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Micron-scale phage-based magnetoelastic biosensors for the enhanced detection of *Salmonella* Typhimurium on fresh spinach leaves

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The potential usefulness of phage-based magnetoelastic (ME) biosensors for the direct detection of pathogenic bacteria on fresh produce has been recently reported [1 – 3]. These biosensors are, as shown in Fig. 1, composed of a freestanding, strip-shaped ME resonator coated with a filamentous landscape phage that is engineered to specifically bind with a target pathogenic bacterium [4].

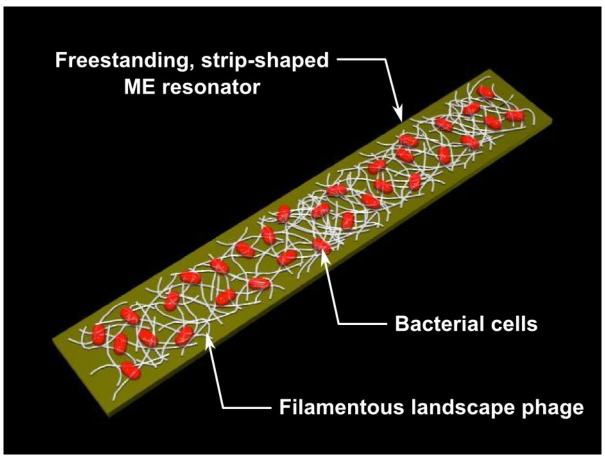

Figure 1: Phage-based ME biosensor.

These biosensors can be directly placed on a food surface, due to their wireless, freestanding nature, and used to detect possible bacterial contamination. The detection principle is based on a change in a biosensor's resonant frequency caused by the specific binding of target bacterial cells. This methodology eliminates any pre-test sample preparation (e.g., washing, purification, concentration, and enrichment) and thus enables rapid bacterial detection. In this investigation, the above methodology was used to detect *Salmonella* Typhimurium on fresh spinach leaves as illustrated in Fig. 2.

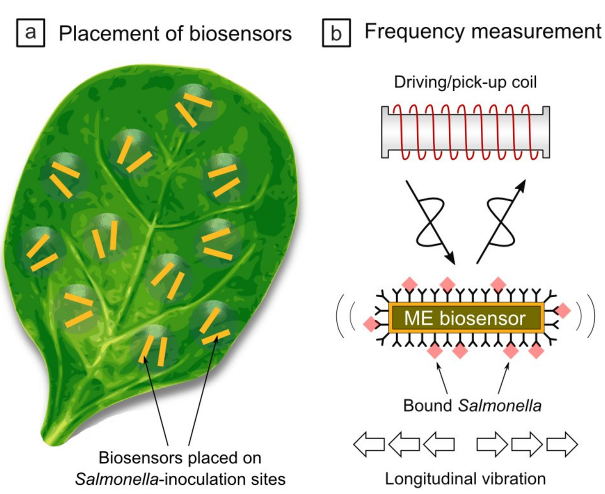

Figure 2: Schematic illustration of the experimental procedures.

Spinach leaves, in general, possess complex surface topography, which is likely to affect the degree of physical contact between biosensors and *S.* Typhimurium cells on the leaf surfaces. Hence, to reduce such a topographic effect, micron-scale ME biosensors with a size of 150 μm × 30 μm × 4 μm were fabricated and used. Figure 3 shows a scanning electron micrograph of a typical biosensor on a *Salmonella*-inoculated spinach leaf.

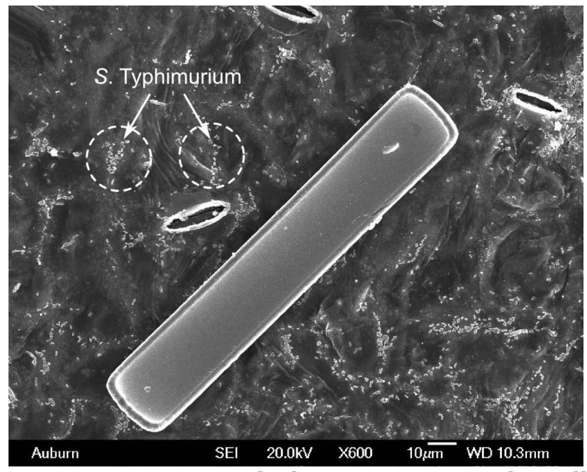

Figure 3: A micron-scale biosensor on a *Salmonella*-inoculated spinach leaf.

Results

The dose-response relationship is shown in Fig. 4. Resonant frequency changes for measurement sensors (solid circles, with phage) were found to be largely dependent on the surface density of *S.* Typhimurium. By contrast, control sensors (open squares, without phage) showed much smaller responses, indicating that selective binding of *S.* Typhimurium on the measurement sensors occurred. The limit of detection was determined by the method described in Ref. 3 and found to be 4.77×10^4 cells/cm^2.

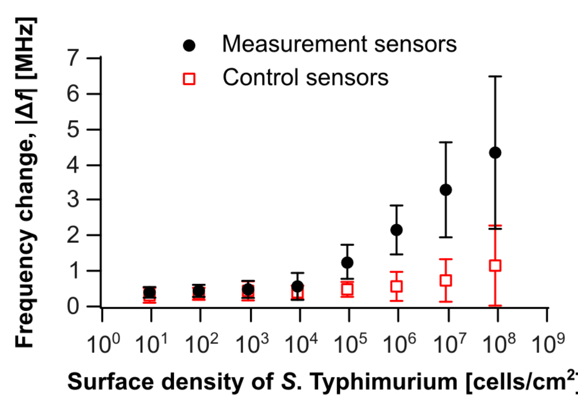

Figure 4. Dose-response plot.

References

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