Cleaning in place: a source of contamination of food processing line?

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INTRODUCTION

Cleaning in place (CIP) procedures are designed to ensure a good hygiene of food processing lines. However, previous works have evidenced that bacterial contamination is still observed on equipment surfaces after cleaning. This residual surface contamination was proven to be at least in part due to bacteria detached during CIP and able to re-adhere downstream. The objective of this work was to investigate if CIP procedure could be considered as critical in terms of food safety.

MATERIALS & METHODS

Measurements of wall shear stresses and velocity profiles were carried out in test CIP rigs with straight pipes, valves and bends at different flow rates. In order to investigate the re-adhesion phenomenon, similar items were used. Uncontaminated items were inserted in the loop along with highly contaminated pipes and their level of contamination after CIP was quantified (level of spores able to germinate and grow). The consequences of the conditions encountered in CIP (NaOH at high concentrations, high temperatures, and shear stresses) on spore injury (observation by transmission electron microscopy) and viability (germination and growth) was also investigated.

RESULTS & DISCUSSION

Environmental conditions encountered during CIP induced changes in the spore surface properties. Treatment with NaOH at high temperature of spores belonging to the B. cereus species resulted in a loss of appendages and exosporium integrity [1]. Recently, we showed that spores of other species, such as B. subtilis, were injured as well. For example, the thick layer surrounding the B. subtilis 98/7 spores and largely composed of saccharidic moieties was removed when subjected to the NaOH treatment. Moreover, the coat layers were also injured as previously observed on B. cereus spores with a lost of cohesion and a partial disruption of the more external layers. A high level of the treated spores were also unable to form colonies on agar medium.

However, previous works demonstrated that spore re-adhesion occurred during CIP procedures [2] and that some of these re-adherent spores were still able to germinate and further grow under favourable conditions. Indeed, when unsoiled coupons and pieces of equipment were inserted in loops including items contaminated with Bacillus spores, adherent spores were detected on their surface following a CIP procedure. The uncontaminated surfaces were therefore contaminated during the cleaning procedure, indicating that some of the detached spores were able to re-adhere downstream.
We then investigated if the flow patterns governed in the same way Bacillus spore adhesion during food processing and spore re-adhesion during CIP procedures. We first showed that flow conditions far from those considered as efficient on contamination removal can be found at different places of the test loop [3]. For example, unsteady flow conditions inducing low wall shear stresses were found in pipe contractions and expansions, while recirculation zones were observed e.g. after bends. Items inducing unsteady flow conditions were chosen to estimate Bacillus spore re-adhesion during CIP. Hence the presence of recirculation zones corresponding to low shear stresses and long residence times, observed in straight pipes downstream a bend, or at entries and exits of valves, promoted high level of spore re-adhesion.

CONCLUSION
In conclusion, re-adhesion of viable spores occurs during CIP, mainly in geometries already considered as poorly hygienic, at level sufficient enough to be considered at risk for further cross-contamination. Indeed, these adherent spores would be able to further contaminate food in contact with the contaminated surfaces but also to produce biofilms.

REFERENCES

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