

The Effect of Dried Coffee Waste and Eggshell Powder on Improving Laundry Water Properties, Carbon Dioxide Absorption, and Tomato Plant Growth



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1. Abstract

This research investigates the effect of a natural powder prepared from dried coffee waste and crushed eggshells on improving the physical and chemical properties of laundry water, its impact on tomato plant growth, and its potential environmental role in carbon dioxide (CO₂) absorption or retention. The study was motivated by increasing freshwater scarcity and the accumulation of household organic waste, highlighting the need for sustainable and low-cost environmental solutions.

The study applied established environmental protocols, including the water protocol, vegetation cover protocol, and air protocol, without developing a new experimental protocol. The prepared powder was added to laundry water, and changes in temperature and pH were measured and compared with untreated laundry water.

Two similar tomato plants were grown under the same conditions; one was irrigated with treated laundry water and the other with untreated water. Plant growth indicators such as stem strength, leaf color, leaf thickness, and soil water retention were observed and recorded.

The results showed that treated laundry water created a more suitable environment for plant growth. The treated tomato plant exhibited stronger stems, darker and thicker leaves, and improved soil water retention. These findings suggest that coffee waste and eggshell powder can contribute to safe greywater reuse and environmentally friendly agricultural practices.

2. Research Questions

- 1/How does dried coffee waste and eggshell powder affect the properties of laundry water?
- 2/What is the effect of treated laundry water on tomato plant growth?
- 3/How does the powder contribute to improving soil structure and reducing plant stress?
- 4/How can the environmental role of the powder in carbon dioxide absorption be explained based on previous studies?

3. Introduction and Literature Review

Many communities face two major environmental challenges: increasing freshwater consumption and the accumulation of organic household waste such as coffee residues and eggshells. Laundry water is classified as greywater and can be reused for irrigation; however, its salinity and chemical residues may negatively affect soil structure and plant health.

Previous studies support the use of organic waste materials to improve soil and water quality. Lehmann and Joseph reported that carbon-rich materials improve soil structure and contribute to long-term carbon sequestration. Pandey and Singh found that coffee waste enhances soil moisture retention and microbial activity. In addition, studies by Yuan et al. showed that eggshells, which are rich in calcium carbonate, help regulate soil pH and reduce salinity stress on plants.

Environmental research also indicates that organic materials containing stable carbon compounds can retain carbon in soil, reducing carbon dioxide release into the atmosphere. Based on these findings, this research applies established environmental protocols to examine the interaction between water, vegetation cover, and air,

aiming to evaluate the environmental and agricultural benefits of using simple household waste materials.

4. Research Methods

Dried coffee waste and eggshells were collected from household sources.

The materials were thoroughly cleaned, dried, and finely ground.

Coffee waste and eggshell powder were mixed in equal proportions.

The powder was added to laundry water and left for a specific period before use.

Water temperature and pH were measured for treated and untreated laundry water according to the water protocol.

Two similar tomato plants were grown; one was irrigated with treated water and the other with untreated water following the vegetation cover protocol.

Environmental conditions related to air interaction were observed under the air protocol.

Daily observations of plant growth and soil behavior were recorded.

7. Results

Water property	Laundry Water only [Before]	Laundry water with powder [After]	Scientific note explanation
Temperature	23.5	21.5	Better water stability
pH	7.99	7.57	Closer to optimal range for plant
Electrical conductivity [EC, mS/cm]	2.2	1.3	Increases soil water retention and reduces drainage

These results show that adding the coffee waste and eggshell powder improves water quality, reduces salinity stress, stabilizes temperature, enhances soil water retention, and supports healthier tomato plant growth, demonstrating multiple environmental and agricultural benefits of the powder.

parameter	Laundry water only	Laundry water With powder
Leaf color	Pale green	Dark green
Stem strength	Weak	Strong
Leaf thickness	Thin	Thick
Soil water retention	Low	High

6. Discussion of Results

The results demonstrate that treating laundry water with dried coffee waste and eggshell powder improved tomato plant growth compared to irrigation with untreated laundry water. According to the water protocol, the powder helped moderate water properties, reducing the negative effects of detergent residues and unsuitable pH levels. Under the vegetation cover protocol, the treated plant showed improved leaf color, increased leaf thickness, and stronger stems, indicating better nutrient uptake and enhanced photosynthetic activity.

The air protocol supports the environmental interpretation of the results, as organic carbon present in coffee waste may contribute to carbon retention in soil, potentially reducing carbon dioxide release into the atmosphere. The improved soil water retention observed in the treated sample suggests better soil structure and aggregation.

These findings are consistent with previous studies highlighting the role of organic matter and calcium carbonate in improving soil quality and supporting plant growth. The results confirm that applying established environmental protocols is sufficient to evaluate the effectiveness of this natural treatment without developing a new experimental protocol.

7. Conclusion

This research concludes that dried coffee waste and eggshell powder provide a practical and environmentally friendly method for improving laundry water quality and enhancing tomato plant growth. Plants irrigated with treated laundry water showed stronger stems, darker and thicker leaves, and improved soil water retention compared to plants irrigated with untreated water.

The study demonstrates the potential of reusing greywater safely while recycling household organic waste. The method is low-cost, simple, and suitable for application in homes and schools, contributing to water conservation and sustainable agriculture. Although the experiment was limited by a short duration and a small sample size, the results are promising.

Future research should extend the experimental period, include more plants, test different crops, and measure additional parameters such as electrical conductivity and salinity. Overall, this study highlights the environmental value of combining greywater reuse with organic waste recycling using established scientific protocols.

8. Acknowledgments

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9. References

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10. Figures and photo



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DRIED COFFEE GROUNDS

GROUND EGGSHells

GROUND EGGSHELL POWDER MIXED WITH DRIED COFFEE GROUNDS



WASHING MACHINE WATER



PH LEVEL BEFORE ADDING THE POWDER



PH LEVEL AFTER ADDING THE POWDER