Nano-Bioelectric Technique for Novel Microbial Interventions

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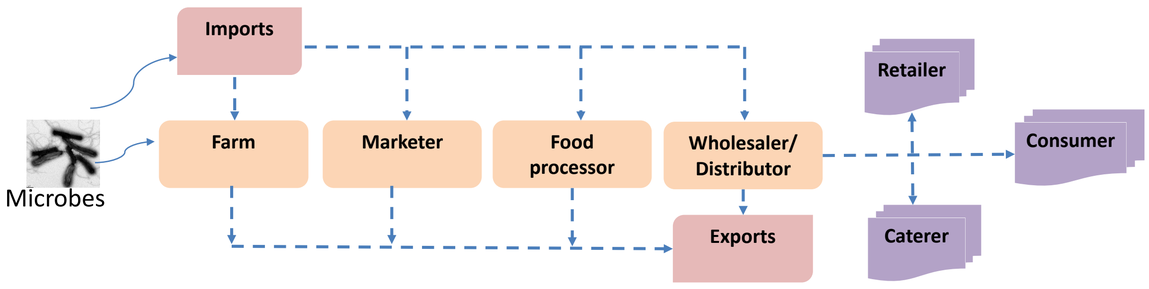
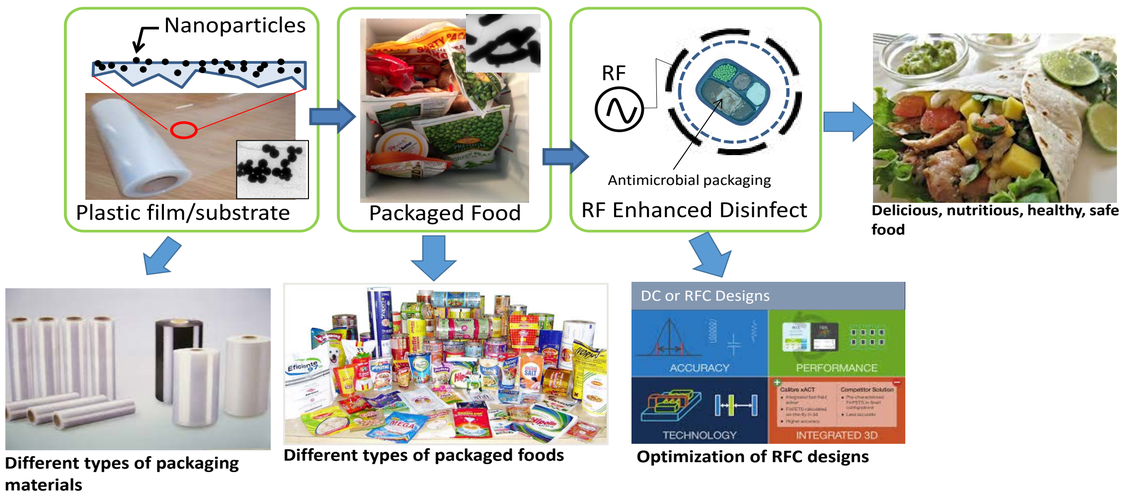
1. Research Project & Axia Theme

Microbial pathogens are a major cause of illness outbreaks in the US and around the world, leading to deaths, chronic health issues, reduced productivity, job losses, and overall economic chaos. Microbial contamination can propagate in the supply chain with devastating and catastrophic consequences.



Thus, the goal of this project is to prevent and control pathogenic contamination and biofilm formation in various bio-based systems, such as the food supply chain, healthcare, water, cosmetics, and biofuels among others, through the development of novel nano-bioelectric technologies (NBET). NBET combines the unique properties of antimicrobial bioactive agents and direct or radio frequency current (DC/RFC) to eliminate microbial pathogens. Output from this research could lead to the synthesis and development of smart materials and systems with a wide range of societal benefits.

A schematic of the NBET approach is shown below.



Axia Institute Grand Challenge:

The scope of this project aligns with the mission and vision of the Axia Institute, especially in the grand challenge “Food Safety and Sustainability.”

Project theme:

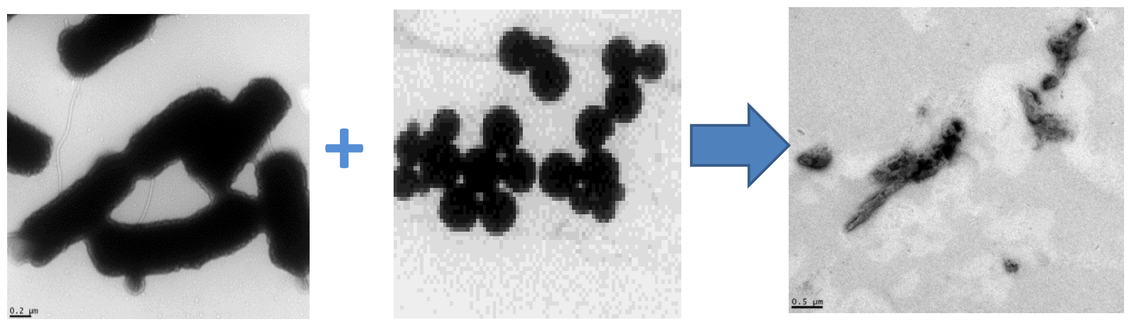
Antimicrobial development combining bioactive agents and DC/RFC for a novel nano-bioelectric technology.

2. Value Created

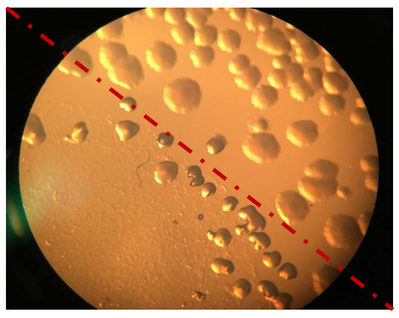
1. Antimicrobials for disease prevention and control
2. Increased shelf-life of highly perishable products; minimized waste
3. Extended shelf-stay in stores; increased variety of products
4. Improved water quality
5. Reduced illness outbreaks
6. Reduced wound infection; improved health
7. Reduced healthcare cost
8. Improved biofuel efficiency
9. Cost saving in the supply chain infrastructure, such as reduced cold storage
10. Reduced overall financial burden to consumers

3. Results/Future Directions

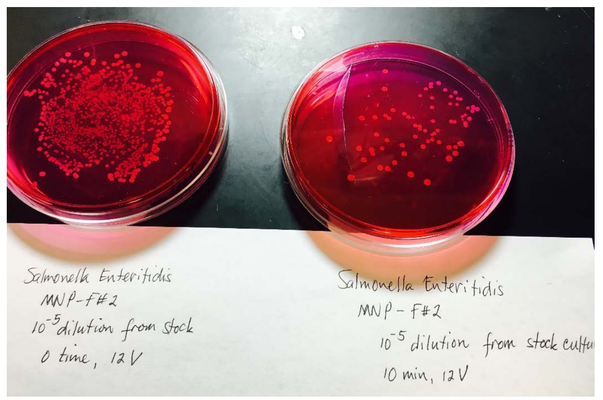
Preliminary Data:



Transmission electron microscope images of *E. coli* bacteria (left) treated with antimicrobial bioactive agent (middle) resulting in the death of the bacteria (right).



Light microscope image of *E. coli* bacteria treated with antimicrobial bioactive agent (below red line) and bacteria without treatment (above red line). Note empty space below the red line: there is no bacterial growth due to the antimicrobial agent.



Pictures of *Samonella* bacterial plate count before treatment with DC (right) and after treatment with DC for 10 min.

Expected technologies to be generated:

1. New class of antimicrobial bioactive agents
2. Handheld antimicrobial-current device
3. Smart active packaging
4. Antimicrobial patches for wound healing
5. Ballast water and biofilm water treatment
6. Treatment for microbial growth prevention in medical implants
7. Alternative to antibiotics
8. Coatings for medical implants

4. Project Plan

Year 1:

Assess the current information on antimicrobials and related FDA regulations, and identify potential barriers to adoption; synthesize novel antimicrobial bioactive agents and characterize their properties; and design DC or RFC interrogation protocols and its assembly.

Year 2:

Incorporate the antimicrobial bioactive agents in packaging materials; evaluate DC/RFC interrogation against biofilms inside packaging; evaluate sensory effect.

Year 3:

Scale-up studies: Assess the efficacy of the antimicrobial bioactive agents in scaled-up packaging materials and determine their effect with DC or RFC interrogation.