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Fabrication and Analysis of Soy Flour Filled Polyethylene Fibers

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INTRODUCTION

Textile fibers from annually renewable agricultural products have attracted increasing attention due to economic and environmental sustainability concerns. Such fibers are attractive because they can be produced with current industrial processes in addition to reducing on the dependence over oil-based resins which are non-biodegradable and from non-renewable resources. Defatted soy flour is an inexpensive material (50 cent/lb) used as a filler in polymeric composites, though its physical properties are not suitable for direct use as fibers or films. Blending soy flour with polyethylene (PE), improves spinnability of soy flour, and enables new nonfood applications of soy flour.

OBJECTIVES

- Converting soy flour into non-food, value-added products such as fibers and textiles
- Fabrication of PE-soy fibers by a continuous melt process
- Characterization of the properties and microstructure of PE-soy composite fibers spun

EXPERIMENTAL

- Fine defatted soy flour was obtained from ADM Specialty Food. Fine defatted soy flour was dispersed in PE with a compatibilizer by using a DSM extruder. Effective dispersion of flour in PE matrix resulted in significantly better dispersion with reduced agglomerates and better spinnability of the blend.
- Increase in mixing time allows more number of passage over the high stress regions of the micro-compounders, which reduces size and enhances soy distribution in PE.

MECHANICAL PROPERTIES OF PE-SOY FIBERS

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tensile Modulus (MPa)</th>
<th>Tensile strength (MPa)</th>
<th>Strain to failure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base PE</td>
<td>950 ± 220</td>
<td>43 ± 0.1</td>
<td>53 ± 0.97</td>
</tr>
<tr>
<td>PE-soy</td>
<td>615 ± 138</td>
<td>32 ± 8</td>
<td>292 ± 52</td>
</tr>
<tr>
<td>Washed PE-soy</td>
<td>690 ± 230</td>
<td>32 ± 2</td>
<td>262 ± 53</td>
</tr>
</tbody>
</table>

- Tensile properties of PE-soy fibers are marginally lower than those of base PE.
- Tensile properties were comparable to those of the base PE even after accelerated washing simulation.

CONCLUSIONS

- About 6 minutes of compounding in a DSM semi-batch micro-extruder sufficiently dispersed soy flour (30 wt%) in PE matrix.
- The blend could be successfully melt-spun into fibers with diameter of 52 ± 4 µm.
- PE-soy fibers have soy particles appearing on the surface with some particle agglomeration evident. Washing does not deteriorate fiber mechanical properties drastically.

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