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| **Applying electrospinning to develop advanced nanofiber formulations** |
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| **Background:**  Irritable bowel syndrome (IBS) is a common functional bowel disorder characterized by altered bowel habits associated with abdominal discomfort or pain without detectable structural and biochemical abnormalities. The aetiology is poorly understood, and many factors are involved, such as altered gastrointestinal motility, visceral hypersensitivity, post-infectious reactivity, and brain-gut interactions (Occhipinti and Smith, 2012) (Saha, 2014). However, the perceived symptoms from these mechanisms consist of abdominal pain or discomfort, bloating, diarrhoea, and constipation. Not all symptoms are gastrointestinal such as fatigue and depression.  The gastric-resistant coating is a protective barrier applied to orally administered pharmaceutical formulations. It can protect drugs from stomach acid and enzymatic degradation in the stomach. Electrospinning (ES) is a fabrication technology which can be used to formulate colonic-targeting drug delivery systems. Electrospun nanofibers can be formulated with varied architectures and different polymers to achieve sophisticated drug delivery properties, such as controlled release and targeted drug delivery.  The Island-in-the-sea is much like a coaxial spinneret except that instead of having a single inner needle, it features three separate inner needles (shown as right image) - each one capable of ejecting a separate liquid. |
| **Methods:**  The aim of this work is to construct a colonic-targeted platform. Two traditional formulation development methodologies, film-casting and hot-melt extrusion, were first compared with electrospinning to determine the most appropriate technology for further study. The electrospun fibres were found to have better properties than the other formulations in terms of in vitro drug release profile. Multi-drug-loaded nanofibres were prepared with three polymers, including Eudragit S100 as a pH-sensitive trigger, Eudragit RL100 as a time-extended trigger, and maize starch as a colonic microbiota-dependent trigger. |
| **Results:**  The research process started with a simple conventional mono-axial electrospinning method to formulate a single-stimulus-triggered product. A final product with three triggers was prepared using multiple techniques, such as side-by-side ES, co-axial ES, island-in-sea ES, and multi-jet ES. The final product successfully encapsulated the drug cargo with more than 90% efficiency, with less than 5% burst release in fasted state simulated gastric fluid, and more than 85% of the drug loading successfully released in conditions mimicking the colon. |
| **Conclusions:**  Cylindrical, smooth, flattened fibers can be observed in all optimised electrospun fibers. No drug crystals or bead-on-string morphology are visible on the surfaces or outside of the freshly prepared fibers, suggesting a homogeneous product formed between polymers and APIs. The average diameter of the product is around 550nm. Clear core-shell structure can be observed through the TEM results. |