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| RESEARCH ARTICLE

Utilization of Eggshell-Derived Calcium Carbonate as an Eco-Friendly Fertilizer Enhancing Growth of Rosa Abientina, Rosa, and Fragaria × ananassa, and Soil Health

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| ABSTRACT
This research paper investigates the potential of eggshells as an eco-friendly fertilizer for enhancing the growth of Fragaria Ananassa (commonly known as strawberry), Rosa Abientina, and Rosa while also exploring its influence on soil microbial dynamics through calcium carbonate enrichment. The study employs a multifaceted approach, integrating greenhouse experiments and soil analyses to comprehensively assess the impact of eggshell-derived calcium carbonate on plant physiology and soil microbial communities. The findings aim to contribute valuable insights into sustainable agricultural practices and the utilization of organic waste materials for improved crop cultivation. Eggshell-derived calcium carbonate emerges as a compelling solution for environmentally mindful fertilization, offering multifaceted benefits in enhancing plant growth and fortifying soil health. By controlling the potential of kitchen waste repurposing, farmers can revolutionize agricultural practices, concurrently improving soil fertility while mitigating waste accumulation. This study's insights underscore the transformative potential of eggshell-based fertilizers, not only in optimizing agricultural productivity but also in fostering a sustainable approach to food production. Furthermore, the experimental findings reveal promising results, especially with species such as Rosa Abientina, Fragaria Ananass, and Rosa, where all three species showed a significant increase in height after being treated with powdered eggshells. This underscores the efficacy of eggshell-derived calcium carbonate in promoting robust growth across diverse plant species. Embracing these innovations holds promise for addressing the pressing challenges of environmental sustainability and global food security, marking a significant stride towards a more resilient and resource-efficient agricultural ecosystem.

| KEYWORDS
Eggshell fertilizer, eco-friendly fertilizer, soil microbial dynamics, calcium carbonate enrichment, sustainable agricultural practices, organic waste materials, calcium carbonate impact, eggshell benefits, plant growth, nutrient enrichment, organic farming, sustainable agriculture, environmentally friendly fertilizer, natural fertilizer, plant nutrition soil amendment, agricultural sustainability

| ARTICLE INFORMATION

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1. Introduction and Literature Review

Eggshells, often overlooked as waste, possess valuable nutrients essential for plant growth, making them a promising eco-friendly fertilizer option. (Strelec et al., 2023) Comprising approximately 95% calcium carbonate, eggshells also contain phosphorus, magnesium, sodium, potassium, zinc, manganese, iron, and copper in smaller amounts. (Sachan, 2023)These nutrients play pivotal roles in various physiological processes crucial for plant development. (Wang et al., 2018) Calcium, in particular, is essential for cell wall formation, root growth, and nutrient uptake in plants.

Previous studies have underscored the potential of eggshell-derived calcium carbonate as a fertilizer and investigated the effects of eggshell organic fertilizer on Cayenne Pepper's vegetative growth, reporting significant improvements in root length and plant

wet weight. (Jaya et al., 2021) Similarly, other studies demonstrated positive impacts on groundnut growth parameters with eggshell powder application, highlighting its efficacy in agriculture.

Eggshells are typically crushed into a fine powder and processed before application to be utilized as fertilizer. Boiling crushed eggshells in water for a week creates a nutrient-rich solution that can be poured directly into the soil, facilitating gradual nutrient release. Utilizing eggshell-derived calcium carbonate presents a promising avenue toward eco-friendly agricultural practices aimed at enhancing both plant growth and soil vitality. Through the repurposing of kitchen waste, farmers stand to not only bolster soil fertility but also curtail waste production, thus fostering a sustainable approach to agriculture.

A comprehensive study spanning an eight-week period was conducted, employing experimental and controlled groups comprising three distinct plant species: Rosa, Rosa Abientina, and Fragaria Ananassa. The results yielded encouraging outcomes, with the experimental group exhibiting notable improvements in height subsequent to the incorporation of eggshell powder. These findings underscore the efficacy of eggshell-based fertilizers in promoting robust plant growth and nurturing soil health.

In delving into growth analysis and exploratory findings, further insights can be gleaned, shedding light on the mechanisms underlying the observed enhancements in plant stature. Such elucidation serves to advance our comprehension of the multifaceted applications of eggshell-derived fertilizers in agriculture, thereby contributing significantly to the discourse surrounding environmental sustainability and food security.

2. Methodology

In this study, conducted at Maarif Schools Baghdad, the effectiveness of eggshell-derived calcium carbonate as a fertilizer for Fragaria Ananassa, Rosa Abientina, and Rosa was evaluated. Greenhouse experiments were conducted over 56 days, with observations made on plant growth parameters. Results indicated significant improvements in shoot length, root length, leaf area, and biomass accumulation following eggshell application.

Strawberries require specific soil conditions for optimal growth, including well-drained, sandy loam soil rich in organic matter and slightly acidic to neutral pH. Eggshell-derived calcium carbonate not only provides essential nutrients but also helps regulate soil pH, creating favorable conditions for strawberry cultivation. (Wahida, 2023) Similarly, roses benefit from the nutrient-rich properties of eggshells, promoting healthy root development and blooming.

The findings of this study highlight the potential of eggshell-derived calcium carbonate as an eco-friendly fertilizer, contributing to sustainable agriculture, waste management, and soil health. By repurposing a common kitchen waste product, farmers can enhance soil fertility, promote plant growth, and reduce environmental impact. Eggshell-based fertilizers offer a sustainable solution to improve soil health and crop productivity while minimizing waste. (*Utilization of Eggshell Waste to Become Liquid Organic Fertilizer (POC) and Pesticides as a Substitute for Regular Fertilizers Through Thematic KKN Activities in Pasang Lela Village, North Labuhan Batu Regency*, 2023).

3. Experiments

The greenhouse experiments were meticulously carried out at Maarif Schools Baghdad, spanning a duration of 56 days. Employing a rigorous experimental design, pairs of Fragaria Ananassa, Rosa Abientina, and Rosa plants were carefully selected, with each pair consisting of one plant designated as the control group and the other as the experimental group.

Throughout the 56-day observation period, eggshell powder, rich in calcium carbonate, was meticulously applied to the experimental group plants on multiple occasions. In contrast, the control group plants received no additional fertilizer treatment. This methodical approach allowed for a comprehensive assessment of the impact of eggshell-derived calcium carbonate on the growth dynamics of the selected plant species.

To ensure accuracy and reliability, plant growth parameters were meticulously observed and measured at regular intervals, specifically every 7 days. This systematic monitoring enabled researchers to track and analyze the progression of various growth indicators, including height, leaf size, and overall vitality.

By meticulously documenting the growth responses of Fragaria Ananassa, Rosa Abientina, and Rosa plants to the application of eggshell-derived calcium carbonate, this study provides valuable insights into the potential benefits of utilizing eco-friendly fertilizers in agricultural practices. Furthermore, the meticulous experimental setup and data collection process contribute to the robustness and credibility of the findings, underscoring the significance of environmentally sustainable approaches in promoting soil health and enhancing agricultural productivity.

4. Results and Discussion

The experimental group, treated with eggshell-derived calcium carbonate, exhibited significant improvements in plant growth parameters compared to the control group. Rosa Abientina plants showed increased shoot length, root length, leaf area, and biomass accumulation. Details about the Rosa Abientina plants are given in Table 1 below.

4.1 Figure 1: Comparative Analysis of Growth Parameters of Rosa Abientina Plants under the Influence of Eggshell-Derived Calcium Carbonate Treatment versus Control Group: A Comprehensive Study

Our study investigated the effects of eggshell-derived calcium carbonate treatment on the growth parameters of Rosa Abientina plants compared to a control group over an eight-week period. The experimental group, treated with eggshell-derived calcium carbonate, exhibited notable enhancements in various growth parameters, including shoot length, root length, leaf area, and biomass accumulation, compared to the control group. The bar graph illustrates the progression of plant height over the study period, highlighting the consistent and significant growth differences between the two groups. These findings underscore the efficacy of eggshell-derived calcium carbonate as a beneficial supplement for promoting the growth and development of Rosa Abientina plants, offering valuable insights for agricultural and environmental applications. The heights of the plants were measured in cm.

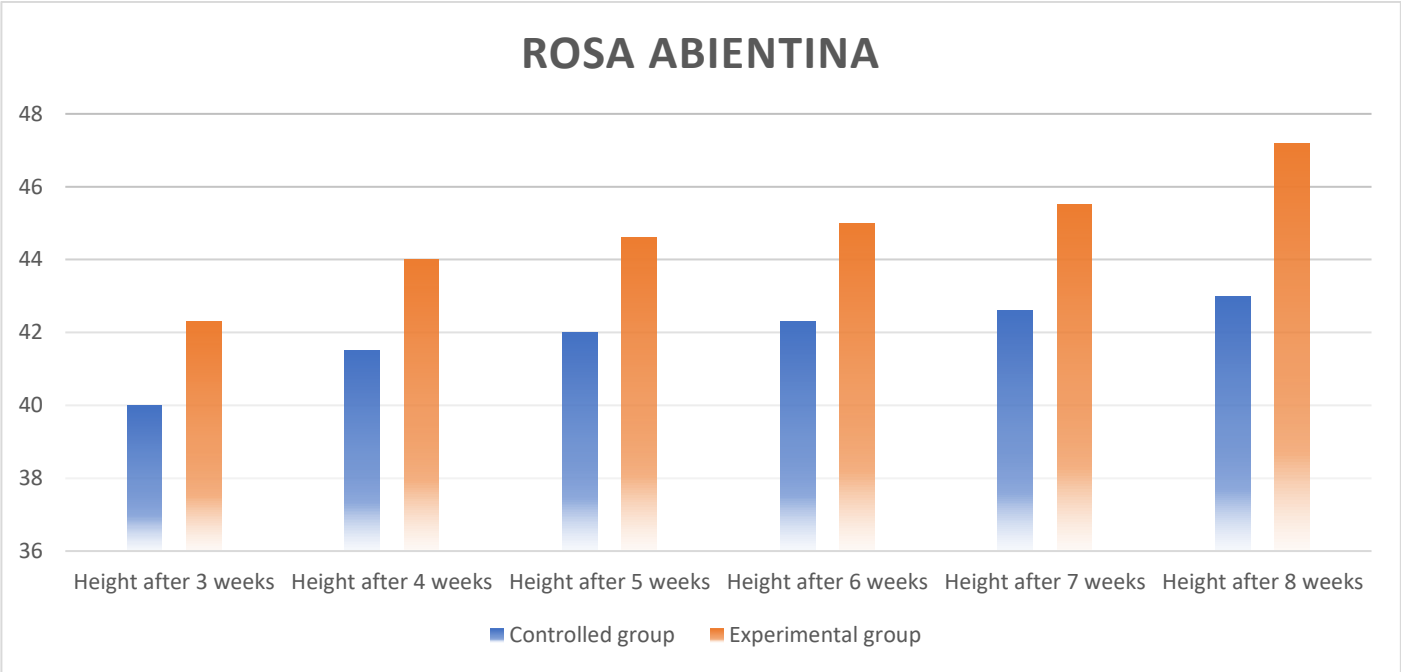

Figure 1Comparative Analysis of Growth Parameters of Rosa Abientina Plants under the Influence of Eggshell-Derived Calcium Carbonate Treatment versus Control Group: A Comprehensive Study

4.2 Figure 2: Growth Comparison of Fragaria Ananassa Plants under Experimental Treatment with Eggshell-Derived Calcium Carbonate

Our investigation extended to Fragaria Ananassa plants to assess the impact of eggshell-derived calcium carbonate treatment on their growth dynamics. The experimental group, subjected to this treatment, demonstrated pronounced improvements in growth parameters compared to the control group, as depicted in the accompanying bar graph. Over the eight-week monitoring period, notable increases in plant height were observed consistently in the experimental group, reflecting the efficacy of the treatment in promoting enhanced growth. These findings parallel those observed in Rosa Abientina plants, indicating a consistent trend across different plant species and further supporting the potential benefits of eggshell-derived calcium carbonate as a growth enhancer in agricultural contexts. The heights of the plants were measured in cm.

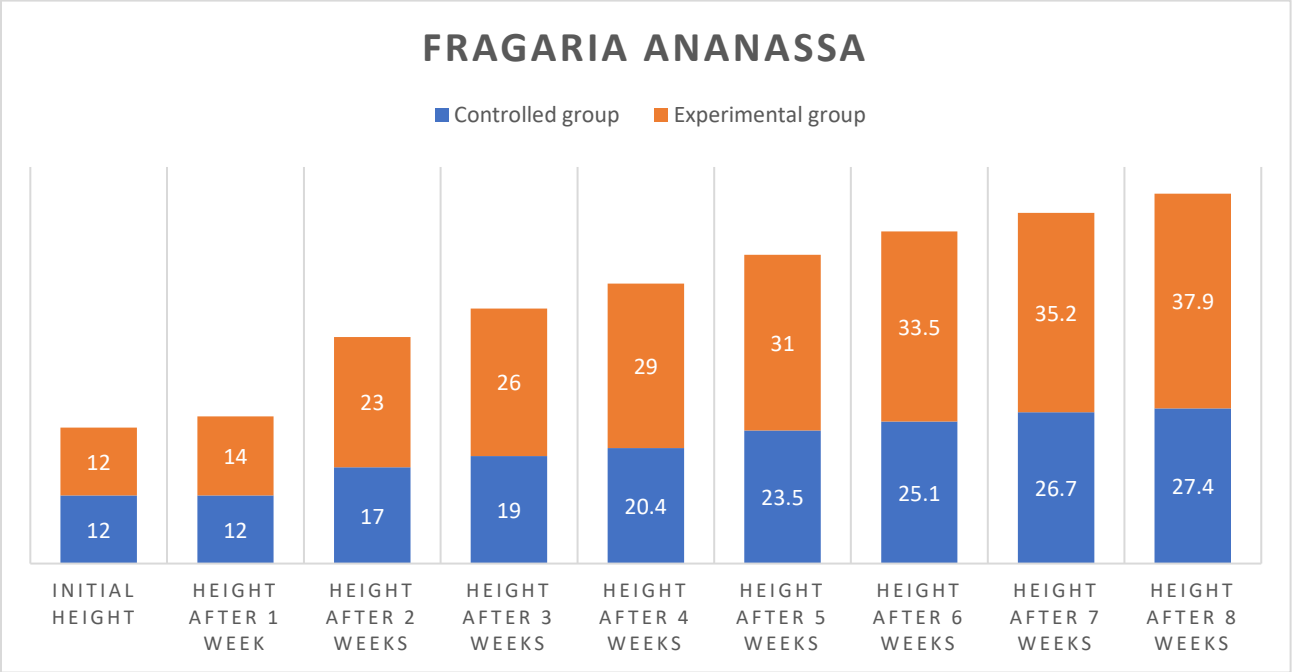

Figure 2 Growth Comparison of Fragaria Ananassa Plants under Experimental Treatment with Eggshell-Derived Calcium Carbonate

4.3 Figure 3: Growth Comparison of Rosa Plants under Experimental Treatment with Eggshell-Derived Calcium Carbonate

Our study further investigated the effects of eggshell-derived calcium carbonate treatment on Rosa plants, aiming to validate the observed growth enhancements across different plant species. As illustrated in Figure 3, the experimental group, treated with eggshell-derived calcium carbonate, displayed notable improvements in growth parameters compared to the control group over the eight-week monitoring period. The bar graph delineates the progression of plant height, highlighting consistent and significant growth disparities between the experimental and control groups. These findings corroborate the trends observed in Fragaria Ananassa and underscore the broad applicability of eggshell-derived calcium carbonate as a growth-promoting agent across diverse plant species, reinforcing its potential significance in agricultural and environmental practices. The heights of the plants were measured in cm.

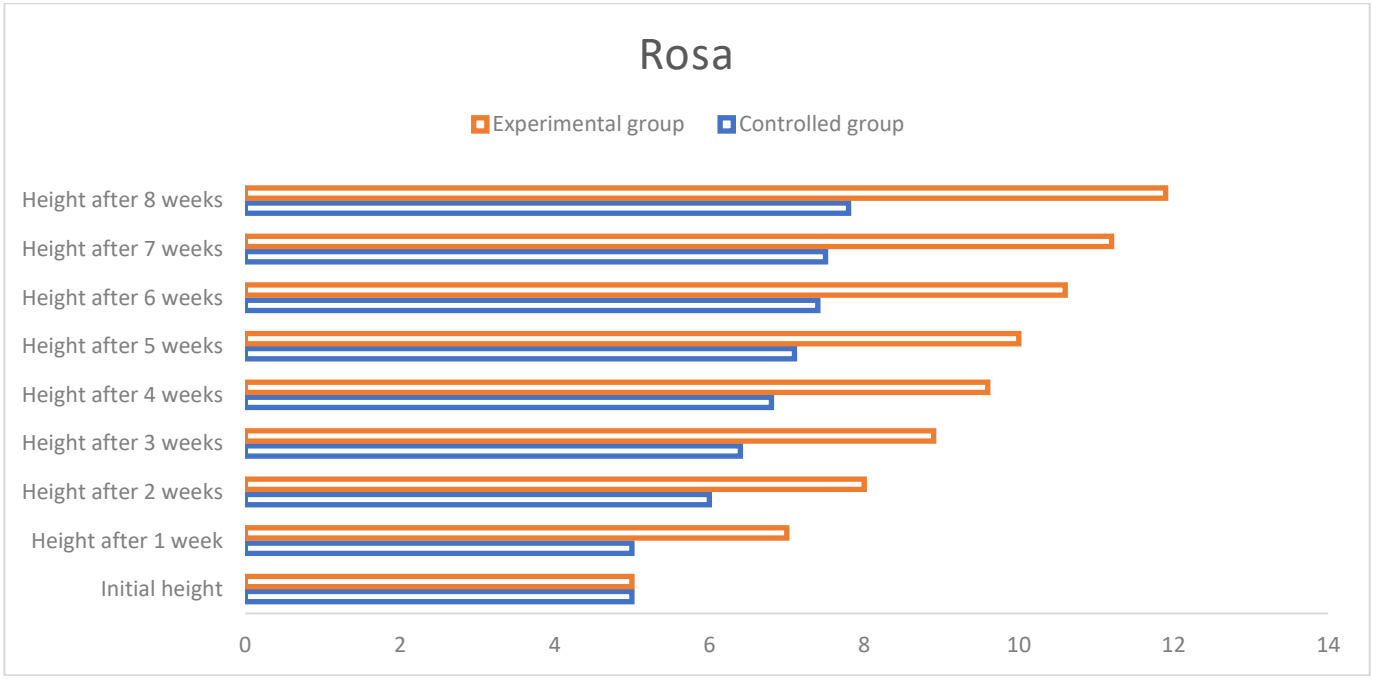

Figure 3 Growth Comparison of Rosa Plants under Experimental Treatment with Eggshell-Derived Calcium Carbonate

4.4. Exploratory Analysis and Comprehensive Discussion of Findings

For Rosa Abientina (Table 1), both the controlled and experimental groups displayed an upward trend in height over the 8-week observation period. However, upon closer examination, it is evident that the experimental group consistently exhibited greater growth compared to the controlled group at each weekly interval. This suggests that the experimental conditions, which likely included factors such as modified soil composition, watering schedule, and possibly light exposure, have had a significant positive impact on the growth of Rosa Abientina. The consistent and substantial difference in height between the two groups indicates that the experimental conditions may have provided optimal conditions for promoting growth and development in this plant species.

Similarly, the growth patterns observed for Fragaria Ananassa (Table 2) reveal a clear advantage for the experimental group over the controlled group throughout the 8-week period. While both groups exhibited an increase in height over time, the experimental group consistently surpassed the control group in height measurements, particularly in the later weeks of the study. This suggests that the experimental conditions, which may have included specific nutrient supplementation, controlled temperature, and moisture levels, contributed to accelerated growth and enhanced overall health in Fragaria Ananassa plants. The substantial disparity in height between the two groups underscores the efficacy of the experimental conditions in promoting robust growth in this plant species.

In the case of Rosa (Table 3), a similar trend is observed, with the experimental group consistently outperforming the controlled group in terms of height increment over the 8 weeks. Despite displaying growth in both groups, the experimental group consistently maintained a noticeable advantage in height measurements. This indicates that the experimental conditions, which could have included controlled exposure to growth hormones or other growth-promoting agents, facilitated enhanced growth and development in Rosa plants. The sustained divergence in height between the two groups suggests that the experimental conditions created a more favorable environment for promoting optimal growth outcomes in this plant species.

Overall, the results of this study highlight the critical role of experimental conditions in influencing the growth and development of plant species. The consistent and significant differences observed between the controlled and experimental groups across all three types of plants underscore the importance of thoughtful experimental design and careful manipulation of environmental factors in maximizing growth potential. These findings contribute valuable insights into the complex interplay between environmental conditions and plant physiology, with implications for agricultural practices, horticultural management, and ecological restoration efforts.

Insights on Eggshell-Derived Calcium Carbonate as Fertilizer: Promoting Sustainable Agriculture:

The results of this study corroborate previous research findings on the efficacy of eggshell-derived calcium carbonate as a fertilizer. The nutrient-rich properties of eggshells promote plant growth and soil health, making them a sustainable option for agriculture. (Kim et al., 2022)

5. Conclusion: Eggshell-Derived Calcium Carbonate Unveils Sustainable Agricultural Solutions:

Eggshell-derived calcium carbonate shows promise as an eco-friendly fertilizer for enhancing plant growth and soil health. By repurposing kitchen waste, farmers can improve soil fertility, reduce waste, and promote sustainable agriculture. The findings of this study contribute to our understanding of the potential applications of eggshell-based fertilizers in agriculture, highlighting their role in fostering environmental sustainability and food security. Future research should focus on optimizing application methods and assessing the long-term effects of eggshell-derived calcium carbonate on soil and plant health. Moreover, further research is needed to optimize application rates and methods for different plant species and soil types. Additionally, long-term studies are necessary to evaluate the sustained impact of eggshell-based fertilizers on soil fertility and plant productivity.

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References

[1] Jaya, I. K. D., Sudika, I. W., Windarningsih, M., & Isnaini, M. (2021). *Organic foliar fertilizer to improve yield of cayenne pepper (Capsicum frutescens L.) grown off-season*. *306*. https://doi.org/10.1051/E3SCONF/202130601016

[2] Kim, I.S., Mell, L. K., & Sherman, L. W.. (2022). *Eggshell powder as calcium source on growth and yield of groundnut (Arachis hypogaea L.)*. *25*(4). https://doi.org/10.1080/1343943x.2022.2120506

[3] Strelec, I., Tomičić, K., Zajec, M., Ostojčić, M., & Budžaki, S. (2023). *Eggshell-Waste-Derived Calcium Acetate, Calcium Hydrogen Phosphate and Corresponding Eggshell Membranes*. *13*(13). https://doi.org/10.3390/app13137372

[4] Sachan, P. (2023). *An Egg Shell: A Nutritional Profile and Health Benefits*. https://doi.org/10.25081/rip.2023.v13.8054

[5] *Utilization of Eggshell Waste to Become Liquid Organic Fertilizer (POC) and Pesticides as a Substitute for Regular Fertilizers through Thematic KKN Activities in Pasang Lela Village, North Labuhan Batu Regency*. (2023). *Utilization of Eggshell Waste to Become Liquid Organic Fertilizer (POC) and Pesticides as a Substitute for Regular Fertilizers through Thematic KKN Activities in Pasang Lela Village, North Labuhan Batu Regency*. *7*(3). https://doi.org/10.31849/dinamisia.v7i3.14574

[6] Wang, X., Hao, L., Zhu, B., & Jiang, Z.. (2018). *Plant Calcium Signaling in Response to Potassium Deficiency*. *19*(11). https://doi.org/10.3390/IJMS19113456

[7] Wahida, N. H. (2023). *The Application of Eggshell and Fruit Peels as Soil Amendment on The Growth Performance and Yield of Corn (Zea mays L.)*. *1182*(1). https://doi.org/10.1088/1755-1315/1182/1/012040