Mathematical Modeling of Produce Washing in an Industrial-scale Flume Washer

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Cross contamination of fresh produce during washing use to sub-optimal sanitizer conditions has been regarded as a critical risk factor that leads to majority of foodborne disease outbreaks. Fresh produce undergoes minimal processing before consumption. Therefore, it is necessary to develop an efficient and effective process in produce washing. In our study, we investigated two factors to reduce the microbial load on produce: shear stress on produce surface during washing and free chlorine as a sanitizer. Our objective was to mathematically model the combined role of shear stress and free chlorine on microbial attachment during produce washing.

COMSOL® Multiphysics was used to numerically simulate washing of spherical produce in an industrial-scale flume washer. The goal was to examine how the relative positions of the produce affect the shear stress on the surface of the produce in a flume washer. Multiple simulations were carried out by varying the distance between spherical produce. The results showed that the upstream produce always experienced higher surface shear stress than the downstream produce. The shear stress on the surface of the downstream produce was maximum when the distance between the two was four times as the diameter.

In this study we also simulated the transport of free chlorine in the flume washer without produce, where chlorine was injected at selected locations. A chlorine dynamics model was used to understand its transport. The results showed that low main-flow velocity with higher injection velocity gave a better distribution of free chlorine. The results of this study should provide guidelines for designing better produce washing equipment and the flow conditions to be used in produce washing.

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