CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

S0612

Project Title

Developing a Novel Method for the Detection of Pathogens on Surfaces Using Cell Imprinted Polymers

Abstract

Objectives/Goals

Each year, 1 in 6 Americans suffers from food-borne illnesses; worldwide, the death toll from consumption of contaminated food and beverages approaches 2 million annually. Methods currently in place to control the spread of food-borne pathogens are cumbersome and inefficient--the USDA reports a ~7-day time period to confirm safety of food products against bacteria. Thus, there is a huge need for simple, effective, and rapid onsite detection of pathogenic microorganisms on surfaces like food. This project developed a novel method to detect pathogens on surfaces using cell imprinted polymers (CIPs) and investigated varying pH, cell density, and centrifugal force levels to optimize their production. It was hypothesized that varying these parameters would affect the CIP's cell count and surface coverage, important factors in assessing the polymer's quality.

Methods/Materials

Separate CIPs were produced using stamp fabrication for E. coli and S. enterica. PDMS served as the base for the CIP and the thin film for imprinting. Bacterial smears on templates were analyzed with an optical microscope, and CIPs were characterized using AFM. Independent variables were pHs (5, 7, 9), cell densities (OD 2, 3, 4), and centrifugal force levels (radius 5, 10, 15, 20, and 25mm); dependent variables were the characteristics of the CIP produced, measured by cell count and surface coverage.

Results

Optimal conditions for production of an effective CIP were pH 5, OD 3 for E. coli and pH 7, OD 3 for S. enterica. Varying centrifugal force levels had little effect. AFM images reveal the presence of cavities complementary to the cells in shape and highlight that the cells imprinted were close to a monolayer, optimal for a CIP.

Conclusions/Discussion

Hypotheses were partially supported. An important finding is that pH 5 displayed the best results for CIP production using E. coli since a lower pH increases surface charge on cells due to protonation of amine groups, increasing the cells' electrostatic interactions and affinity to surfaces. The novel approach investigated and optimized in this project yields a disposable, amplification-free, simple-to-use biosensing wipe for point-of-care detection of pathogens on surfaces like food. This innovation can usher in a new paradigm for food safety management to prevent microbial outbreaks before they occur and significantly minimize the instances of foodborne diseases throughout the world.

Summary Statement

I developed and optimized the production of cell imprinted polymers (CIPs) as biosensing wipes for the simple, effective, and rapid onsite detection of pathogenic microorganisms on surfaces like food.

Help Received

I acknowledge my family and science teacher for their constant support; Dr. Ren and Dr. Zare from Stanford University for giving me the opportunity to use their lab and to present my research at Stanford.