# ENVIRONMENTAL AND STRAIN-SPECIFIC INFLUENCES ON *LISTERIA MONOCYTOGENES* BIOFILM FORMATION AND THE EFFICACY OF SANITIZATION ON FOOD CONTACT SURFACES

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## ABSTRACT

Food-contact surfaces have been identified as a principal source of *Listeria monocytogenes* contamination in fresh produce, including caramel apples and cantaloupes, emphasizing the importance of effective disinfection and sanitization. *L. monocytogenes* can firmly attach to these surfaces and form biofilms—complex bacterial matrices protected by extracellular polymeric substances (EPS). This study evaluates the microbiological risks associated with *L. monocytogenes* on food-contact surfaces in food processing environments.

The first phase examined environmental and strain-specific influences on *L. monocytogenes* biofilm formation across different food chain surface materials. Regression modeling revealed significant biofilm formation over time **(**estimate = 0.3358, $p < 0.001$) with a clear surface-specific effect. New stainless steel and PVC surfaces exhibited high biofilm formation, while silicon rubber surfaces were significantly less conducive. Temperature also played a role, with significantly lower biofilm formation at 4°C **(**estimate = –0.1044, $p < 0.001$**).** Additionally, medium composition influenced biofilm formation, with apple juice supporting higher levels than water. Untargeted metabolomics analysis indicated strain-specific variations, showing that strain V7 exhibited superior biofilm formation with upregulated purine metabolism compared to strain LCDC.

The second phase assessed the effectiveness of sanitizers—including chlorine, quaternary ammonium compounds (QAC), and UV-C light—on biofilms formed on common food contact surfaces (stainless steel, PVC, and silicon rubber) in an apple-processing plant. The efficiency of each sanitizer varied based on surface material and biofilm age. Chlorine and UV-C light were significantly effective ($p < 0.05$) against 1-day-old biofilms on stainless steel, reducing bacterial load by 2.84 log CFU/coupon and 2.71 log CFU/coupon, respectively. QAC was effective against 1-day-old biofilms across all surface materials ($p < 0.05$). However, no significant reduction was observed in 7-day-old biofilms ($p > 0.05$), highlighting the importance of early intervention.

These findings underscore the critical role of surface type, environmental conditions, and strain-specific differences in *L. monocytogenes* biofilm formation. They provide valuable insights into effective sanitization strategies to mitigate contamination risks in food processing facilities, emphasizing the significance and relevance of this research to the food safety industry.

*Keywords: microbiological risks, food processing environments, Listeria monocytogenes, biofilms*

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