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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

Renewable
Biodegradable
Non-toxic
Lubricating

Transesterification of TAG
Hydrolysis of TAG, followed by esterification of FFA

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)

Optimization of FAME and FAEE yield

Alcohol stepwise additions to avoid enzyme inhibition

Immobilized enzyme Lipozyme 435 as catalyst

Different reaction conditions were evaluated

Condition | Range | Unit
--- | --- | ---
Temperature | 35, 50, 60 | °C
Alcohol-to-oil molar ratio | 3:1 – 6:1 | –
Enzyme content | 3 – 15 | wt%
Water content | 0 – 15 | wt%
N-hexane content | 0 – 75 | wt%

RESULTS AND DISCUSSION

Identification of fatty acid alkyl esters

FAME
FAEE

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

N-hexane content
Reduction on the mass transfer limitations

Different pair of conditions result in different behaviors in the biodiesel yield

CONCLUSIONS

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.

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