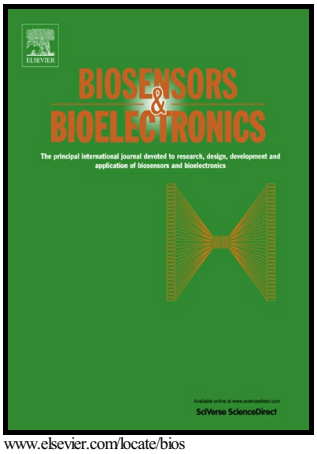

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Micro-nano-bio acoustic system for the detection of foodborne pathogens in real samples

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ABSTRACT

The fast and efficient detection of foodborne pathogens is a societal priority, given the large number of food-poisoning outbreaks, and a scientific and technological challenge, given the need to detect as little as 1 viable cell in 25 gr of food. Here, we present the first approach that achieves the above goal, thanks to the use of a micro/nano-technology and the detection capability of acoustic wave sensors. Starting from 1 *Salmonella* cell in 25 ml of milk, we employ immuno-magnetic beads to capture cells after only 3 h of pre-enrichment and subsequently demonstrate efficient DNA amplification using the Loop Mediated Isothermal Amplification method (LAMP) and acoustic detection in an integrated platform, within an additional ½ h. The demonstrated 4 h sample-to-analysis time comes as a huge improvement to the current need of few days to obtain the same result. In addition, the work presents the first reported Lab-on-Chip platform that comprises an acoustic device as the sensing element, exhibiting impressive analytical features, namely, an acoustic limit of detection of 2 cells/μl or 3 aM of the DNA target and ability to detect in a label-free manner dsDNA amplicons in impure samples. The use of food samples together with the incorporation of the necessary pre-enrichment step and ability for multiple analysis with an internal control, make the proposed methodology highly relevant to real-world applications. Moreover, the work suggests that acoustic wave devices can be used as an attractive alternative to electrochemical sensors in integrated platforms for applications in food safety and the point-of-care diagnostics.

Keywords: Lab-on-a-chip, molecular diagnostics, acoustic biosensor, *Salmonella* detection

1. Introduction

The application of micro-nano/technologies in the life sciences has brought a paradigmatic change in the area of molecular diagnostics and the analysis of genetic biomarkers, especially when combined with a Lab-on-Chip (LOC) platform for target analyte detection.(Jain, 2003; Rosi, 2005) Ultra-sensitive, label-free, fast and integrated systems employing a biosensor as the detection platform have been developed for the analysis of a variety of nucleic acid analytes, including cancer biomarkers such as circulating tumor DNA(Das, 2016), pathogens, such as Salmonella(Cinti, 2017), Escherichia coli and Staphylococcus aureus(Ahmed, 2013; Safavieh, 2014), and infectious diseases, such as influenza virus(Ferguson, 2011), Mycobacterium tuberculosis and Klebsiella pneumonia(Luo, 2014). One of the critical challenges in the development of point-of-care (POC) integrated systems is the sample preparation which is normally required prior to amplification and detection. With the exception of few works(Das, 2015; Ferguson, 2011; Patterson, 2013a), the majority of the reported LOC systems employ synthetic or bench-top pu-