

Photonic Monitoring of Microbial Viability under Pulsed UVC Irradiation Using UV-Vis Spectroscopy

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Abstract

Pulsed UV radiation is widely used for microbial decontamination, however rapid assessment of treatment efficiency remains a practical challenge. In this study, *Saccharomyces cerevisiae* served as a model system to investigate the feasibility of tracking optical spectral changes during UV-induced inactivation. Yeast suspensions were exposed to pulsed UV radiation for increasing time intervals and analyzed using UV spectroscopy, microscopic viability assessment, and independent culture-based CFU measurements. Irradiation induced systematic changes in spectral regions associated with cellular proteins and nucleic acids, particularly near the 230 nm and 265 nm wavelengths. These optical changes corresponded to the decrease in the viable cell fraction observed microscopically and aligned with the reduction in colony-forming ability measured in triplicate cultures. Statistical analysis confirmed a significant effect of irradiation time on viable cell concentration ($F(5,12) = 89.49$, $p < 0.001$). By correlating the optical response with the biological outcome, the study establishes a practical framework for evaluating irradiation efficacy without relying solely on final microbiological analysis. The results demonstrate that spectral monitoring can provide a rapid, reagent-free assessment of microbial response during photonic decontamination. Such measurements can complement traditional microbiological methods by enabling faster process evaluation and may facilitate the development of compact optical systems for real-time monitoring of decontamination efficacy in biomedical, biotechnological, and environmental applications.

Keywords

Pulsed UVC irradiation, microbial viability, photonic monitoring, UV-Vis spectroscopy.

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