A new approach for the preparation of functional pharmaceutical nanoparticles using glass capillary millifludic devices

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1. Introduction

Functional pharmaceuticals nanoparticles are solid carriers with a mean size of less than 1 µm, which are capable to dissolve, entrap, encapsulate or attach active ingredients (drug) to its nanoparticle matrix [1,2]. In this study, a new approach for the formation of acetaminophen (PCM) encapsulated poly(ε-caprolactone) (PCL) nanoparticles with controllable size dependent has been performed in a glass capillary milifluidic device by nanoprecipitation("diffusion-stranding") method.

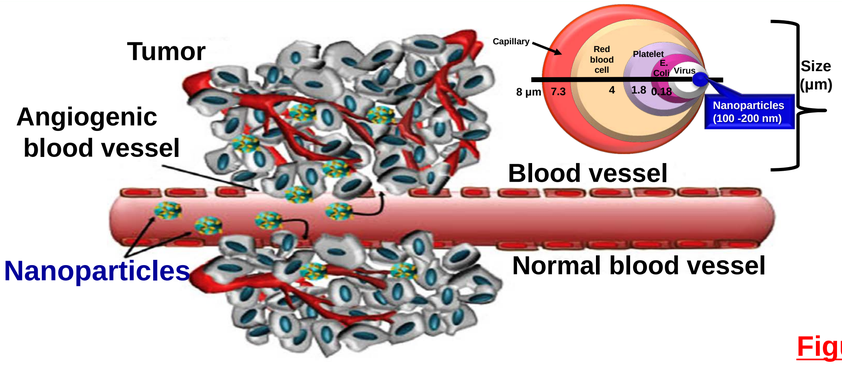

Figure 1. Functional nanoparticles administration route.

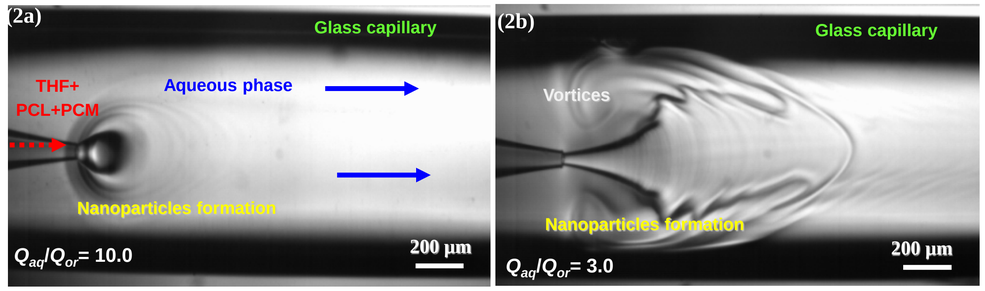

Figure 2. The position of liquid/liquid interface in a glass capillary milifluidic devices at the orifice size of 60 µm. (THF = tetrathydrofuran).

2. Research objectives

1. To investigate the optimum conditions for the formation of PCM loaded nanoparticles by nanoprecipitation method using glass capillary milifluidic device.
2. To characterise the properties of encapsulated nanoparticles based on its microscopic morphology, size, encapsulation efficiency, drug loading and in vitro drug release.

3. Methodology

The experiment was performed at different;
(i) milifluidic device orifice size, (ii) flowrate ratio, (iii) PCL concentration, (v) PCM concentration and (vi) surfactant concentration.

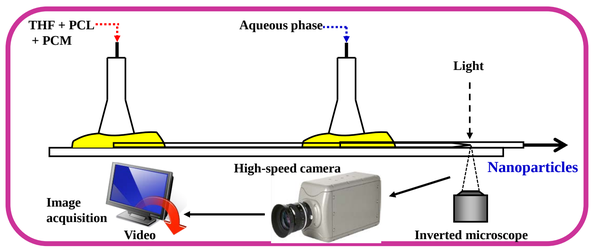

Figure 3. Schematic diagram for experimental set-up.

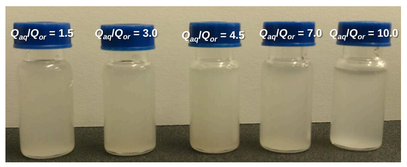

Figure 4. Sample collections at different Q_{aq}/Q_{or} values and constant Q_{aq} = 5 ml/h.

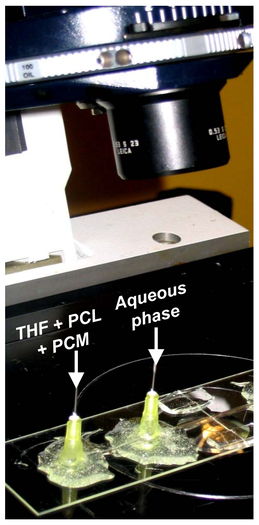

Figure 5. Real diagram for experimental set-up.

4. Nanoparticles formation

Table 1. Optimum conditions for the formation of functional pharmaceutical nanoparticles.

Materials		Composition
Aqueous phase	1. Mili-Q-water 2. PVP	1. 0.99 (wt/wt) % 2. 0.02 (wt/wt)%
Organic phase	1. THF 2. PCL 3. PCM	1. 20 ml 2. 6 mg/ml 3. 70 (wt/wt) % of polymer

** Note : PVP = polyvinyl pyrrolidone*

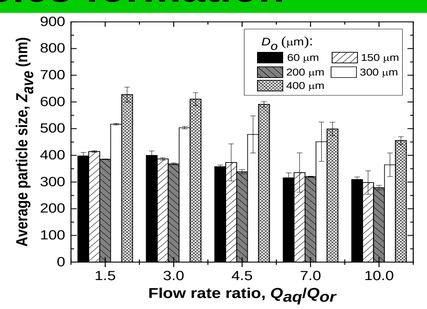

Figure 6. Particle mean size, Z_{ave} of PCL nanoparticles at different flowrate ratio and orifice size. (Conc.$_{Organic\ phase}$ = 1 mg/ml.)

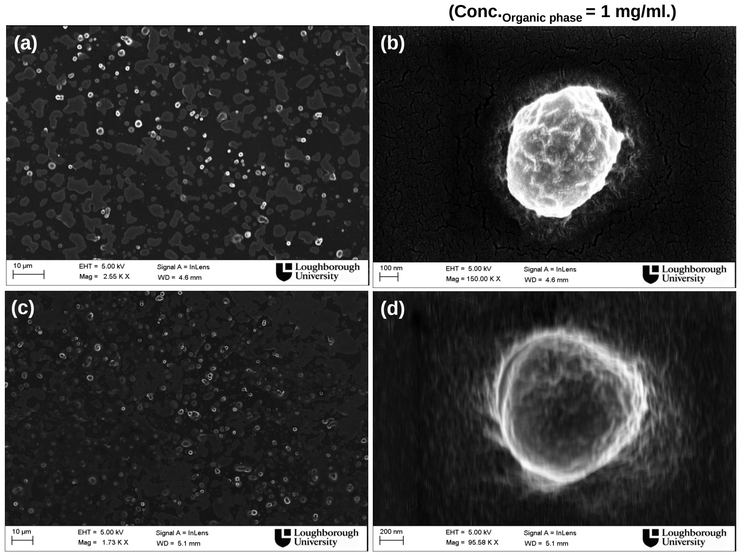

Figure 7. FEG-SEM images of; (a-b) blank poly(ε-caprolactone (PCL) and (c-d) acetaminophen encapsulated PCL nanoparticles at various magnifications.

5. Characterisation & release study

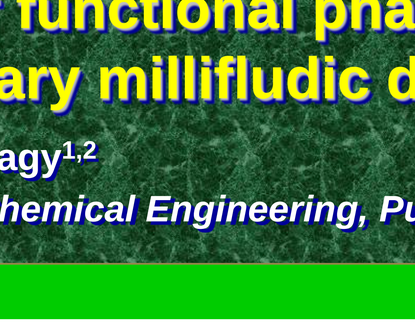

Figure 8. Differential scanning calorimetry (DSC) thermograms.

Figure 9. X-ray diffractometry (XRD) peaks.

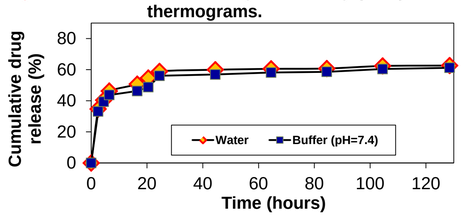

Figure 10. In vitro release profile of PCM encapsulated nanoparticles in two different release mediums.

The highlight results:

- The mean size of encapsulated nanoparticles exhibited less than 500 nm with 52 % encapsulation efficiency and 22 % of drug loading.
- PCM encapsulated nanoparticles showed significantly encouraging results in FEG-SEM, DSC and XRD analyses.
- In vitro release studies showed that PCL nanoparticles could successfully control the release of acetaminophen up to more than 120 h.

6. Conclusions

Acetaminophen (PCM) encapsulated nanoparticles are potentially can be considered as a promising functional pharmaceutical carrier produced by a new approach of glass capillary milifluidic device.

7. Acknowledgement

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References: [1] Legrand, P. *et al.* (2007). *Int. J. Pharm. 344*, 33–43. [2]. Konno & Taylor (2008). *Pharm. Res.* 25, 969-978.