

Research Article

Derivation of Carbon Quantum Dots (CQD) from Banana (*Musa acuminata*) Leaves on Duckweed Growth

Kylie Eunice R. Olipas^{1,*}¹ Tayug National High School, Tayug, Pangasinan; olipaskylieeunice@gmail.com;  ORCID ID: 0009-0009-4094-4720

* Correspondence: olipaskylieeunice@gmail.com; 09917106104

Abstract: Duckweed (*Lemna minor*) is an aquatic plant with great potential in food, pharmaceuticals, biofuels, and phytoremediation. Despite its ability to double biomass every 24–48 hours under ideal conditions, its growth rate remains too slow to maximize these applications. This study aimed to enhance duckweed growth using carbon quantum dots (CQDs) synthesized from banana (*Musa acuminata*) leaves. The CQDs were produced via hydrothermal processing and stabilized with chitosan, then tested on duckweed using a randomized complete block design with three treatments: experimental (CQDs), positive control (sunlight), and negative control (untreated). Across three replications, duckweed treated with CQDs consistently outperformed controls, with counts of 14 vs. 12 and 5 (Replication I), 10 vs. 7 and 5 (Replication II), and 10 vs. 6 and 5 (Replication III). These results confirm the biostimulant effect of CQDs on duckweed growth. The findings highlight the promise of green nanotechnology to accelerate biomass production while valorizing agricultural waste, offering a sustainable pathway for both environmental management and bioresource utilization.

Keywords: Duckweed; Carbon Quantum Dots; Biostimulation; Banana leaves; Chitosan



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1. INTRODUCTION

Duckweed is recognized as a fast-growing aquatic plant with high protein, carbohydrate, and bioactive compound content, making it useful in pharmaceuticals, food, feed, biofuels, and phytoremediation. However, its growth rate remains insufficient to fully harness its potential in large-scale applications. Enhancing duckweed growth sustainably could increase its ecological and economic value. Banana leaves, often discarded as waste, can be converted into carbon quantum dots (CQDs), nanomaterials with strong photoluminescence and high biocompatibility. This study explores whether banana leaf-derived CQDs can stimulate duckweed growth, providing both an agricultural waste valorization strategy and a sustainable biostimulant.

2. METHOD & MATERIAL

Banana leaves were processed using a one-step hydrothermal method to produce CQDs, which were stabilized with chitosan. A randomized complete block design was implemented with three

treatments: untreated control, sunlight-exposed control, and CQD treatment. Each group consisted of three replications, with five duckweeds per container. Growth was observed and recorded over time.

3. FINDINGS

Duckweed treated with CQDs showed consistently higher growth across replications. Replication I recorded 14 plants in the CQD group compared to 12 in sunlight and 5 untreated. Replications II and III followed similar trends, with CQDs yielding 10 plants each, outperforming both controls. These results indicate that CQDs effectively promote duckweed growth.

4. DISCUSSION

The findings clearly show that CQD treatment consistently enhanced duckweed growth compared to both sunlight and untreated controls. In Replication I, the CQD group grew 14 plants, exceeding the sunlight group (12) and the untreated group (5). Similar trends were observed in Replications II and III, where CQDs yielded 10 plants in each case, while sunlight produced only 7 and 6, and untreated controls remained at 5. This consistent performance demonstrates the ability of CQDs to stimulate biomass production even under varying conditions. These outcomes highlight the potential of banana leaf-derived CQDs as reliable biostimulants, supporting sustainable approaches to increase duckweed productivity and expand its applications in environmental and industrial fields.

Table 1. Results Table

Test/Control	Positive Control (Sunlight)	Negative Control (Untreated)	Experimental Control (CQD)
Replication I	12	5	14
Replication II	7	5	10
Replication III	6	5	10



Figure 1. Results Graph (Legend: Wherein X is the results)

5. CONCLUSION

Banana leaf-derived CQDs significantly improved the growth rate of duckweed in controlled experiments. This provides a sustainable and eco-friendly strategy for maximizing the plant's potential in food, pharmaceuticals, biofuels, and phytoremediation. By transforming banana leaf waste into functional nanomaterials, the study contributes to circular economy practices while offering a practical solution to enhance aquatic plant productivity.

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