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

Andrade, Thalles Allan; Al-Kabalawi, Ibrahim F.; Errico, Massimiliano; Christensen, Knud Villy

Publication date:
2018

Document version:
Final published version

Document license:
Unspecified

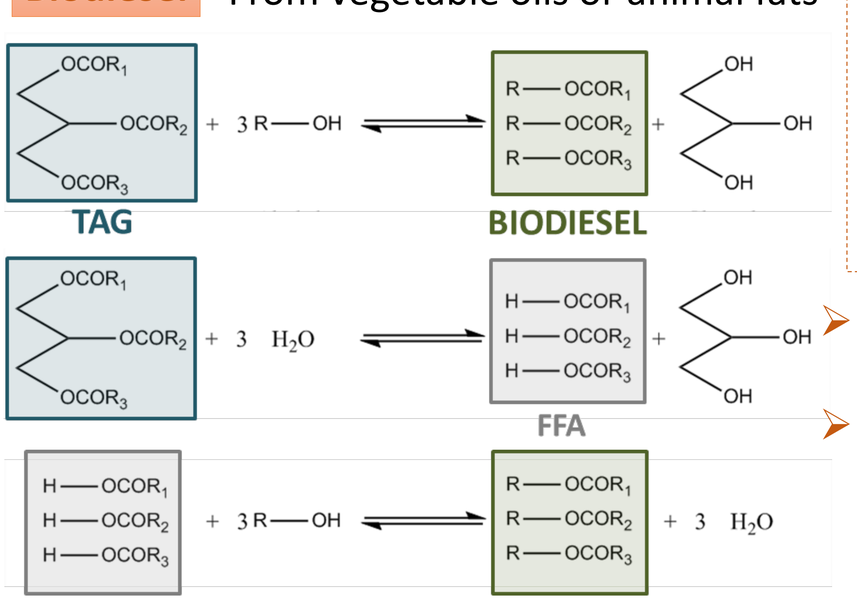
Citation for pulished version (APA):
Andrade, T. A., Al-Kabalawi, I. F., Errico, M., & Christensen, K. V. (2018). *Evaluation of the Optimal Reaction Conditions for the Methanolysis and Ethanolysis of Castor Oil Catalyzed by Immobilized Enzymes*. Poster session presented at European Biomass Conference & Exhibition, København, Denmark.

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

Thalles A. Andrade (thal@kbm.sdu.dk), Ibrahim F. Al-Kabalawi, Massimiliano Errico, Knud V. Christensen
Department of Chemical Engineering, Biotechnology and Environmental Technology, University of Southern Denmark
Campusvej 55, 5000 Odense M, Denmark

INTRODUCTION

Biodiesel From vegetable oils or animal fats

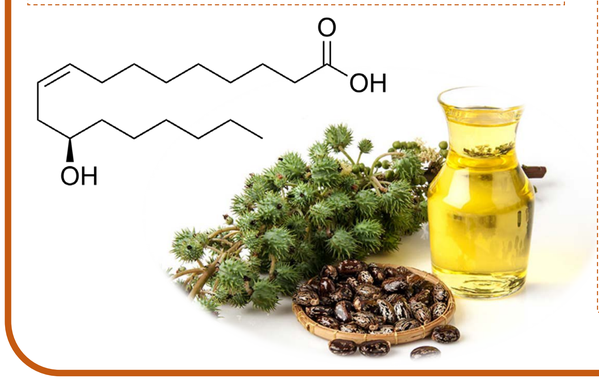


- Renewable
- Biodegradable
- Non-toxic
- Lubricating

➢ 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) / → Absolute

Optimization of **FAME** and **FAEE** yield

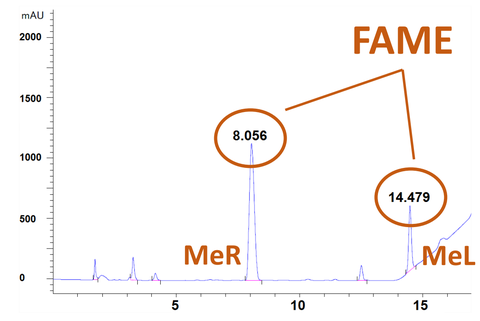
- Alcohol stepwise additions to avoid enzyme inhibition
- Immobilized enzyme Lipozyme 435 as catalyst
- Different reaction conditions were evaluated

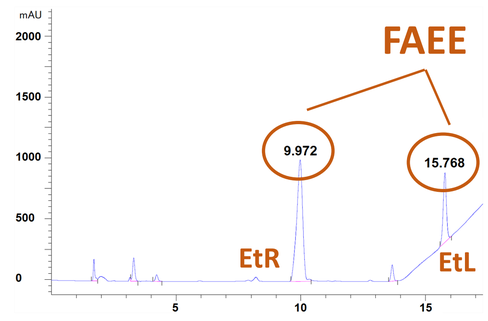
Condition	Range	Unit
Temperature	35, 50, 60	°C
Alcohol-to-oil molar ratio	3:1 – 6:1	–
Enzyme content	3 – 15	wt%
Water content	0 – 15	wt%
N-hexane content	0 – 75	wt%

- Reaction samples analyzed in a HPLC system

RESULTS AND DISCUSSION

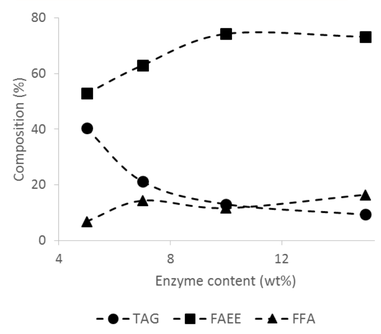
Identification of fatty acid alkyl esters





Influence of the reaction conditions

Enzyme content

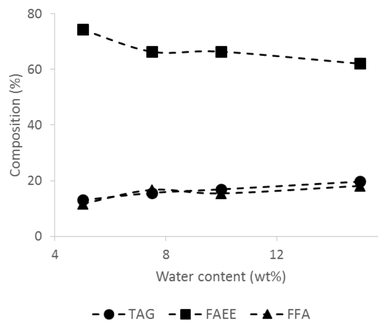


- Favorable influence on the yield
- High cost of enzymes

Temperature

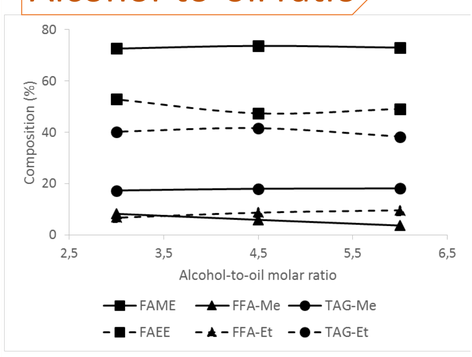
- Increase in the temperature favors the yield
- Higher temperature may cause enzyme denaturation

Water content

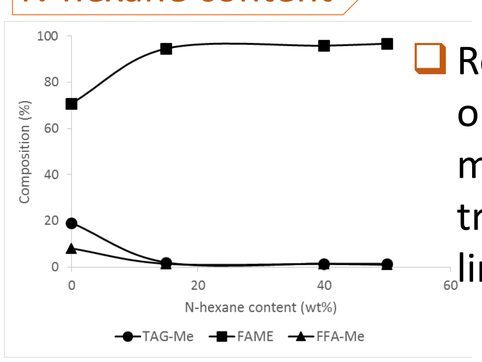


- Addition of water results in higher hydrolysis rate
- Ethanolysis: higher yield using absolute ethanol
- Methanolysis: in the presence of solvent, FAME content increased when the water content increased

Alcohol-to-oil ratio



N-hexane content



- Reduction on the mass transfer limitations
- Small variations in FAME and FAEE content: enzyme inhibition compensated by the increase on esterification rate

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.

Acknowledgements
This project has received funding from the European Union´s Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 778168.
The authors are grateful to the Brazilian National Council for Scientific and Technological Development (CNPq) for the scholarship and Novozymes A/S for providing the enzymes.

SDU

EUBCE 2018