A NOVEL SET-UP TO STUDY THE BIOFILM DYNAMICS UNDER SPECIFIC TURBULENT FLOW CONDITIONS ENCOUNTERED IN FRESH CUT FOOD INDUSTRY PROCESSING

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ABSTRACT

The fresh cut food processing equipment consist in a set of closed and open flow sections in which the hydrodynamic conditions as well as the design and the surfaces properties make a complex environment. Therefore, an original experimental approach breaking with those widely used to study biofilm growth dynamics was proposed to be able to identify physical parameters impacting the biofilm development in such environmental conditions. The set-up comprised both a closed flow section with flow cells and an open flow section with a series of mock-ups mimicking generic features of washing tanks. It allowed us to study the biofilm dynamics on welding zones, folds or flat surfaces; wet surfaces or air/liquid/wall interfaces; surfaces in vertical or horizontal positions. The characterization of the flow pattern in mock-ups was performed using two computational fluid dynamics calculation approaches. Full trials were run for 48 h at 10 °C with a Pseudomonas fluorescens strain to identify the preferential biofilm formation areas. As actual industrial systems, the pilot rig implements recirculation areas and low rate wall shear stress conditions (τ_w<0.1 Pa) in corners and angles, which were identified as the main critical areas with a Surface Microbial Load (SML) over 5 Log_{10}/cm². However, τ_w appeared to be insufficient to explain why significantly higher SML was observed in the flow cell compared to those observed in the mock-up under lower τ_w conditions (0.1-0.5 Pa). In addition the air/liquid/wall interfaces condition enhanced criticality compared to immersed surfaces. This work validated the approach according to the biofilm formation and the understanding of the associated therewith flow arrangements using CFD methods. The proposed methodology can be applied to further investigations as the characterization of biofilm growth kinetics and as the identification of the potential criticality of other pieces of equipment.