**Encapsulation of Flutriafol Fungicide into Electrospun Biodegradable Poly (L-lactide) Nanofibers**

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**Introduction**

- Electrospinning techniques have attracted interest as versatile, low cost techniques to manufacture sub-micron fibres and nanofibers from polymer solutions or polymer melts [1].
- High surface area and ease of incorporation of active ingredients have prompted some researchers to investigate using electrospun nanofibers in agricultural application [2].
- However, most of the reports have focused on using electrospun nanofiber delivery systems for the encapsulation of drugs and food materials [3-4], and there are few studies have reported the encapsulation of agrochemical materials into electrospun nanofibers [2].
- Flutriafol is a commonly used fungicide in plant protection, and in this study, for the first time, we aimed to encapsulate flutriafol fungicide into poly(L-lactide) (PLLA) nanofibers matrix by optimizing electrospinning conditions.

**Materials and Methods**

- PLLA with a average molecular weights (MW) of 282,000 g/mol was purchased from Vorin Biomaterials, Ireland (CAS Number: 33135-50-1).
- Solvents, Chloroform (CF); anhydrous, ≥ 99%; and Acetone (AC) for HPLC, ≥ 99.8% were obtained from Sigma Aldrich.
- Flutriafol PESTANAL (C₁₃H₁₈F₄N₂O) with molar mass of 301.29 g/Mole was purchased from Sigma Aldrich.
- The schematic setup for nanofiber electrospinning is shown in Figure 1. It consists of a high voltage (HV) power supply, model 73030, DC input 30 kV @ 1 mA, from Genvolt, Ireland, and a New Era NE-300 “Just Infusion” syringe pump. A metal frame 14cm × 16cm with attached aluminium foil was located 15cm from the syringe needle to collect nanofibers. The positive terminal of the HV was connected to the needle and the ground was attached to the collector (metal frame). The electrospinning process occurs between the needle tip and the aluminium collector, and nanofibers are gathered on the surface of the foil.
- PLLA solution with optimum concentrations of 5% (w/w) in chloroform-acetone (75–25 v/v) was prepared and mixed with 10% (w/w) flutriafol powder relative to the weight of PLLA. The PLLA/flutriafol mixture was fed with a syringe to a basic electrospinning setup. Optimum electrospinning conditions were observed at 32 °C with a flow rate speed of 1/mL h, and 12kV high voltage.

**Results and Discussion**

**Figure 1:** Schematic diagram of the electrospinning setup

**Figure 2:** SEM image and related diameter histogram of the PLLA electrospun nanofibers containing 10% flutriafol

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**Table 1. Effect of flutriafol concentration on nanofiber diameter**

<table>
<thead>
<tr>
<th>Flutriafol Concentration (% w/w)</th>
<th>Nanofiber diameter (nm)</th>
<th>%CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>496.183</td>
<td>22.0%</td>
</tr>
<tr>
<td>10</td>
<td>162.079</td>
<td>9.7%</td>
</tr>
</tbody>
</table>

*% w/w based on amount of PLLA used. **Coefficient of Variation (CV).*

**Table 2. Percentage of identified elements in PLLA nanofibers.**

<table>
<thead>
<tr>
<th>Statistics</th>
<th>C</th>
<th>N</th>
<th>O</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>72.63</td>
<td>1.30</td>
<td>44.06</td>
<td>2.27</td>
</tr>
<tr>
<td>Min</td>
<td>53.57</td>
<td>0.40</td>
<td>24.42</td>
<td>1.36</td>
</tr>
<tr>
<td>Average</td>
<td>63.10</td>
<td>0.85</td>
<td>34.24</td>
<td>1.81</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>13.40</td>
<td>0.74</td>
<td>12.76</td>
<td>0.64</td>
</tr>
</tbody>
</table>

**Figure 3:** (a) SEM micrograph, and (b) EDS analysis of PLLA nanofiber containing 10% flutriafol.

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**Conclusion**

- EDS analysis of PLLA nanofibers proved that flutriafol compound elements have been successfully encapsulated into PLLA nanofiber structures.

**Acknowledgment**

- A major portion of this work was supported financially by Centre for Crop Health (CCH) at University of Southern Queensland (USQ), Australia.

**References**