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A Novel technique for detection of Tryptophan using carbon quantum dots synthesized from plastic waste

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Abstract

Tryptophan, an essential amino acid, plays a unique and critical role in biology due to its distinctive structure and functions. Its indole side chain, featuring an aromatic, binuclear ring, sets it apart among amino acids, and it exists in cells at notably low levels. As humans cannot synthesize tryptophan, it must be obtained from dietary sources. In the body, tryptophan supports protein synthesis, growth, and overall health and acts as a precursor to several important biomolecules, including the neurotransmitter serotonin, the hormone melatonin, and niacin. Deficiencies in tryptophan are linked to a range of metabolic and neurological disorders, underscoring the importance of accurate detection in both food and biological samples. Variations in tryptophan levels are associated with numerous health conditions, including depression, cancer, and cardiovascular disease. For example, reduced tryptophan levels can serve as a biomarker for diabetic nephropathy, colorectal cancer, and Alzheimer's disease. In the fields of food safety, clinical diagnostics, and biochemical research, monitoring tryptophan and its metabolites is essential to understanding metabolic processes and assessing nutritional quality. Fluorescent nanoparticles, especially carbon quantum dots (CQDs), have garnered significant attention for their applications in bioimaging and sensing. Synthesizing CQDs from plastic waste, such as polyethylene terephthalate (PET), offers an environmentally friendly approach to repurposing waste materials for scientific applications. In this study, CQDs synthesized from PET via a hydrothermal method were used for the detection of tryptophan. The addition of tryptophan effectively quenched the fluorescence of the CQDs, demonstrating a novel approach for tryptophan detection.

Keywords: tryptophan, optical sensor, graphene quantum dots (GQDs), circular economy, waste upcyclying, bioimaging

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