SIFF 2026
Singapore International Food Forum 2026

XLED-activated tungsten photocatalytic coatings for inactivation of *Listeria monocytogenes*

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Abstract

Listeria monocytogenes is a critical foodborne pathogen responsible for listeriosis, a severe infection with high mortality rates [1]. Effective non-thermal strategies are needed to control this pathogen during storage while preserving the quality and shelf-life of fresh produce. Although 405 nm light-emitting diodes (LEDs) induce photodynamic inactivation, their antimicrobial efficacy is often limited when applied alone [2]. The use of exogenous photosensitizers can enhance inactivation but is constrained by cost and the need for direct food contact [3]. In contrast, integrating an economically efficient photocatalyst may provide a practical approach by enhancing reactive oxygen species (ROS) generation [4]. This study evaluated the antimicrobial efficacy of a tungsten trioxide–modified photocatalytic coating (NEP6-CBC1120) activated by a custom exchangeable LED (XLED) system. The photocatalyst was applied as a uniform thin film onto surfaces using a spin-coating method. Among 24 *L. monocytogenes* strains screened, isolate LM35 was identified as the most resistant to 405 nm LED illumination and was selected for subsequent experiments. Photocatalyst concentrations ranging from 0.2% to 1.0% showed no significant differences in inactivation efficacy under 405 nm LED illumination, and 0.2% was selected as the most cost-effective condition. Under these conditions, the combination of the photocatalytic coating and 405 nm LED reduced bacterial populations from approximately 7.3 log CFU/mL to 2.0 log CFU/mL. In contrast, treatment with 405+450 nm mixed light resulted in a lower reduction to 5.3 log CFU/mL. Mechanistic analysis indicated that enhanced antimicrobial activity was associated with increased ROS generation, with hydroxyl radicals playing a major role under photocatalytic conditions. These findings indicate the potential of XLED-activated photocatalytic coatings as a cost-effective non-thermal approach for controlling *L. monocytogenes* on foods stored in photocatalyst-coated containers.

References

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