Nanoparticles production from microfluidics: the elixir?

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Nanoparticles production from microfluidics: The Elixir?

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INTRODUCTION

- Nanoparticles offer improved performance of active ingredients, stability, controlled delivery, increased comfort and reduce the overall drug content and cost.
- Nanoparticles are helpful in drug delivery in cases where drugs have poor water solubility.
- Drugs such as Hydrocortisone (HC) pose a problem, because the right amount of unchanged drug needs to reach the targeted cells.

AIM:
- Produce hydrocortisone nanoparticles using laboratory-fabricated microfluidic devices and investigate a variety of device parameters on nanoparticle properties.
- Study the effect of stabilisers and polymer on the produced nanoparticles.

EXPERIMENTAL SET UP

Experiments were carried out in fabricated glass capillary co-flow microfluidic devices, to synthesise hydrocortisone nanosuspensions. Figures 1 and 2 are the schematic diagrams of the co-flow microfluidic device and the experimental set-up of the synthesis of the hydrocortisone nanoparticles respectively while Figure 3 is the flow diagram of the steps taken in producing the nanoparticles.

CHARACTERISATION

DSC thermal profile of processed and unprocessed HC were analysed, to show the changes in the crystallinity of the drug. A sharp peak observed in Figure 7 corresponds to the melting point of the pure unprocessed sample. This peak shifted for the processed drug, which indicates the encapsulation of the drug in the polymer and stabilisers. This was corroborated by the XRPD analysis carried out on the processed and unprocessed samples (Figure 8A and 8B).

The table shows the stability study over a period of 2 months. Gradual reduction in the size of nanoparticles produced shows the effect of the stabilisers and polymer wearing off over a period of time.

CONCLUSION

- Nozzle diameter affects the size of nanoparticles produced.
- HPMC (and other stabilisers) has a major effect on the size and stability of nanoparticles produced.

FUTURE WORK

- Production and encapsulation of nanoparticles using counter-current devices and other types of nanoparticles and study of the release rates of drugs encapsulated.
- Synthesis of Liposomes and Niosomes using both Dispersion Cell and 3D-printed Microfluidic devices to encapsulate drugs

NANOPARTICLES FORMATION

Drug nanoprecipitation occurred at the exit of inner capillary of the co-flow microfluidic devices as shown in Figure 4. This contained the organic phase – 10ml solution of the drug in 60/40 v/v ethanol in water, and the aqueous phase (deionised water) which is contained in the outer capillary where the mixture occurs. The formed nanosuspensions were collected in stirred vials, containing mixtures of polymer, hydroxypropyl methyl cellulose (HPMC) and stabilisers (Poly Vinyl Pyrrolidone, PVP and Sodium Dodecyl Sulfate, SDS).

EXPERIMENTAL RESULTS

It was observed that increase in flow rate ratio of the aqueous phase to dispersed phase led to decrease in the size of nanoparticles produced as shown in Figure 10. This was expected, as the precipitation formation, which is the main force of supersaturation of the solution, being induced by the shorter mixing time of the drug solution and antisolvent, as flow rates are increased thereby reducing the nucleation time. This can also be explained by the increasing Reynolds Number as a result of higher flow rates improving the mixing within the system.

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REFERENCES


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