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Portable and Simultaneous Mass and Optical Food Safety Detection Tool Based on Smartphone-based Quartz Crystal Microbalance

Smartphone-compatible QCM biosensor rapidly detects Salmonella with simultaneous optical and mass readouts.

According to the FDA, 1 in 6 Americans gets sick from a foodborne illness each year. Although many of these cases arise from improper post-sale handling and storage, the presence of foodborne pathogens coming from food producers remains a significant risk to public health. For this reason, foods are federally required to undergo stringent testing at official facilities to screen for potentially dangerous pathogens. Many ways of streamlining and improving this process have been proposed, including the use of a Quartz Crystal Microbalance (QCM) as a biosensor. QCMs are one of the latest iterations of technologies intended to help the food screening process move from time-intensive and expensive benchtop testing to simpler, portable methods that require less specialized equipment and personnel training. Researchers at Purdue University have incorporated QCM technology into a novel, portable food safety detection device. Their device is smartphone-compatible and handheld, allowing personnel to carry it from location to location, quickly testing multiple samples. The user's smartphone captures images generated by an in-situ fluorescence imaging subsystem in which a specialized lens detects the presence of bacteria on the quartz crystal surface using a fluorescence-tagged antibody. With this unique device, personnel anywhere in the food production chain can accurately test liquid samples for the presence of foodborne pathogens with ease and efficiency. This device will help make the food production process faster, easier, and, most importantly, safer for consumers.

Technology Validation:

The smartphone-based system was used to detect Salmonella by simultaneously capturing fluorescence images and obtaining frequency data. First, a solution of 109 CFU/mL of Salmonella Typhimurium was injected into

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the system, followed by a solution of FITC-labeled antibody. The combined frequency shift indicated the presence of Salmonella Typhimurium, which was improved by the FITC-labeled antibody. Next, to test the abilities of the fluorescence image system, FITC beads were dropped on the gold surface of the quartz crystal in different concentrations. Higher concentrations resulted in higher intensities of the fluorescence dots. In future studies, the beads will be replaced with FITC-labeled antibodies to indicate the presence of Salmonella cells captured on the surface of the quartz crystal.

Advantages:

-Smartphone compatible

-User friendly, minimal personnel training required

-Handheld

-Accurately detects target bacterial species

Applications:

-Food safety testing, particularly for preliminary screening

-Rapid food testing

Publications:

Jung Min, Hyun, et al. "Smartphone-based pathogen detection using simultaneous monitoring of resonant frequency and optical fluorescence," Proceedings Volume 12545, Sensing for Agriculture and Food Quality and Safety XV; 125450A (2023) https://doi.org/10.1117/12.2665235

TRL: Mechanical Engineering

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