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# Conserving Water in a Time of Climate Change: What are the Benefits of Using Greywater on Household Gardens

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## ABSTRACT

We were curious if there would be any simple way to decrease water use in communities because of the ongoing drought in California. To do this, we would use three different types of greywater, soap water with kitchen contaminants, soap water, and regular tap water to see if there would be any difference in the growth of plants. This experiment would tell us whether to use greywater on household plants. If a positive result comes out, people can proceed to use greywater on common household plants to decrease their usage of water. Using six petunias (*Petunia axillaris*) and six marigolds (*Tagetes patula*), we charted the growth for three weeks and analyzed the data. I hypothesized that there would be no negative impacts on plant growth if greywater was used. After the first week, I noticed some major growth patterns in plants between each type of water, some of which supported my hypothesis and others that didn't. In the end, we figured out that dishwater with kitchen contaminants had no negative impact on plant growth.

## INTRODUCTION

Around the world, drinking water has become a scarce commodity, as around 1.1 billion people don't have direct access to water (1). This also means when fires are evident, especially from late July-early September in California, tons of water is used, which leads to water being scarce. California currently uses 714,000 acre-feet of water per year (2). To use less water, we can look at a feasible solution, which would be to use greywater on things that don't need fresh water, such as toilet water, watering plants, and laundry.

Greywater is relatively clean water from home and/or kitchen appliances, such as water from the sink, washing machines, and bathwater. This type of water would also go under the classification of non-potable water, which is water that can't be used for drinking. In such cases, non-potable water would be used for landscape and crop irrigation, industrial process, toilet flushing, groundwater recharge, and more. It also helps lower wastewater utility bills, meaning people don't have to pay as much money for the water they waste if they use greywater.

Another benefit of using recycled greywater is that aquatic animals' would have a better environment to live in. "Water recycling provides tremendous environmental benefits" (3). Greywater also has a lot of nutrients, such as nitrogen and phosphorus. The nitrogen is obtained through kitchen waste, while the phosphorus is found majorly through sodium tripolyphosphate (Marigolds). Using greywater also saves energy and money, as people don't have to pump water for appliances you can use recycled greywater for. There is also some amount of treatment you have to do to greywater, depending on how much it has been exposed. Home greywater treatment systems cost from $700 up to $20,000 depending on the complexity (4). If you were to use greywater on crops, it should be of sufficient quality. This is the broad picture, and we can ask ourselves how we can save water at a community-based level. My research will give us a better understanding of how greywater can impact our lives.

How does recycled dishwater impact the growth of outdoor perennial and annual garden plants? I hypothesize that if recycled dishwater is used, there will not be a negative impact on plant growth. I set up my petunias (*Petunia axillaris*) and marigolds (*Tagetes patula*) in a 4 x 3 setting and put them in their respective groups (tap water - control group, soup water - treatment 2, and dishwater with kitchen contaminants - treatment 3). Every day in the evening, I would give the plant 2 tablespoons of their water and measure the highest point of that flower. Using statistical calculators, we analyzed our data at the end of the experiment.

## METHODS

Two types of common garden flowers were used: petunias (*Petunia axillaris*) and marigolds (*Tagetes patula*). Each pack came with six of each, and we would use two of each in a group. We bought the same pot for all the flowers, except for two of them. For pot preparation, they were filled with about $^1/_2$ inches of soil. Then we took the plant out of the box, and before placing it in the pot, we loosened the roots by gently tapping the soil. Then filled the rest of the pot with soil, with just a ½ inch of space at the top. The flower pots would be set up in 4 by 3 settings. This would be set up in a backyard, a secluded area where no animals would interfere with growth. Also, a place where plants would get sufficient sun and shade.

Three treatments were used to water plants: potable tap water, potable tap water with 4 teaspoons of dish soap, and captured dishwater aka greywater captured dishwater consisting of potable tap water, dish soap, and food bits. Water was collected in a container and was filled up to the same point every time.

The plants would be watered two times a day, with 2 tablespoons of their respective treatments, the first watering session being between 8-9 a.m., and the second watering session being between 6:30-7:30 a.m. We made sure the weather wasn't too hot or too cold when the plants were being watered. Petunias should grow at 60 -75°F (5). Marigolds should be growing at 65-75°F (6). After the plants were done being watered, we measured the highest point of the plant. To do this, there was a piece of cardboard on the pot, with the ruler on that piece of cardboard. Then you'd line up the ruler with the highest point of the flower and chart the measurement. This was done once a day with each plant after the plants are done being watered in the evening.

## RESULTS

In this experiment, I tested the impacts of kitchen-contaminated soap water, soap water without contaminants, and potable water on plant growth. During the 19 days of experimenting, I noticed that the kitchen-contaminated soap water enabled more plant growth than soap water without contaminants, comparing it with the control group, which was just plain water. I tested three groups, a control group (tap water), treatment 1 (soap water), and treatment 2 (soap water with kitchen contaminants).

According to figure 1, we found out that the soap water test group has a general decrease in plant height, meaning that the plants tested in that group did not do well. Both the control group and treatment 2 did well, but looking at the equation for the second test group, we see that the slope is a bit greater than the control group, indicating higher growth over time. The slope indicates the change in the y-axis compared to the change in the x-axis.

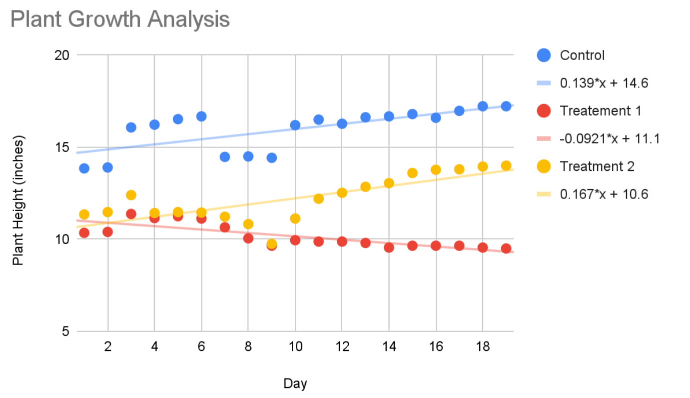


**Figure 1:** Comparison of plant growth over 19 days

## DISCUSSION

From our research and analysis, we found that soap water had a negative impact on plant growth while soap water with kitchen contaminants had a positive impact. Compared to the control group, treatment 2 did marginally better than the control group, while just treatment 1 did worse. This could be because treatment 2 had some sort of nutrient, boosting the growth of plants, while treatment 1 just had chemicals in it. This then suggests that recycling dishwater can be an alternative for watering household and garden plants.

I initially hypothesized that treatment 1 would make a difference in plant growth, but I never took into account how treatment 2 could affect plant growth. Based on my results, my hypothesis was wrong. It is possible that some sources of error occurred as a result of the plants being relocated during the experiment, inconsistencies in measurement, and the concentration of soap and other dishwater contaminants. When I was measuring, I would always have a point at which I would look at the ruler, and that could have changed a bit from day to day. Also, when I was mixing my soap with water, I could have put in a bit too much soap, increasing the concentration, and not taking into account how much water the plants could handle. Overall, what we found did agree with other articles and papers, saying that greywater is a good alternative for watering plants, and in general, enhanced and improved the environment.

These findings are encouraging because they prove we can save water and it doesn't negatively affect the growth of plants. As for future experiments/research, I would want to figure out how to make a city-based solution, rather than a community-based solution. Thinking about how to get an efficient way of drawing greywater, because, during the experiment, I would get the water after washing dishes. This then leads to thinking about alternatives for greywater, such as rainwater or bath/sink water. For rainwater, we could have buckets outside while it's raining. This is called rainwater harvesting, which is when collecting run-off water from a structure and using it at a later time, but we have to take into account that it only rains during a certain time of the year. For bath/sink water, it would be hard to get water when we are washing our hands, but when we use shower heads, there's always a stream of water coming from the faucet near the bottom of the bathtub. If you were to place a bucket under there, you could collect a good amount of water for just a 20-minute shower.

If I were to do this experiment again, I would want to expand the same experiment, maybe having more species, such as Arabidopsis Thaliana, which is a species that is commonly used for this type of experiment because of its short growth cycle. I could also use different types of greywater. Increasing the sample size would also be beneficial because my experiment was scaled down for efficiency. At a minimum, there should be at least 10 plants of the same species for each treatment. I would also expand the time I experimented. Since this was a three-week experiment, we didn't get the full results we would have gotten from a longer one. I would also fix all the errors I found in this experiment and make sure they don't happen in this hypothetical experiment.

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