Evaluation of the Optimal Reaction Conditions for the Methanolysis and Ethanolysis of Castor Oil Catalyzed by Immobilized Enzymes

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Evaluation of the Optimal Reaction Conditions for the Methanolysis and Ethanolysis of Castor Oil Catalyzed by Immobilized Enzymes

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INTRODUCTION

- Biodiesel: From vegetable oils or animal fats
  - Renewal
  - Biodegradable
  - Non-toxic
  - Lubricating
- Castor oil
  - Non-edible
  - Diverse weather conditions
  - Unique properties: ricinoleic acid
- Enzymes
  - Available in LIQUID and IMMOBILIZED forms
  - Alternative biocatalyst
  - Mild reaction conditions
  - High raw material compatibility
  - Better glycerol separation

MATERIALS AND METHODS

- Castor oil transesterification performed for 8 hours
- Methanol
- Ethanol
- Solution 96% (v/v)
- Absolute
- Alcohol stepwise additions to avoid enzyme inhibition
- Immobilized enzyme Lipozyme 435 as catalyst
- Different reaction conditions were evaluated

<table>
<thead>
<tr>
<th>Condition</th>
<th>Range</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>35, 50, 60</td>
<td>°C</td>
</tr>
<tr>
<td>Alcohol-to-oil molar ratio</td>
<td>3:1 – 6:1</td>
<td>—</td>
</tr>
<tr>
<td>Enzyme content</td>
<td>3 – 15</td>
<td>wt%</td>
</tr>
<tr>
<td>Water content</td>
<td>0 – 15</td>
<td>wt%</td>
</tr>
<tr>
<td>N-hexane content</td>
<td>0 – 75</td>
<td>wt%</td>
</tr>
</tbody>
</table>

Reaction conditions have different impacts in FAME and FAEE content

- FAME: 96.8% was obtained using 3:1 methanol-to-oil, 5 wt% enzymes, 7.5 wt% water, 50 wt% n-hexane, at 50 °C.
- FAEE: 98.0% was obtained at 60 °C, 4:1 ethanol-to-oil, 5 wt% enzymes, 40 wt% of n-hexane with no water.

RESULTS AND DISCUSSION

- Identification of fatty acid alkyl esters
- Influence of the reaction conditions
  - Enzyme content
    - Favorable influence on the yield
    - High cost of enzymes
  - Temperature
    - Increase in the temperature favors the yield
    - Higher temperature may cause enzyme denaturation
  - Water content
    - Addition of water results in higher hydrolysis rate
  - Alcohol-to-oil ratio
    - Small variations in FAME and FAEE content: enzyme inhibition compensated by the increase on esterification rate
  - N-hexane content
    - Reduction on the mass transfer limitations

CONCLUSIONS

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This project has received funding from the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 778168.
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