RESEARCH IN PROCESS

Rechargeable antimicrobial and antifouling plastics for improved cleaning and sanitation of plastic bins and totes

SUMMARY

Sanitation of reusable plastic containers (RPCs) is a significant challenge and can lead to cross-contamination of fresh produce. These cross-contamination events can result in a foodborne disease outbreak as well as reduce the shelf life or quality of the product. To address this challenge, the project is aimed at development of a rechargeable antimicrobial and antifouling plastic material and its evaluation for eliminating contamination of RPCs by various sources and reducing biofilm formation. This novel plastic material can be used as a rechargeable liner attached to existing RPCs and/or development of new RPCs with this material. In summary, this research proposal addresses a significant unmet need in the industry to improve sanitation of RPCs.

OBJECTIVES

1. Demonstrate continuous sanitation of reusable plastic container (RPC) food contact surfaces using a novel rechargeable antimicrobial plastic surface.
2. Develop non-fouling functionality in polymer films and evaluate the influence of this modified composition on: (a) attachment of *Listeria* to the plastic surface; and (b) formation of biofilms on the RPC surfaces under simulated conditions.
3. Combine non-fouling functionality with rechargeable antimicrobial functional material to improve sanitation of RPCs and conduct pilot-scale testing.

METHODS

Transfer of *Listeria innocua* from contaminated produce to RPC surface:
In these experiments two sets of RPC surfaces were evaluated—one set was modified with Halamine (antimicrobial plastic film) and the other set was modified with control film.

Transfer of *Listeria innocua* from contaminated RPC to fresh produce:
For these experiments, the RPC surface was inoculated with *Listeria innocua* at 10^7 CFU/cm^2. After the initial inoculation, spinach leaf slices were brought in contact with the RPC surface and then the leaves were brought in contact with a TSA plate.

Halamine and Zwitterion Non-Fouling Surface:
We also developed a photografting process to combine deposition of halamine-modified polymer and a zwitterion polymer for combining the antimicrobial activity and non-fouling properties on a polymer material.

RESULTS TO DATE

Transfer of *Listeria innocua* from contaminated produce to RPC surface:
Initial test results demonstrated that the halamine-modified surface reduced the transfer from contaminated fresh produce to the RPC surface as compared to the control. Further testing is ongoing to quantify the reduction. *(Figure 1.)*

Transfer of *Listeria innocua* from contaminated RPC to fresh produce:
Results show that the halamine-modified surface prevented transfer of bacteria from a contact surface to spinach leaves. *(Figure 2.)*

New materials with a combination of non-fouling and antimicrobial properties:
Testing of antimicrobial properties of modified polymers with non-fouling and antimicrobial properties is ongoing. *(Figure 3.)*

BENEFITS TO THE INDUSTRY

The near-term benefit for the fresh produce industry would be to improve sanitation of RPCs—this will be achieved through two stages: In the first stage we will develop and demonstrate the efficacy of the novel antimicrobial and antifouling material as a liner for RPCs. Success in this demonstration, including pilot-scale testing, would enable us to motivate both produce industry and plastic suppliers to consider developing new totes and bins with the modified material as well as lining material that can be used for existing totes and bins. In the future, this novel lining material also may be tested for wooden bins, which are even more difficult to sanitize.

Figure 1.

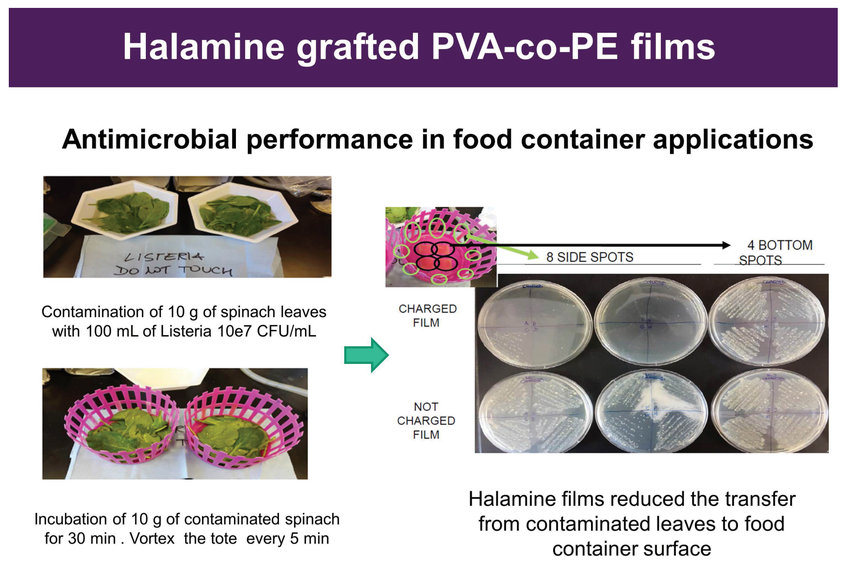


Figure 2.

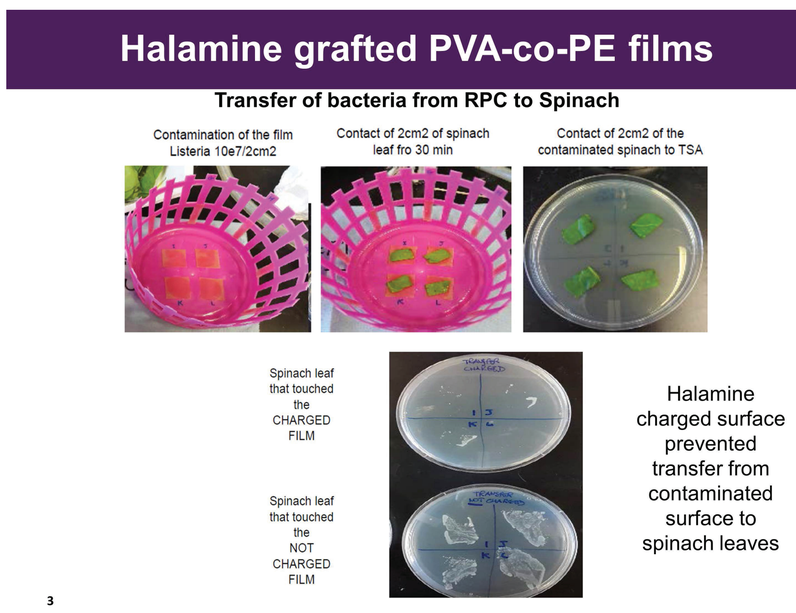
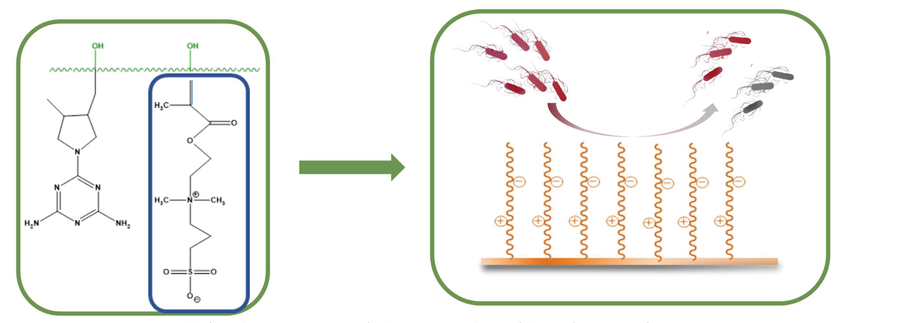


Figure 3.



N-halamine
- Biocidal property
- Rechargeability

Zwitterion: both cationic and anionic groups; High dipole moment
- Strong hydration: electrostatic interaction → lower mobility and wider dipole orientation distribution
- Hydrophobic interaction

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