Cold plasma bubbles for apple juice preservation

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This study aimed to develop a cold plasma bubbling system to ensure the microbial safety and retention of quality attributes of apple juice by using a gas-liquid phase reactor. A Cold Plasma Bubble (CPB) reactor was developed to assess the antimicrobial efficacy against pathogens (*E. coli & Listeria monocytogenis*) in fresh apple juice using air as the inducer gas at various frequency discharges (500, 1000 and 2000 Hz), flow rates, and applied voltages. Further, optimal processing conditions were used to investigate the effect on the inactivation of undesirable endogenous enzymes such as polyphenol oxidase (PPO) and peroxidase (POD).

The CPB reactor was found to achieve the target minimum 5 log reduction in the population of pathogens in apple juice. Scavenging assays indicated the importance of reactive oxygen species (ROS), especially superoxide, to play a key role in the observed antimicrobial effects. Further, the optimal cold plasma processing conditions yielded up to 50% reductions in endogenous enzyme activities. The mechanisms of actions were eluded from in-situ diagnostics of the plasma discharge and the induced recreative metastable species. The energy efficiency of the reactor is quantified for the targeted antimicrobial effects.

In conclusion, the CPB reactor developed for this study demonstrated high efficacy in ensuring the microbial safety and retention of the quality attributes in apple juice while using air as the processing gas, which is free and abundant. This highlights the potential of this green processing approach as a cost-effective alternative to current conventional approaches.