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# Carbon Quantum Dots' Impact on the Biome

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**ABSTRACT**

*Carbon quantum dots, the newest class of synthetic nanomaterial's, have gained attention since they are produced using environmentally friendly chemical processes and organic waste. These nanoparticles are made from biomass, such as fruit peel and other organic materials, and the process produces mixes of CQD species with various chemical identities, levels of activity, and photo physical characteristics. They are typically utilized as a chemically heterogeneous ensemble and have already had an impact on a number of environmental industries; including biomedicine, model agro-fertilizers, wastewater sensors, and switches. An accurate and thorough evaluation of their impact on agriculturally significant crops and produce is required as their applications to crops transition, which is a crucial crossover point. We discuss the knowledge gaps that need to be filled in order to ensure the safe use of CQDs in agronomy as we assess the current state of CQDs in relation to their influence on the biosphere using recent model studies. For human and environmental safety and sustainability, it is essential to have a thorough understanding of their effects on aquatic systems and the food chain.*

**Keywords:** Agriculture, Toxicity, Carbon quantum dots, Environmental consequences

## INTRODUCTION

Inorganic nanoparticles like CdS, $CeO_2$, gold nanoparticles, and paramagnetic lanthanide ions have been replaced with carbon quantum dots, which are now seen as a viable and comparatively bio friendly alternative. Due to the alluring chemical, physical, optical, and surface features of CQDs, interest has been generated. Naturally fluorescent CQDs, which have a size range of 2 to 10 nm, are widely used in environmental sensing, water purification, bio-sensing, imaging, switches, prophylactics, and therapies. Making CQDs from clean carbon-containing sources like citric acid, resorcinol, urea, sugars, as well as from a variety of benign agro-based waste products like lemon peel, leaves, water melon shell, bio-waste lignin, and paper, has made them particularly alluring in terms of lowering the environmental impact and carbon footprint.

Additionally, the synthesis method is comparatively eco-friendly. The hydrothermal method offers the most control, is reasonably economical, and is ecologically benign when compared to other documented procedures including laser ablation, electric arc, and microwave-assisted protocols. Using this technique, CQDs are regularly created from the aforementioned natural carbon precursors without the need of any potentially harmful or poisonous solvents.

### *In plants, CQDs*

It is particularly interesting to note that CQDs have frequently been used in water-based and biologically applicable applications as a result of their high hydrophilicity and high cell permeability.

For instance, the individual effect of five oxygen-containing graphene-derived CQDs on rice plants was assessed in a relatively recent and significant study. The CQDs were discovered to reach all areas of the plant via microscope imaging, albeit to varying degrees." entered the nucleus and caused the most physiological reactions of all the substances examined, despite having the highest oxygen concentration. The Os06g32600 gene expression was raised by CQD-1's interference with the DNA structure, which also improved the rice plant's capacity for disease resistance. Additionally, the addition of CQD-1 was associated with a 42% rise in Rubisco activity. The fact that CQDs have a metabolic destiny similar to plant hormones may be the reason why they encourage plant growth.

Additionally, the anabolic photosynthetic pathways are probably fed by the CO2 released during CQD catabolism. The positive phenotypic end-results included a net increase in rice yield and improved disease resistance. To date, the emphasis on CQDs as engineered nanomaterial has mostly been on environmentally friendly synthetic processes and applications. The necessary and thorough understanding of the environmental consequences of CQDs, including their transport, fate, and influence in the biome, is lacking. However, as will be discussed later, the fact that carbon-based QDs are less toxic than their inorganic counterparts alone is neither sufficient nor a good enough reason to ignore concerns about their effects on the environment.

Although the study on model rice seems to indicate that CQD infiltration in a plant species is relatively harmless, it should be noted that the synthesis of CQDs results in an ensemble of CQD and non-CQD species as shown by a recent study describing the preparation of CQDs from resorcinol, which revealed the presence of 21 chemically distinct species using reversed-phase HPLC. Furthermore, only 10 out of the 21 compounds produced by the hydrothermal treatment of resorcinol could be categorized as CQDs based on their fluorescence signatures. None of the 21 chemicals have precise chemical classifications or toxicological information at the time of writing. The same underlying cause is specifically referred to as such for CQDs 1–5 from the rice study.

### *Biome and CQD Chemical Footprint*

In recent years, CQDs have come from both diesel exhaust and the synthesis of cigarette waste. However, research on the potential negative effects of CQDs on aquatic and plant life appears to be generally insufficient and has been disregarded. This situation is made worse by the fact that hydrothermal synthesis, the mildest method for creating CQDs, yields byproducts other than the desired sp2 and sp3 hybridized carbon frameworks. These include reactive carbonyls that operate as precursors to hazardous compounds like glyoxal, methylglyoxal, 3-deoxyglucosone, hetero-cyclic amines, and acrylamides, among others, such as reactive carbonyls like keto-aldehydes, di-carbonyls, and reductones. The majority of these chemical substances may be byproducts that are difficult to track or follow using fluorescence-based tracking procedures because they lack fluorescence. This could cause harmful chemicals to enter the biosphere undetected and/or without additional inspection.

As an illustration, it was discovered that D was rendered immobile and died when exposed to citric acid and ethylenediamine-condensed carbonized CQDs. These findings imply that the CQDs or their metabolites were poisonous. The same CQDs interfered with photosynthesis and nutrient uptake in green algae in a dose- and time-dependent manner. It appears that oxidative stress and water acidification may be the processes behind the toxicity of CQDs to S. obliquus because the citric acid and ethylenediamine-derived CQDs increased oxidative stress in algae cells and decreased the pH value of an algae medium.

Even if these compounds aren't hazardous to plants, their influx into the food chain could pose a risk to human health. The community should therefore focus on the lessons discovered as a result of the existence of nanoparticles in the environment. Initially disregarded, the effects of nanoparticles on plant development, bioaccumulation, and the aquatic environment are now being studied independently, with the results showing the effects they have on agricultural output and influencing global policies. Prior to testing chemically singular species on the genomes, proteomics, or metabolomics of plants, it is crucial to fractionate CQD ensembles into their individual components and determine their chemical identities. Due to both planned and unintentional releases, ENMs play significant roles throughout their entire life cycles in the aquatic ecosystem, which serves as the terminal sink for all contaminants. In light of their risk assessment, the behaviour of ENMs in the aquatic ecosystem has thus become a pressing topic. These freshly found Nano sized tailored carbon-based materials are likely to penetrate the environment more quickly than their metal-based equivalents because of the variety of CQDs' sources and ease of preparation.

## CONCLUSION

A few articles have demonstrated the impact of CQDs in plants, but that is all. Rome lettuce produced hydroponically grew better after receiving a 25-day exposure to 10 mg/L–30 mg/L of CQDs derived from rapeseed pollen, according to Zheng. The mechanism was hypothesized to involve an increase in leaf area and leaf number. Additionally, they noted that the 20 mg/L CQD treatment lowered the amount of nitrate in leaves, indicating that the CQDs may disrupt physiological processes. The lettuce plants were exposed to a family of CQDs, which makes it challenging to link the plant response to a particular biochemical system affected by a single chemical stimulant, even though the data is interesting and suggests possibilities in agriculture. CQDs with their surfaces modified with polyacrylic acid and poly-ethylenimine made up the treatments. The CQDs-PEI considerably reduced total fresh weight, according to the scientists, and changed stress enzymes. The exposure time, however, prevents the prediction of these effects in a plant's life cycle. The inability to assess the consequences on the finished product is one example of this. The article also lacks evidence of a successful surface coating or a complete characterization of the virgin CQDs, similar to the study stated before. The study by Li. also shows the first indication of the genotoxic effects of CQDs. These recent articles have demonstrated significant physiological and molecular effects of CQDs in higher plants. In 2010, the National Organic Standards Board recommended that ENMs not be allowed to be certified as organic by the USDA. CQDs might suffer a similar fate because they'll probably be lumped in with "GMOs" when it comes to organic goods. Even worse, inadequate understanding of CQDs could lead to calls for a complete ban on consumer use, prematurely disposing of this organic ENM without realizing its full potential. The same level of scrutiny that has been used to analyses the environmental impact of other inorganic ENMs must now be applied by the scientific community that has invested in safeguarding and protecting the ecological and agricultural wealth. This enclosed nanostructure is going to leave a massive footprint. It is still unclear if biotechnology will be detrimental or beneficial. Resolution of the following factors is required in order to produce an accurate footprint of CQD influence on any component of the biome: Analyze the CQD ensemble to determine whether it is made entirely of CQDs or whether byproducts are also present. Divide the CQD ensemble into its constituent parts, and then gather each part separately. Check to see if each species is actually a CQD, and if necessary, ascertain the molar mass, chemical composition, and spatial orientation of each constituent. Finally, test the CQD's bio beneficial properties. First, determine the cytotoxic profile of each constituent utilizing cell line, aquatic, terrestrial, and agricultural models. This will depend on whether it is used in biomedicine, animal husbandry or agriculture.