	3	0.189	0.188	0.902[a]
Within Groups	8.049	8	1.006		
Total	8.616	11			
Cr					
Between Groups	5.509	3	1.836	0.391	0.763[a]
Within Groups	37.536	8	4.692		
Total	43.045	11			
Pb					
Between Groups	13.337	3	4.446	0.985	0.447[a]
Within Groups	36.118	8	4.515		
Total	49.454	11			

[a]$p>0.05$, so there is no significant difference between the heavy metals present in the plant samples treated with water samples

copper was not much assimilated by the different parts of tomato plants. In the case of Pb, the stems were showing more amount of lead content in the order of Fruits<Leaves<Stem. In the case of chromium, fruits had a higher amount (Table 9-11).

Statistical analysis: ANOVA test was conducted for different heavy metals present in the water and the plant samples studied. The F-value showed no significant difference between the water samples used in the treatment and the metals present in the water and parts of the tomato plants which were treated with the corresponding water samples; i.e., $p>0.05$ (Table 12). The test has revealed that in which water sample the heavy metal was very high, the plants treated with that water samples showed very high metal content. So, the hypothesis that the tomato plants treated with untreated domestic sewage water would contain a high content of heavy metals was accepted. In other words, there is no significant difference in the content of heavy metals between the untreated domestic sewage water and leaf, stem and fruits of the tomato plants.

DISCUSSION

The alkalinity of groundwater is due to the presence of weak acid salts, although strong bases may also contribute (i.e., OH) in extreme environments. Alkalinity in groundwater is mainly caused by the presence of bicarbonates. Other salts of weak acids, such as; borate, silicates, ammonia, phosphates and organic bases from natural organic matter, may be present in small amounts[22].

The movement of water and the temperature is likely to influence the dissolved oxygen levels in the water[23]. Adequate dissolved oxygen is essential for good water quality and necessary to all forms of life. Dissolved oxygen levels, that drop below 5.0 mg L^{-1} causes stress to aquatic life. Oxygen levels that go below 1-2 mg L^{-1} for a few hours may result in massive fish deaths. It could be understood from the results that the untreated water had the least dissolved oxygen levels. The reduced level of dissolved oxygen in untreated water could be attributed to the increased amount of sewage materials which might utilize the available oxygen for their processes. Thus, this water cannot harbour life nor can it be used for drinking or even for irrigation.

The COD is closely related to Biochemical Oxygen Demand (BOD), the difference being that BOD is a test of the level of organic matter that can be biologically oxidised while COD is a test of the amount of organic matter that can be chemically oxidised[24]. The higher level of BOD or COD will result in potential damage to biological life in the water bodies[12,25]. The more organic compounds in the water bodies will lead to a higher level of COD than BOD, because chemical oxidation of organic compounds will be extremely high than the biological oxidation[26]. Chemical Oxygen Demand (COD) value found to be in the range of 14-70 mg L^{-1}. The COD is a reliable parameter for judging the extent of pollution in water. The COD of water increases with increasing concentration of organic matter. Higher the COD levels, lesser the Dissolved Oxygen (DO) in the water bodies. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms[11,27]. The present study has shown higher levels COD, alkalinity, pH and lower levels of DO in the untreated sewage water when compared to the groundwater and treated sewage water, which showed the highly polluted condition of the untreated sewage water.

Tomato plants that were treated with groundwater had high stomatal conductance, because leaves might have experienced less stress. Tomato plants that were treated with untreated wastewater have shown the low stomatal conductance because leaf might have undergone high stress because of the presence of the heavy metals as well as other impurities which led to lesser stomatal conductance. The studies have proved that heavy metal absorption by plants leads to high stress in the plants[28,29,30]. By analyzing the stomatal conductance, it was found that untreated domestic sewage water has given more stress to the plant, so that the stomatal conductance also varied than that of treated water and the groundwater.

The irrigation of the plants with the treated sewage water was found to be safe since the plants were less affected by the alkalinity, COD, BOD, DO, heavy metals and stomatal conductance[12]. The treated water had all the parameters in the range approved by the WHO standard[9]. It will be better to analyze in more plants and fruits for the heavy metal analysis. Moreover, roots may have more heavy metals because of the direct absorption of water. More research in this line may be continued to make sure the good quality vegetables for the consumption of human beings.

Heavy metals are not biologically degraded like many organic pollutants; thus, heavy metals tend to accumulate, particularly in sediments in association with organic and inorganic matter and involves adsorption, complex formation and chemical combination[23,24]. Heavy metals such as; Pb, Cr, Mg, Co, Fe and Hg are of particular concern because they produce severe health hazards to animals and human beings once it is accumulated in the various organs of animals[31,32]. The present study has focussed on the heavy metal accumulation in the plants treated with the different water samples.

The accumulation of heavy metals in plants treated with untreated sewage water were experimentally proved in tomato plants and it was not a healthy practice of using sewage water in irrigation of plants. However, the accumulation of heavy metals was not found in the plants that are treated with groundwater and treated sewage water so that they might be used in the irrigation of plants.

CONCLUSION

In the present study, it was concluded that the untreated domestic sewage water should not be used for agricultural purposes in any of the way. However, the treated domestic sewage water would be used for the irrigation of agricultural cultivation.

SIGNIFICANCE STATEMENT

This study discovers the possibility of using the treated sewage water for the purpose of irrigation of agriculture that can be beneficial for the farmers when they are facing the problem of water scarcity. This will help the people think the recycling of water for various purposes. This study will help the researcher to uncover the critical areas of water treatment and use of treated water. Thus, a new theory on water management may be arrived at.

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