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

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Functional pharmaceutical 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 millifluidic device by nanoprecipitation (“diffusion-stranding”) method.

2. Research objectives
1. To investigate the optimum conditions for the formation of PCM loaded nanoparticles by nanoprecipitation method using glass capillary millifluidic 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) millifluidic device orifice size, (ii) flowrate ratio, (iii) PCL concentration, (iv) PCM concentration and (vi) surfactant concentration.

4. Nanoparticles formation

Figure 1. Functional nanoparticles administration route.

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

<table>
<thead>
<tr>
<th>Materials</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqueous phase</td>
<td>1. Mill-Q-water 2. PVP</td>
</tr>
<tr>
<td>Organic phase</td>
<td>1. THF 2. PCL 3. PCM</td>
</tr>
<tr>
<td>Flow rate ratio, Qaq/Qor</td>
<td>1.09 (wt/wt) % 2. 02 (wt/wt) %</td>
</tr>
</tbody>
</table>

*Note: PVP = polyvinyl pyrrolidone

5. Characterisation & release study

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

Figure 3. Schematic diagram for experimental set-up.

Figure 4. Sample collections at different Qaq/Qor values and constant Qaq = 5 ml/h.

Figure 5. Real diagram for experimental set-up.

Figure 6. Particle mean size, \(d_m\) 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.

Figure 8. Differential scanning calorimetry (DSC) thermograms.

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

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 millifluidic device.

7. Acknowledgement
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