Experimental Investigation on the Treatability of Greywater using Cissus quadrangularis

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Abstract. The scarcity of finding clean water for drinking has been increased due to pollution, population, and many other criteria. Multiple philosophies exist about the use of reused water for drinking and domestic purposes despite the warning on health and safety issues associated with residual contamination. This study aims to investigate the changes in the chemical parameters of greywater treating it with naturally available material, to analyze its suitability for potable water. This experimental work was done by treating the greywater using chopped oven-dried Cissus quadrangularis, a natural creeper familiar for its medicinal properties. Greywater represents the water from sinks, automatic washers, showers, and also from other kitchen instruments. The chopped and oven-dried Cissus quadrangularis was mixed with greywater and made to contact with water for the various time duration of 15 minutes, 30 minutes, 45 minutes, and 60 minutes. The change in physic-chemical characteristics of the greywater on the addition of Cissus quadrangularis was analyzed for different contact periods. Results indicated that Cissus quadrangularis was found to be more effective in treating greywater, more particularly acidic samples. Treated greywater can be used for domestic purposes except drinking and needs further treatment if preferred to be used for drinking.

Keywords: Greywater; Creeper; Cissus quadrangularis; time interval.

1. Introduction

Greywater represents the wastewater arising from sinks, automatic washers, showers, and also from other kitchen instruments. In simple words, it can also be defined as the wastewater that comes after domestic usage. Greywater discharging from ships has polluted many seas including the Baltic sea and it causes more threats to the aquatic ecosystem [13, 14]. Many studies related to the treatment of greywater have been proposed. In this study, it was aimed to treat greywater using a natural material named Cissus quadrangularis. In many studies both artificial and natural materials were used to treat greywater. It results in reducing pollution nuisance [1]. When using the treated greywater in concrete mixes, it leads to an increase in initial setting time and a decrease in concrete slump value [12].

Natural materials have more effect in treating the grey water when compared to artificial materials. Many natural materials including pine bark, cactus, and sand can also be used as a filter media to treat wastewater. When considering those natural materials, turbidity can be reduced by using a column study [2].

There were many heavy metals such as lead (Pb), Cadmium (Cd), Zinc (Zn), and Copper (Cu) present in the wastewater. Many treating methodologies have been introduced to remove those heavy metals. When thinking about treating wastewater or greywater, both artificial and natural methods were available now a day. Natural treatment to remove heavy metals includes the usage of peels of banana and peels of orange. But it results in the removal of only 50% of heavy metals [3]. Another way of removing heavy metals by natural materials involves the usage of different fruit cortexes.
Using Cortexes of tangerine, kiwi, and banana also gave good results in the removal of heavy metals in aqueous solution [4]. On the other side, artificial treatment includes Activated Rice Husk and Carbonized Rice Husk. These materials can be used as absorbents for treating heavy metals. It is also an effective method [5]. But many studies state that the efficiency of heavy metals that are removed by using adsorbents decreases with the size of the adsorbent [15].

Sometimes, the cost is also an important criterion when treating wastewater. Many low-cost methods were also developed for treating wastewater. Treating greywater using anaerobic methods is also a cost-effective technique [11]. The carbonization method can also be done to treat water at a low cost. By using the carbonization method, lemon peels were very effective when using it as an adsorbent to treat wastewater [6].

Studies related to equilibrium, thermodynamics, and kinetics were carried out for biosorption of lead, nickel, and cadmium from aqueous solution. Grafted copolymerization-modified orange peel was used for biosorption of ions [7]. Natural Zeolites have abundant properties in wastewater treatment. It consists of cation exchangeability and it also has molecular sieve properties. It can also be used as an effective agent in the purification of wastewater [8].

Microalgae can also be used to treat wastewater. Because microalgae give the best outcomes in tertiary biotreatment combined with the creation of conceivably significant biomass. Biomass can be utilized for various purposes. Hence microalgae method gives a lot of advantages [9].

Studies investigated that materials such as limestone, squander paper, the shell is blended in with regenerated concrete, regenerated cement, additionally handled nitrolite, charcoal-bio, and charcoal. These materials were investigated for the filtration of suspended materials along with Chemical Oxygen Demand removal in wastewater [10].

2. Materials and methods

2.1 Materials

1) Grey Water - Grey water contains all the wastes such as water from sinks, showers, automatic washers, and also from other kitchen instruments. This greywater has been collected from the sewage treatment plant (STP) in Bannari Amman Institute of Technology which is located in Sathyamangalam.

2) Cissus Quadrangularis - Cissus quadrangularis (shown in figure 1) (called pirandai in Tamil) is a medicinal plant that is used for many medicinal purposes. It has a lot of anti-inflammatory constituents with it. This plant has been used to treat a variety of ailments for centuries. Some studies show that this plant may have powerful medicinal properties, including supporting bone health, reducing joint pain, increase appetite, and help to prevent metabolic syndrome. Hence, this natural material is chosen for treating greywater.

![Cissus quadrangularis](image_url)
2.2 Methods

1) **Sample Preparation** - Cissus quadrangularis was collected from different places, from where they are available and they were chopped into small pieces. After that, the chopped pieces were oven-dried and kept for cooling for 24 hours after drying it. These oven-dried materials are used for analyzing the greywater to observe its changes in the chemical parameters at different time intervals.

2) **Chemical Analysis** - Greywater was initially tested for its chemical parameters such as pH, Electrical conductivity, chlorides, and hardness. All the procedures for analysis were followed as per APHA standards. Then each of the prepared oven-dried samples was mixed with some amount of greywater and kept in an orbital shaker as shown in figure 2, for uniform mixing of the sample. After that, each sample of mixed greywater was tested for the same chemical parameters as mentioned above.

![Figure 2. Orbital shaker used for sample extraction](image)

The results obtained are tabulated below: Table 1 represents the characteristics of Greywater before treatment. Table 2 represents the characteristics of Greywater after the addition of the Cissus quadrangularis.

| PARAMETERS       | CONCENTRATION |
|------------------|---------------|
| pH               | 6.300         |
| EC (µmho/cm)     | 0.960         |
| Chlorides (ppm)  | 207.430       |
| Hardness(ppm)    | 262.500       |

| PARAMETERS       | CONCENTRATION |
|------------------|---------------|
| pH               | 8.00          |
| EC (µmho/cm)     | 2.59          |
| Chlorides (ppm)  | 28.36         |
| Hardness (ppm)   | 95.00         |

3. Experimental Investigation

Good results were obtained when mixing the approximate amount of prepared sample with an approximate amount of greywater. Hence, it is decided to observe accurate changes while adding an accurate amount of prepared samples with greywater at different time intervals. The time duration chosen was 15 minutes, 30 minutes, 45 minutes, and 60 minutes. 2 grams of oven-dried sample was taken and mixed with 100 ml of greywater separately.
Figure 3. Filtration of the sample using Whatman filter paper

These separately mixed samples were kept in an orbital shaker and filtered using Whatman filter paper as shown in Figure 3 and are used for testing the chemical parameters. The number of revolutions of the shaker per minute was observed as 133.

4. Results and discussion

4.1 Results

When the Cissus quadrangularis is mixed with greywater, the obtained results for different time intervals for different chemical analyses are tabulated. Table 3 represents the effect of the pH value of the sample after the addition of Cissus quadrangularis for different time intervals.

Table 3. pH of the greywater sample after addition of Cissus quadrangularis

| DURATION (in minutes) | 15   | 30   | 45   | 60   |
|-----------------------|------|------|------|------|
| pH                    | 6.86 | 8.19 | 8.23 | 8.39 |

Figure 4. Time interval vs effect of the addition of Cissus quadrangularis on pH
Figure 4 shows the variation of pH in the greywater sample on the addition of Cissus quadrangularis. The change in the concentration of chlorides in the greywater sample after the addition of Cissus quadrangularis for a different duration is shown in Table 4.

**Table 4. Chlorides of the greywater sample after addition of Cissus quadrangularis**

| DURATION (in minutes) | 15  | 30  | 45  | 60  |
|-----------------------|-----|-----|-----|-----|
| Chlorides (ppm)       | 40.76 | 44.31 | 40.76 | 39.00 |

![Figure 4: Chloride concentration variation](image)

**Figure 5. Time interval vs effect of the addition of Cissus quadrangularis on chloride concentration**

Figure 5 shows the variation of chloride concentration in the greywater sample in contact with Cissus quadrangularis. The change in the concentration of hardness in the greywater sample after the addition of Cissus quadrangularis for different time duration is shown in Table 5. Figure 6 represents the influence of the addition of Cissus quadrangularis on the concentration of Hardness of greywater.

**Table 5. The hardness of the greywater sample after the addition of Cissus quadrangularis**

| DURATION (in minutes) | 15  | 30  | 45  | 60  |
|-----------------------|-----|-----|-----|-----|
| Hardness (ppm)        | 100.0 | 107.5 | 102.5 | 107.5 |
Figure 6. Time interval vs effect of the addition of Cissus quadrangularis on the concentration of hardness

4.2 Discussion

**pH** - When Cissus quadrangularis is mixed with greywater, a greater change in the pH value has been observed. During 15 minutes contact, the pH value observed was 6.86; during 30 minutes contact, the pH value has been changed to 8.19; during 45 minutes of contact, the pH value is 8.23 and during 60 minutes contact, the pH value obtained is 8.39. Hence, the pH value increases with an increase in the time interval.

**Chlorides** - When Cissus quadrangularis is added to greywater, chloride values got changed at different time intervals. During 15 minutes contact, the chloride value is 40.76 ppm; during 30 minutes contact, the chloride value has been changed as 44.31 ppm; during 45 minutes of contact, the chloride value is 40.76 ppm and during 60 minutes contact, the chloride value obtained is 39.00 ppm.

**Hardness** - Hardness in water means some extra minerals are contained in water but safe for drinking, cooking, and cleaning. When the Cissus quadrangularis is mixed with greywater hardness value has been also changed. During 15 minutes contact, the hardness value is 100.0 ppm; during 30 minutes contact, the hardness value has been changed as 107.5 ppm; during 45 minutes contact, the hardness value is 102.5 ppm and during 60 minutes contact, the hardness value obtained is 107.5 ppm.

5. Conclusions
This study was conducted to investigate the effect of Cissus quadrangularis on the chemical parameters of greywater. From the results obtained, it is inferred that the addition of Cissus quadrangularis to the greywater changed its pH, chloride, and hardness with respect to different contact time intervals. It was observed that as contact time increases, the pH value of greywater is also increased. So Cissus quadrangularis can be used to decrease the acidity of the sample by increasing its pH value. Cissus quadrangularis was also effective in reducing hardness and chlorides in the greywater, but with time constraints. Hence from this experimental investigation, it is concluded that Cissus quadrangularis can be used to treat the acidic samples. It can also reduce the hardness of water which is a major problem in many areas causing stone formation in human beings, scaling of boilers in industries, etc. The chloride concentration if found more than the specified limit may affect the taste of food products and corrode metals. Most of the treatment technologies available at present are costly and also involve many chemicals that may prove dangerous to human life and the environment. If the use of naturally available materials like Cissus quadrangularis prove to be more effective in treating...
greywater, then it can be used in individual residents as a decentralized greywater treatment system. Also, the treated greywater may be used for kitchen garden.

6. Further study

Further study is planned to vary the concentration of Cissus quadrangularis with respect to different contact time intervals and study the variation in concentration of the chemical parameters.

It is also planned to study the effect of the addition of Cissus quadrangularis on the Biochemical Oxygen Demand, Chemical Oxygen Demand, and metallic concentration of greywater. A natural material like Cissus quadrangularis, if used in wastewater treatment, may prove to be economical and safe.

7. References

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