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# Programmable Host-Pathogen Interface Peptides for Rapid Electrochemical Detection of *Listeria monocytogenes*

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## Abstract

Rapid detection of foodborne bacterial pathogens is essential for food safety, environmental monitoring, and point-of-care diagnostics. *Listeria monocytogenes* (LM) is particularly challenging because contamination can occur at low bacterial loads, whereas culture-based isolation, PCR, and immunoassays often require enrichment and delay decision-making [1,2]. Here, we present a label-free electrochemical biosensor that converts a native host-pathogen protein-protein interaction into a compact, chemically defined recognition interface for LM detection.

The sensor is based on the interaction between Internalin A (InlA), a major LM virulence factor, and human E-cadherin (E-Cad1) [3]. Three peptides derived from the InlA-binding region of E-Cad1 were synthesized and screened as molecular recognition elements. Flow-cytometry assays showed selective LM binding for E-Cad1(11-31) and E-Cad1(15-24), whereas E-Cad1(22-31) showed no detectable binding. The shorter E-Cad1(15-24) peptide, containing the key Pro16/Pro18 recognition motif, gave the strongest response with an apparent Kd of 5.9 ± 0.1 μM and was selected for sensor fabrication.

Lipoic-acid-modified E-Cad1(15-24) was assembled on gold electrodes and characterized by X-ray photoelectron spectroscopy, ellipsometry, reductive desorption, and contact-potential measurements, confirming formation of an accessible peptide monolayer. Bacterial capture was monitored by electrochemical impedance spectroscopy (EIS) through changes in charge-transfer resistance [4]. The optimized interface detected LM within 10 min, with an estimated limit of detection of 0.5 CFU mL-1, and showed negligible response to *Escherichia coli* or methicillin-resistant *Staphylococcus aureus* under identical conditions.

These results establish host-pathogen interface peptides as programmable receptors for electrochemical biosensing. Lower peptide surface density improved performance by reducing crowding, increasing binding-site accessibility, and enabling multivalent engagement with surface-displayed InlA. This reductionist yet biologically informed strategy provides a rapid and selective alternative to antibody- and aptamer-based assays and should be extendable to other pathogens that use defined surface protein interactions for host colonization or invasion.

**Keywords:** chemical sensor; biosensor; electrochemical impedance spectroscopy; pathogen detection; peptide interface.

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