

COORDINATION-DRIVEN LUMINESCENCE QUENCHING OF EU³⁺ AND TB³⁺ COMPLEXES BY GLYPHOSATE

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ABSTRACT

Lanthanide-based luminescent systems have attracted considerable attention due to their narrow emission bands, long excited-state lifetimes, and pronounced sensitivity to variations in the coordination environment. Europium(III) and terbium(III) complexes are particularly suitable for probing molecular interactions in aqueous solution because their metal-centered emission is strongly influenced by ligand field perturbations and competitive coordination processes [1]. In this study, Eu(III) and Tb(III) complexes with 2,6-pyridinedicarboxylic acid (DPA) were investigated as luminescent molecular probes for glyphosate detection in water.

The coordination systems were prepared in aqueous media and characterized by steady-state absorption and emission spectroscopy. The emission spectra displayed the characteristic f–f transitions of europium (613 nm – main

transition) and terbium (544 nm main transition), consistent with antenna-mediated sensitization via the DPA ligand [2]. The photophysical response of the complexes was subsequently examined upon incremental addition of glyphosate.

A concentration-dependent decrease in lanthanide-centered emission intensity was observed in the micromolar range (9–90 μM). The quenching behavior is attributed to competitive coordination of glyphosate to the lanthanide center, leading to perturbation of the inner coordination sphere and modulation of the sensitization efficiency. Such interaction likely alters the ligand field environment and promotes enhanced non-radiative deactivation pathways, resulting in attenuation of the characteristic emission bands [3]. The response exhibited a reproducible correlation between emission intensity and glyphosate concentration, supporting the feasibility of a luminescence-based sensing mechanism.

The influence of common inorganic ions typically present in natural water matrices (Na(I), Cu(II), Fe(III), and Al(III)) was evaluated to assess the robustness of the system under chemically relevant conditions. Although certain metal ions induced partial emission modulation, the quenching response toward glyphosate remained distinguishable, indicating that the sensing behavior arises primarily from specific coordination interactions rather than nonspecific ionic effects.

These findings demonstrate that structurally simple lanthanide coordination complexes can function as effective luminescent molecular probes in aqueous environments without the need for nanostructured materials, immobilization platforms, or advanced instrumentation. The system should be interpreted as a coordination-driven luminescence modulation platform, in which analyte-induced perturbation of the lanthanide coordination sphere directly impacts metal-centered emission. This approach underscores the potential of classical coordination chemistry combined with photophysical analysis for the development of accessible luminescence-based detection strategies in solutions [4].

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Palavras-chave: lanthanide luminescence; glyphosate detection; luminescence quenching; coordination complexes; aqueous sensing.