Study demonstrates the inhibition and inactivation of Escherichia coli O157:H7 biofilms by Selenium

By Lindsay Pressman

Escherichia coli O157:H7 (EHEC) is a major foodborne pathogen that causes serious illness in humans estimated to cost the U.S. economy approximately $200 million annually. Biofilms are groups of organisms enclosed in an exopolysaccharide matrix, and can be formed on any surface with an abundance of moisture and nutrients. The protective layer of polysaccharides in a microbial biofilm helps bacteria associated with the biofilm remain resistant to external sanitizers, common disinfectants and antimicrobials. The presence of resistant EHEC biofilms, on food contact surfaces in food processing environments, animal slaughterhouses and meat packing plants can act as a continuous source of food contamination. A research paper, published in the *Journal of Food Protection* by Meera Surendran Nair et al., entitled "Inhibition and Inactivation of Escherichia coli O157:H7 Biofilms by Selenium", explores the efficacy of Selenium (Se) in the reduction of EHEC exopolysaccharide synthesis, inhibition of EHEC biofilm formation and inactivation of mature EHEC biofilms in combination with hot water. Selenium, a naturally occurring microelement, was chosen in this study because it generates superoxide radicals which interact with many bacterial components to exert an antimicrobial action. The ability of organo-selenium compounds to attach to solid surfaces, catalyze oxygen radical generation and reduce bacterial colonization and biofilm formation, could significantly reduce the food safety hazard of food contamination in both food processing equipment and environments.

The EHEC was treated with sub-inhibitory concentration of Se, and then incubated at 37 degrees C for 24 hours. After the biofilm associated EHEC populations were enumerated from the detached cells, plated and incubated, the efficacy of Se in inhibiting and reducing exopolysaccharide production in EHEC biofilms was determined. The authors studied the effect of Se on the initial attachment of EHEC cells to a solid surface as well as the efficacy of Se in combination with hot water for rapid inactivation of EHEC mature biofilm. In addition, the effect of Se on the transcription of EHEC biofilm-associated genes was investigated by using real time quantitative PCR (RT-qPCR). The authors then synthesized Se nanoparticles from sodium selenite, and further studied biofilm inhibition using stainless steel coupons, inoculated with ~6.0 log CFU of EHEC, and coated with and without Se nanoparticles.

The authors found that Se inhibited EHEC biofilm formation on polystyrene surfaces at both 25 and 4 degrees C, and decreased exopolysaccharide production for the entire 96 hour incubation. Selenium inhibited initial surface attachment of EHEC cells and with hot water (80 degrees C), Se decreased biofilm-associated bacterial population by approximately 40%. In addition, EHEC biofilm formation was reduced on Se nanoparticles-coated stainless steel. Overall, it was determined that Se effectively inhibited biofilm synthesis, inactivated mature biofilms in EHEC, and coating stainless steel with SeNps exerted a significant antimicrobial effect. The authors suggest that Se could be used to control EHEC biofilms in food processing environments, but further studies on the potential application of Se coating as an effective antibiofilm treatment, and on the safety and long-term efficacy on food contact areas are justified.

Venkitanarayanan, Kumar, the senior PI on the paper indicates that in these experiments "Selenium was effective in inhibiting and inactivating EHEC on abiotic surfaces. In addition, coating of stainless steel surface with Se nanoparticles exerted significant antibiofilm effect against EHEC."

The view the full article, see M.S. Nair, A. Upadhyay, S. Fancher, I. Upadhyaya, S. Dey, A. Kollanoor-Johny, J. Zhao, K. Venkitanarayanan in the *Journal of Food Protection* Vol. 81, No. 6, 2018, Pages 926-93.