Anti-Microbial Solutions for Supply Chain

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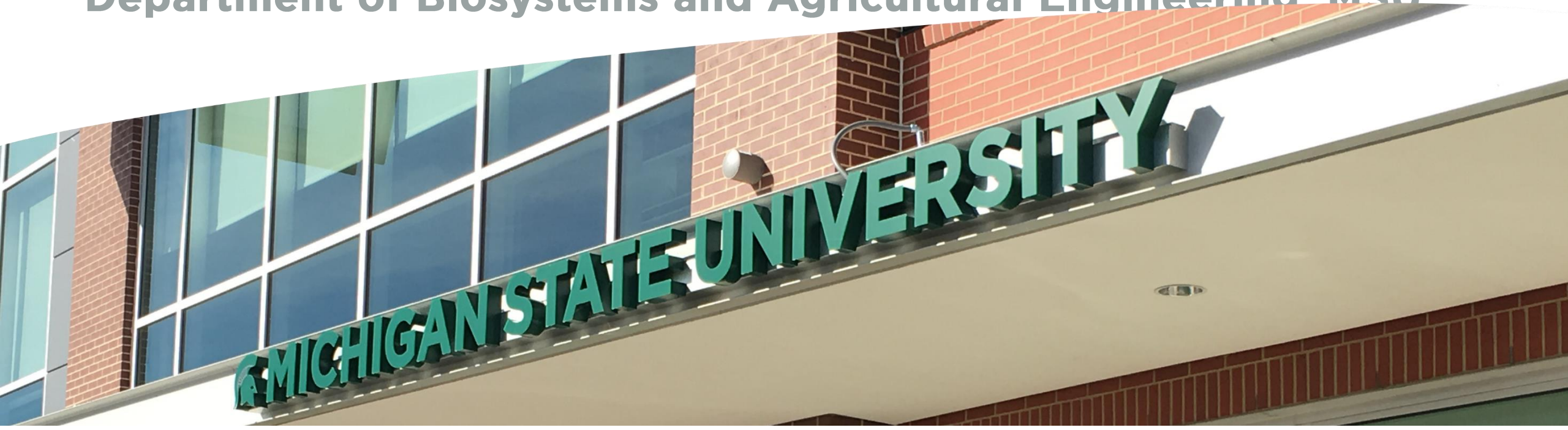

Agenda

- Introduction
- Project Scope
- Impact of Research
- Value to Industry
- Current Results
- Future Direction
- Project Plan

Introduction

Project Team:

PI:	Co-Investigators:	Sponsor:
Evangelyn Alocilja	P. Chahal, E. Almenar, R. Clarke, S. Cho, D. Closs, T. Schoenherr, & C. Mena	Jeff Tazelaar, The Dow Chemical Company

Project Scope

Grand Challenge: Food Safety and Sustainability, and Antimicrobial Resistance

Expected Outcome: Antimicrobial films and antimicrobial nanoparticles for coatings and packaging.

Research Objectives:

1. Assess the current state of the art of biologically-based antimicrobials, DC or RFC to target bacteria, FDA regulations and standards on antimicrobial coatings, and assess potential constraints for industry adoption of the technology.
2. Synthesize antimicrobial nanoparticles and characterize antimicrobial properties that can be used as package coatings; design DC or RFC interrogation protocols and their assembly.
3. Integrate the nanobioelectric system and validate its efficacy on biofilms in packaging materials and its effect on food composition, taste, color, and smell.
4. Incorporate the antimicrobial nanoparticles in packaging materials (e.g. polyethylene) and evaluate the efficacy of the processed materials with DC or RFC interrogation against biofilms inside packaged foods.

Impact of Research: Food Safety

U.S. per year:

$77.7 billion
annual cost of **foodborne illness** in the U.S.

48 million
illnesses

128,000
hospitalizations

3,000
deaths

Global per year:

~600 million
(1 in 10 people) **experience foodborne illness**

420,000
deaths

125,000
deaths for children
<5 years of age

Food safety, nutrition, and food security are **inextricably linked**

Foodborne diseases impede socioeconomic development

Food supply chains cross multiple national borders

Impact of Research: Antimicrobial Resistance

U.S. per year:

>2 million
people get drug-resistant infections

23,000
deaths

$20 billion
in excess direct
healthcare costs

$35 billion
in lost productivity

Global per year:

10 million
extra deaths/year
by 2050

$100 trillion
healthcare cost/year
by 2050

~2.5%
reduction in global real exports

~5%
decline in livestock production

Drug resistant bacteria
are transmitted through the supply chain

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Value to Industry

Awards Received:

Stockholm Junior Water Prize

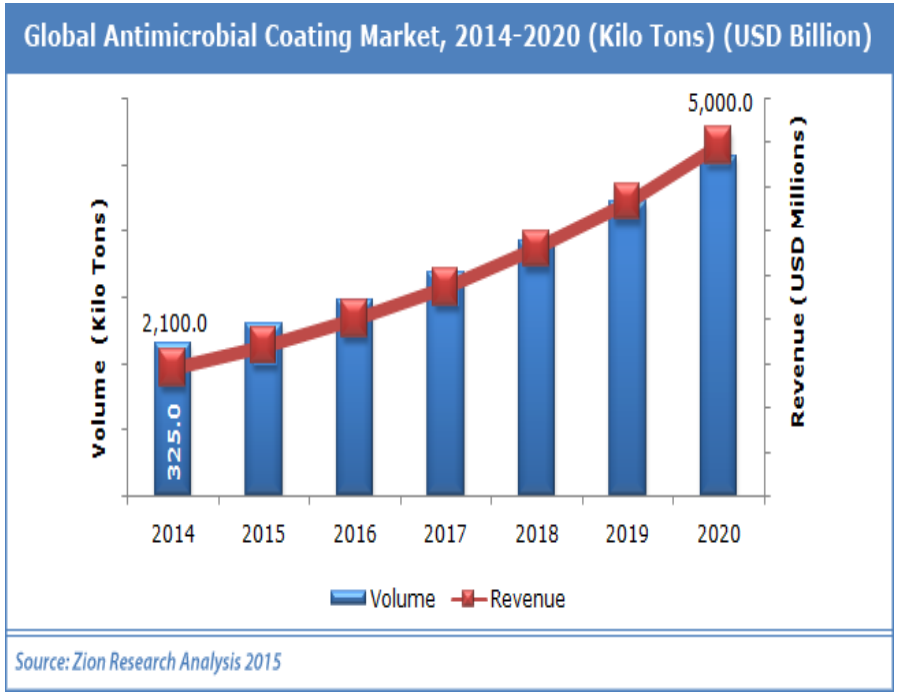
Finalist, Sustainable Manufacturing Leaders Award

Anticipated Benefits to Society:

1. **Reduce infection from pathogenic organisms**
   - ***E. coli, Salmonella, Listeria, Bacillus,*** **and others**
2. **Improve food safety**
3. **Reduce food waste**
4. **Reduce food recalls**
5. **Reduce nosocomial infection**
6. **Improve health**
7. **Improve sanitation**
8. **Support coating and packaging industries**

Value to Industry

Global antimicrobial coating market is set for rapid growth, to reach around US$5.0 billion by 2020.



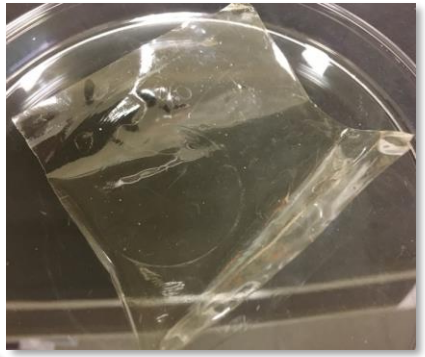
www.marketresearchstore.com/news/global-antimicrobial-coating-market-145

Our proposed technologies can be used as antimicrobial coating in:

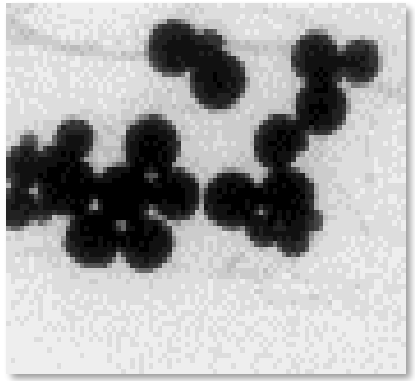
- Food packaging
- Medical devices
- Healthcare settings
- Textiles and medical uniforms
- Indoor air quality
- Mold remediation
- Water purification
- Others

Current Results

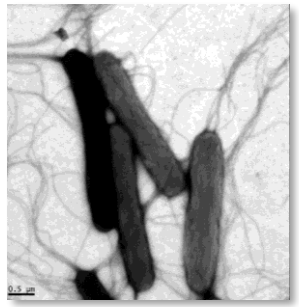
Technologies we have developed:



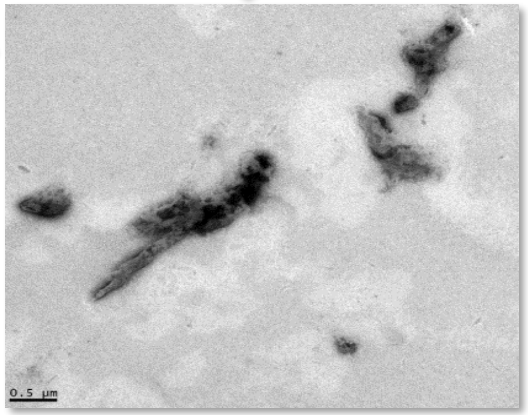
1 Antimicrobial biofilm (AB)



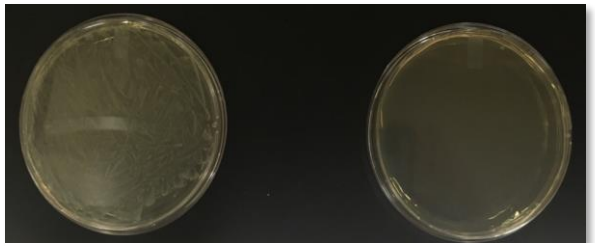
2 Antimicrobial nanoparticles (AN)



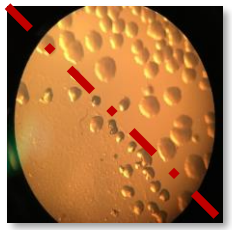
Salmonella bacteria



TEM image of *Salmonella lysed* by the antimicrobial



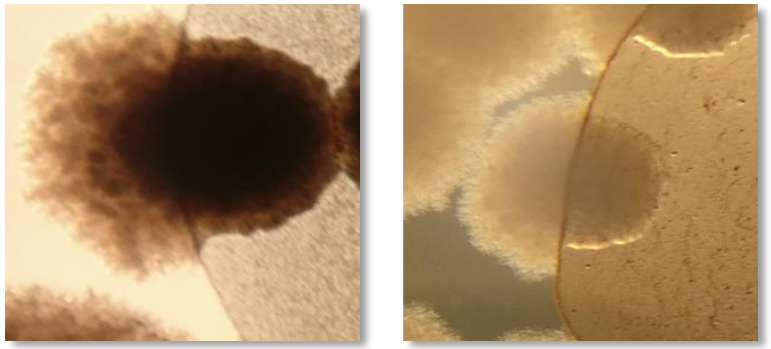
L. monocytogenes in control biofilm (left) and AB (right) after 10 min of contact time. AB provides 5-7 logs of bacterial reduction.



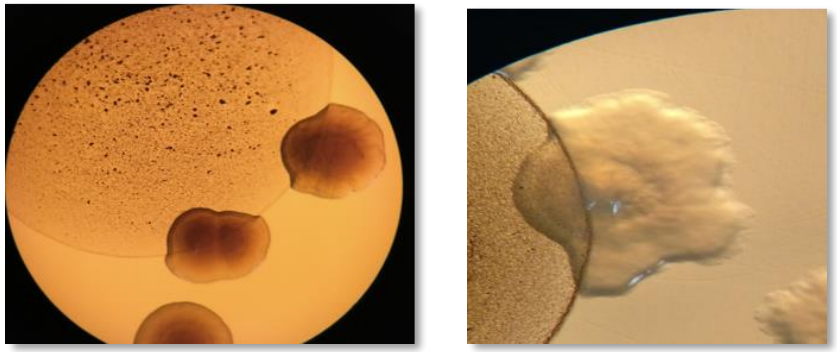
Microscope image of *E. coli* colonies treated with AN (below red line) and without AN (above red line).

Current Results

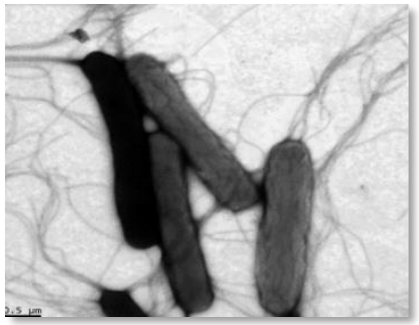
Mechanism of action: Growth inhibition and killing agent



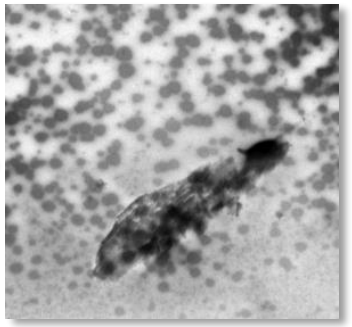
Bacillus cereus



Salmonella enteriditis

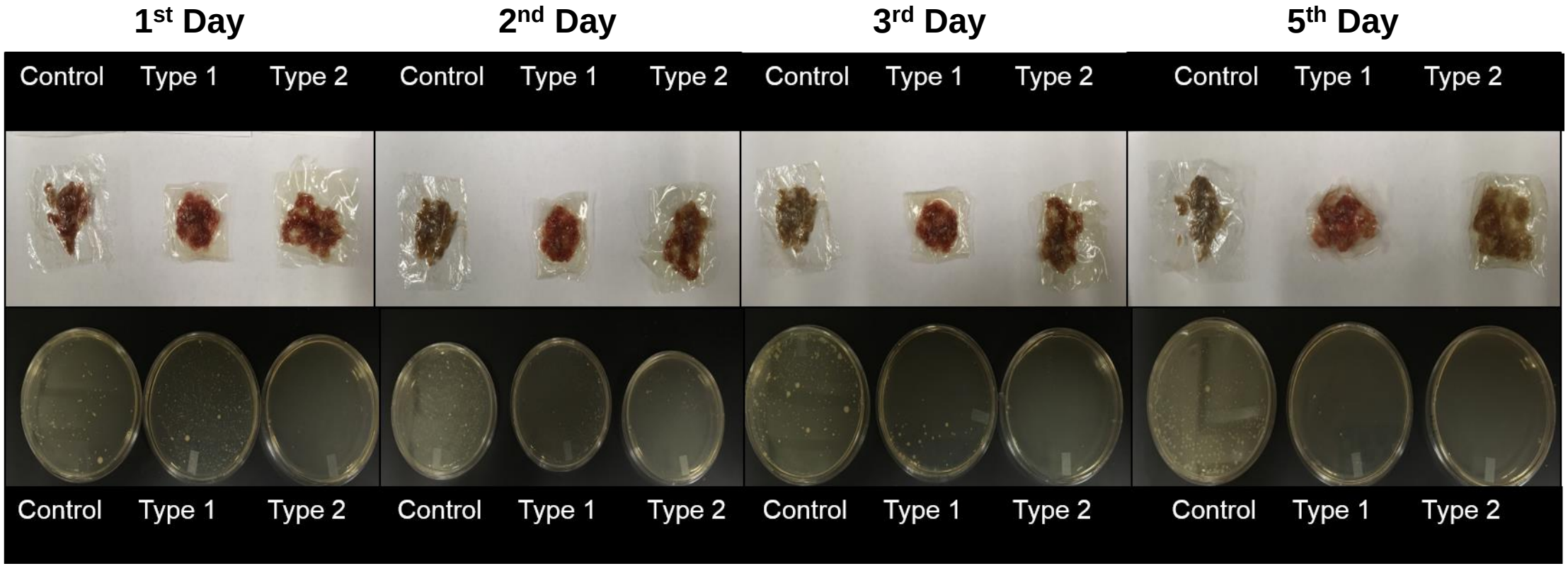


Salmonella enteriditis



TEM of
bacterial lysis

Current Results



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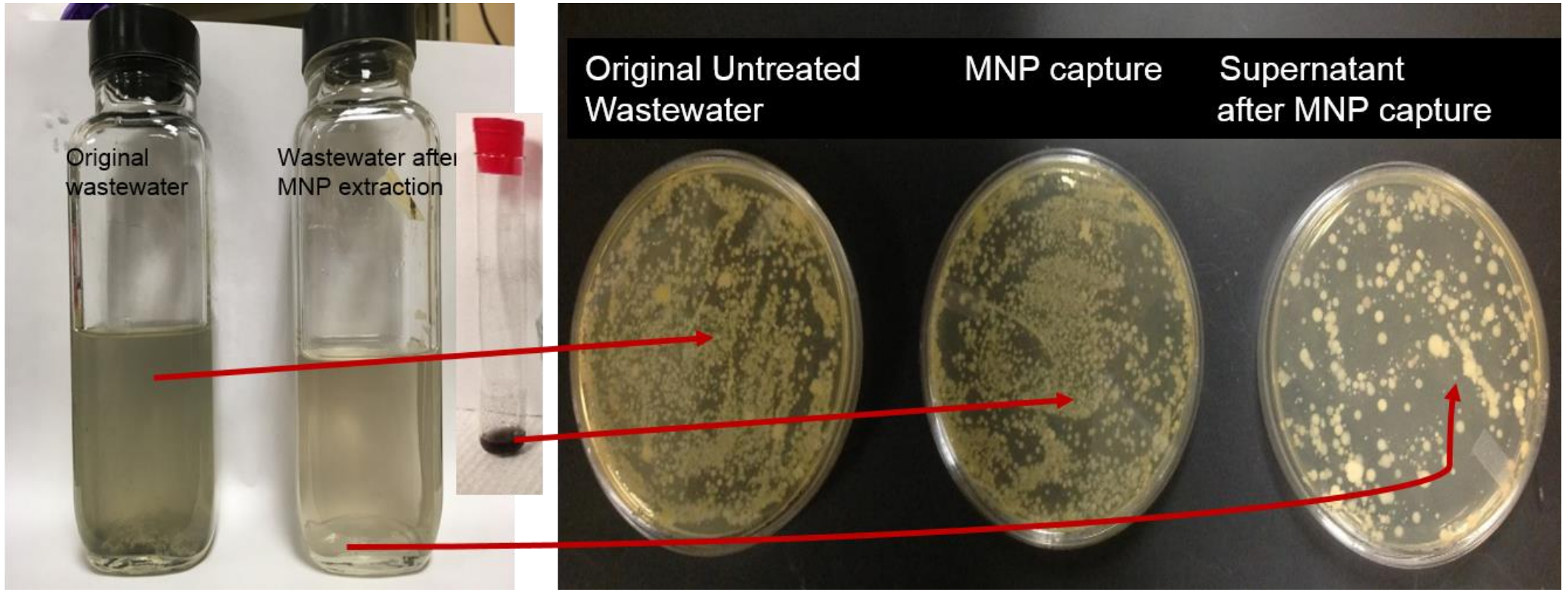
Current Results



Left: Wastewater before and after MNP treatment and extraction; small tube contains extracted MNP-cell.
Right: Equivalent plates of wastewater and extracted MNP cell on left.

Presentations

1. Chinnusamy, S., Shan, S., Alocilja, E. 2017. Antimicrobial Films to Combat Listeriosis. University Undergraduate Research and Arts Forum, Michigan State University.
2. Bassett, C., Shan, S., Alocilja, E. 2017. Reducing Food Waste through Novel Antimicrobial Films. University Undergraduate Research and Arts Forum, Michigan State University.
3. Chandra, A., Shan, S., Alocilja, E. 2017. Extraction of Bacteria from Untreated Wastewater. University Undergraduate Research and Arts Forum, Michigan State University.
4. Chandra, A., Shan, S., Alocilja, E. 2017. Extraction of Bacteria from Untreated Wastewater. Stockholm Junior Water Prize Competition (First place winner), Michigan.
5. Chandra, A., Shan, S., Alocilja, E. 2017. Extraction of Bacteria from Untreated Wastewater. Stockholm Junior Water Prize National Competition, North Carolina.
6. Rodriguez, K.M. and Alocilja, E. 2017. Evaluation of Re-using Magnetic Nanoparticles in Removing Bacteria from River Water. SROP-Program, Mid-Michigan Symposium for Undergraduate Research Experiences (Mid-SURE), Michigan State University.
7. Baasher, F. and Alocilja, E. 2017. Effect of Antimicrobial Nanoparticles on Size and Growth Rate of Bacteria. Mid-Michigan Symposium for Undergraduate Research Experiences (Mid-SURE), Michigan State University.

Future Direction and Project Plan

Timing	Project Plan Activity
Jan-Dec 2018	Validate the technologies for their inhibitory effects in various types of bacteria and viruses that have been known to cause foodborne illnesses and antimicrobial resistance
July-Dec 2018	Evaluate their processability as they are incorporated into coatings, surfaces, and packages
Oct 2018-March 2019	Determine their shelf stability under various environmental conditions
Onward	Develop scale-up strategies
Onward	Prepare proposals for external funding
Onward	Explore commercialization potential

Thank you