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Abstract

On-chip alginate microencapsulation of anaerobic probiotics

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Abstract:
Microencapsulation of probiotics using biomaterials such as alginate is a highly effective strategy for probiotic delivery to prevent the degradation of probiotics from harsh conditions in the gastrointestinal tract.1, 2 This work demonstrates an efficient method for the encapsulation of anaerobic Lactobacillus probiotics in calcium cross-linked alginate microparticles by using on-chip microfluidics to form monodisperse and highly-stable microbeads. In this study, we performed the numerical simulation of the droplet formation method (Fig 1). Following this, we investigated the size variation of microdroplets with different ratios of flow rates of the dispersed and continuous phases (Fig 3). The morphology of the microparticles was characterized using optical microscopy and scanning electron microscopy (SEM). We assessed the viability of encapsulated bacteria using SYTO 9 dye and fluorescence microscopy. The chemical structure of the microparticles containing Lactobacillus was analyzed via Fourier transform infrared spectroscopy (FTIR). We also calculated the encapsulation efficiency of bacteria by measuring their survival after encapsulation. The survival rate percentage of encapsulated versus non-encapsulated probiotic cells was determined at various storage times (at 7, 14, 21 and 28 days). The results indicated the successful entrapment of Lactobacillus within highly stable and uniform microdroplets using the developed microfluidic platform. The optical microscopy and SEM images determined that the probiotic bacteria occupied almost all of the inner space of hydrogel alginate microbeads and the morphology of microparticles were regular spherical structures (Fig 2). Fluorescent images revealed the presence of living bacteria inside the microbeads (Fig 4). The encapsulation yield of the freshly prepared alginate microparticles was 86.95 %. The storage results confirmed that the encapsulated cells stored at -15 °C showed a relatively high survival rate compared to free cells (Fig 6). SEM results indicated that bacterial cells were successfully entrapped, and freeze-dried microbeads exhibited irregularly shaped with cracks on the surface (Fig 5). The Lactobacillus-encapsulated in alginate microparticles also provided prolonged viability and enhanced shelf-life. Taken together, the results demonstrate the promising potential of our microfluidic flow-focusing system to be used as a high-throughput single-step process that provides stable and uniform microparticles containing anaerobic probiotic bacteria.

Biography:
Hoorfar is a Professor in the School of Engineering at the University of British Columbia Okanagan and the head of the Advanced Thermo-Fluidic Laboratory (AFTL). After joining UBC, Dr. Hoorfar established a microfluidics group specializing in the development of portable devices for biomedical applications ranging from DNA purification from saliva, acetone detection from the exhale breath of a diabetes patient, circulating tumor cells detection from the blood of a metastatic patient, and cell patterning on the digital microfluidic platforms for tissue engineering. She has published more than 200 papers in reputed journals.

Recent Publications:

- Mina Hoorfar, ACS Nano. 2020
- Mina Hoorfar, Small. 2020
- Mina Hoorfar, Adv Colloid Interface Sci. 2020
- Mina Hoorfar, J Mater Sci Mater Med. 2020
- Mina Hoorfar, J Breath Res. 2020