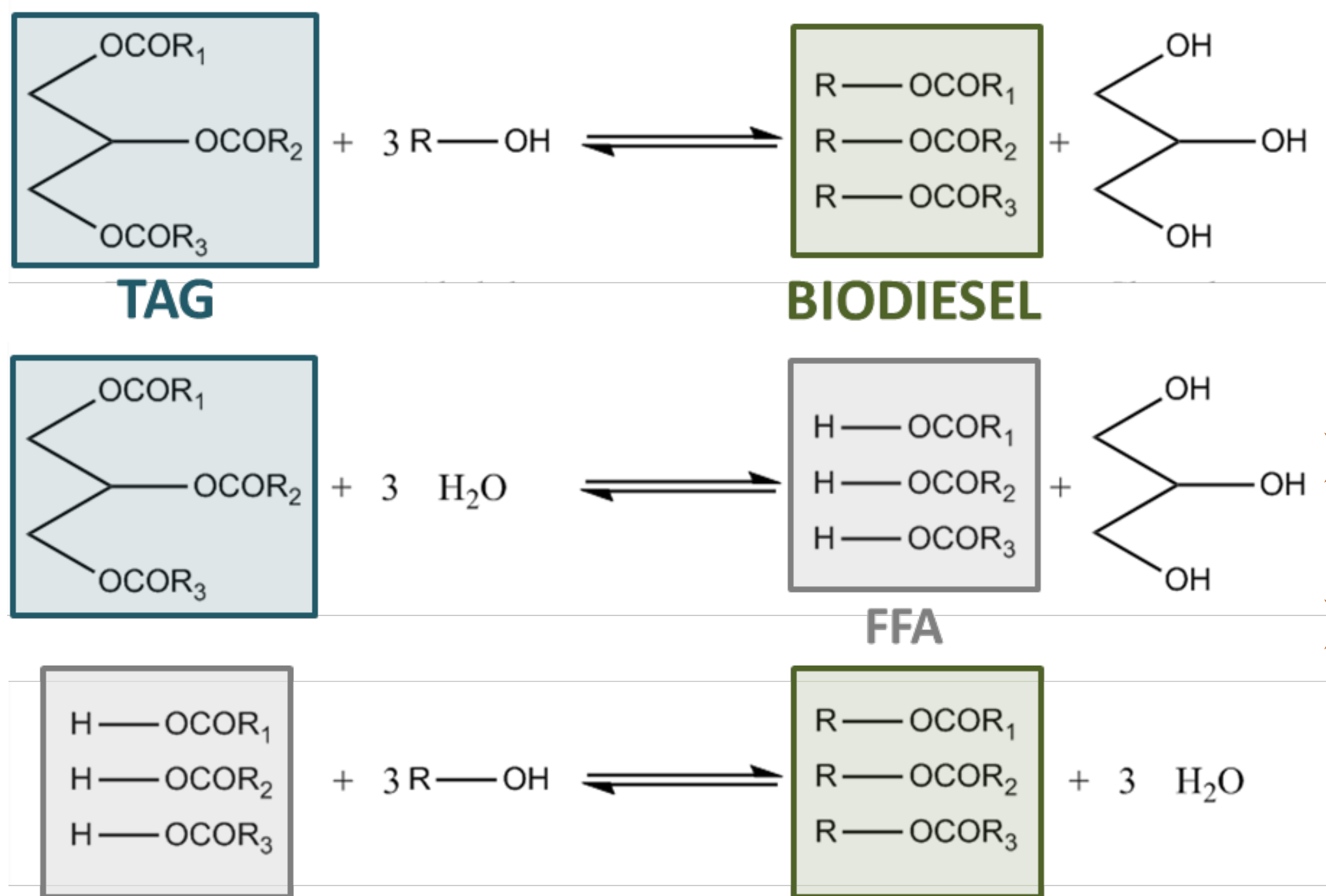


Evaluation of the Optimal Reaction Conditions for the Methanolysis and Ethanolysis of Castor Oil Catalyzed by Immobilized Enzymes

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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

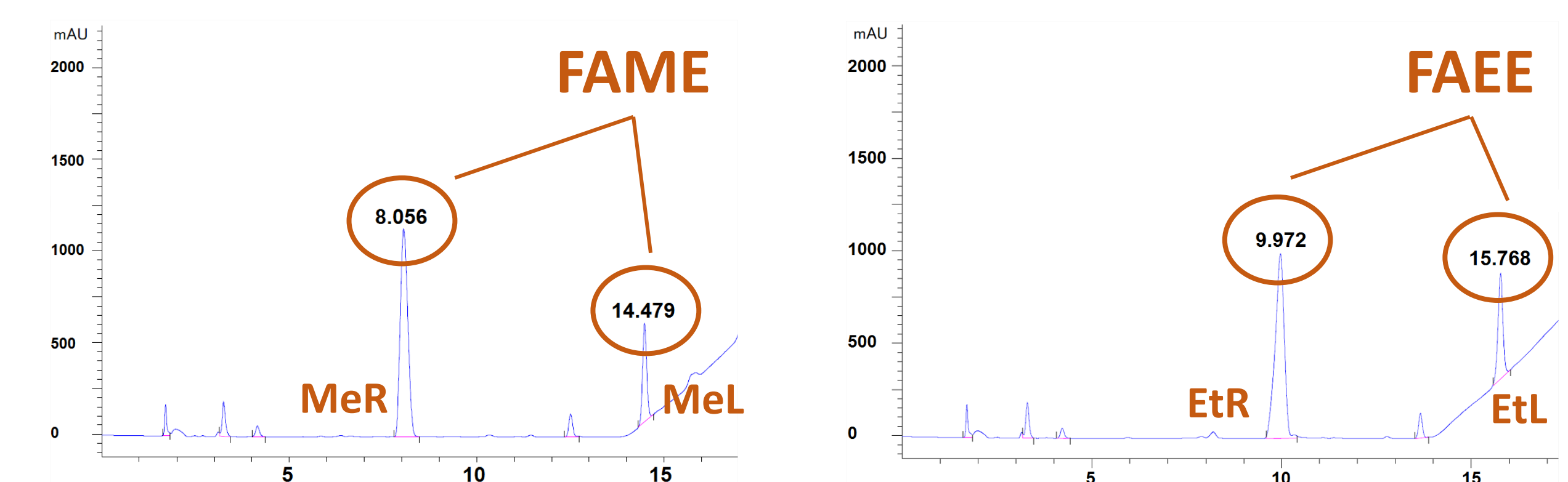
Available in **LIQUID** and **IMMOBILIZED** forms



- Alternative biocatalyst
- Mild reaction conditions
- High raw material compatibility
- Better glycerol separation

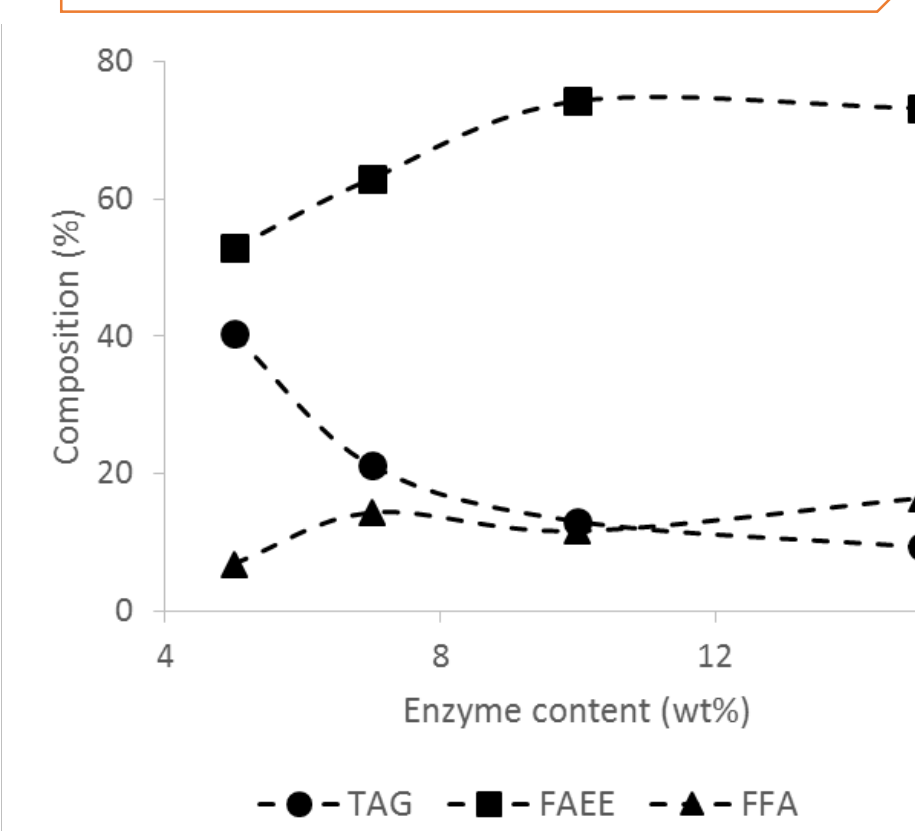
RESULTS AND DISCUSSION

Identification of fatty acid alkyl esters



Influence of the reaction conditions

Enzyme content

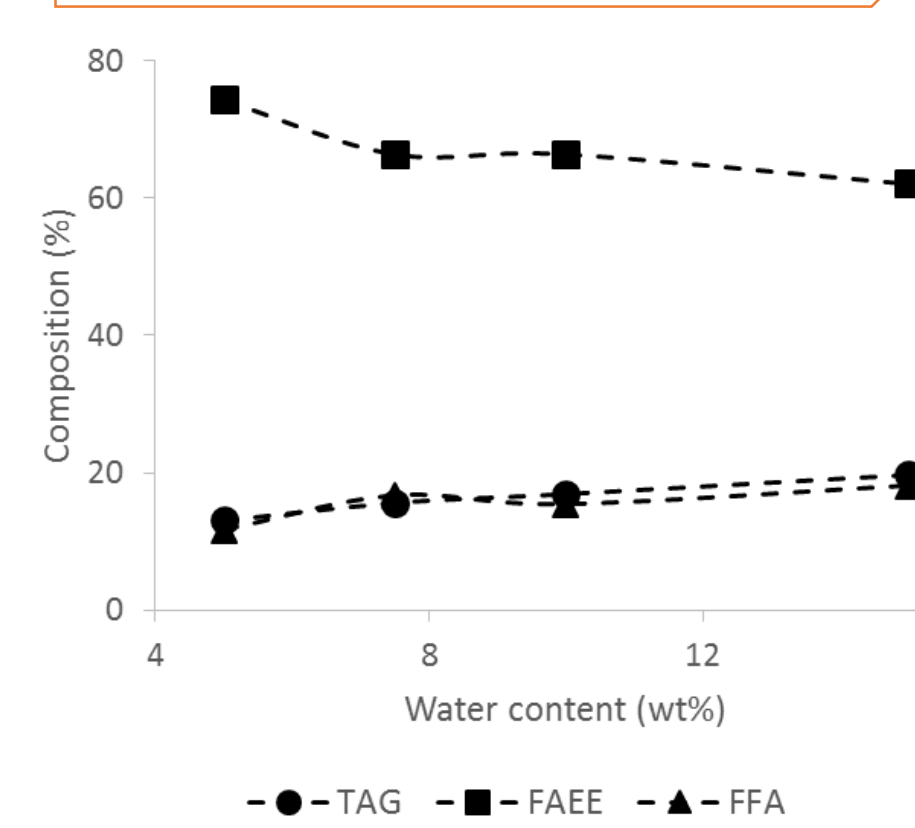


- Favorable influence on the yield
- High cost of enzymes

Temperature

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

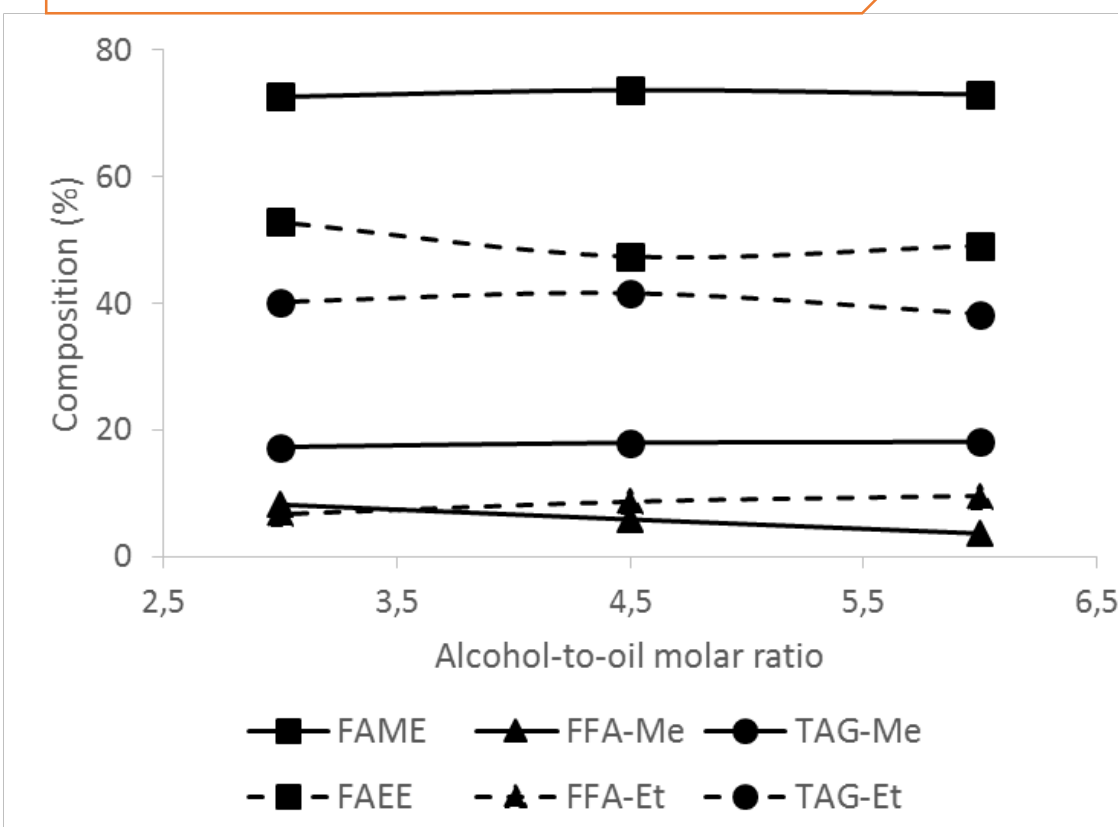
Water content



- Addition of water results in higher hydrolysis rate

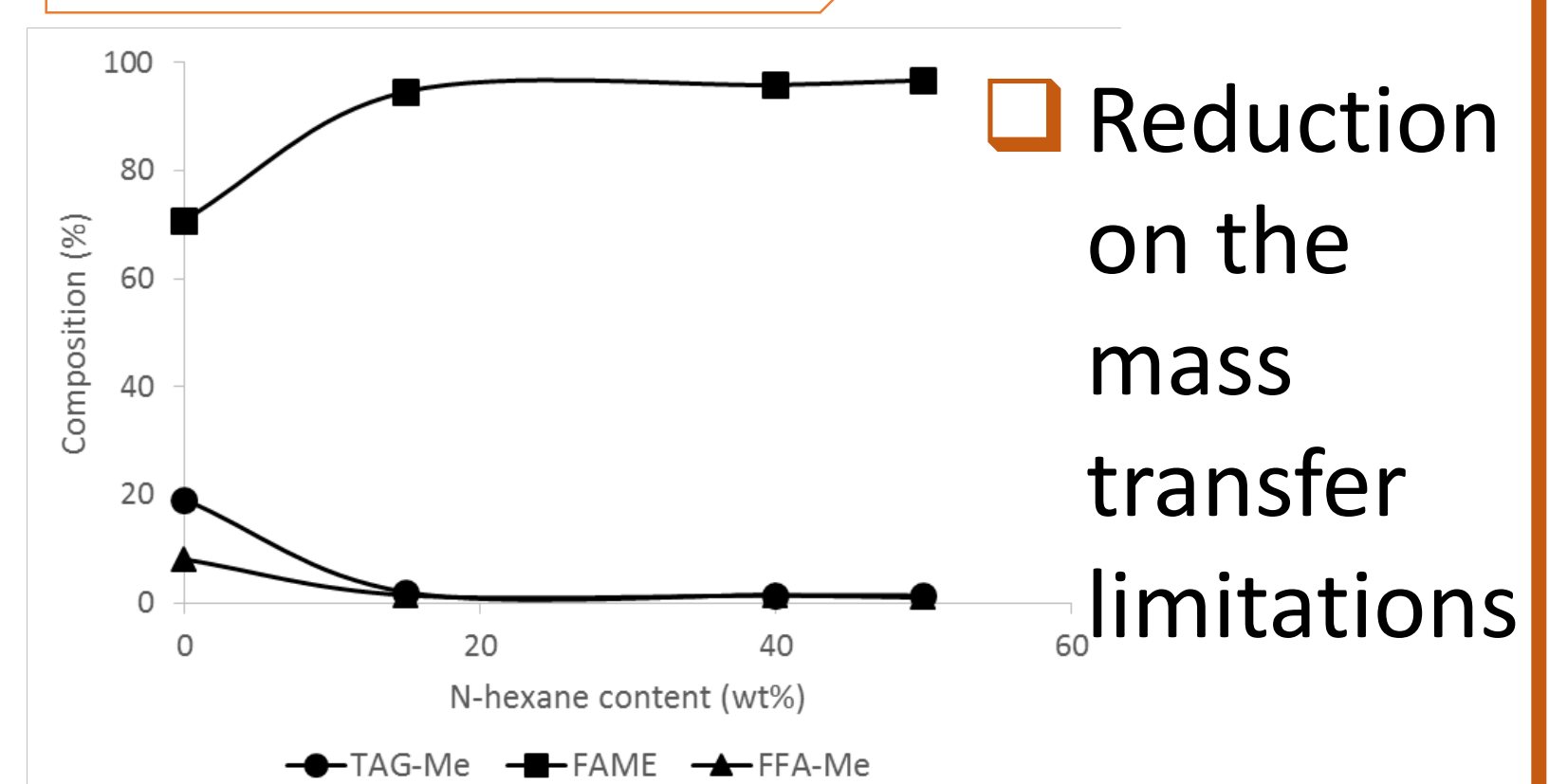
- Ethanolysis: higher yield using absolute ethanol
- Methanolysis: in the presence of solvent, FAME content increased when the water content increased

Alcohol-to-oil ratio



- 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

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

MATERIALS AND METHODS

Castor oil transesterification performed for 8 hours

- Methanol
- Ethanol
 - Solution 96% (v/v)
 - Absolute

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

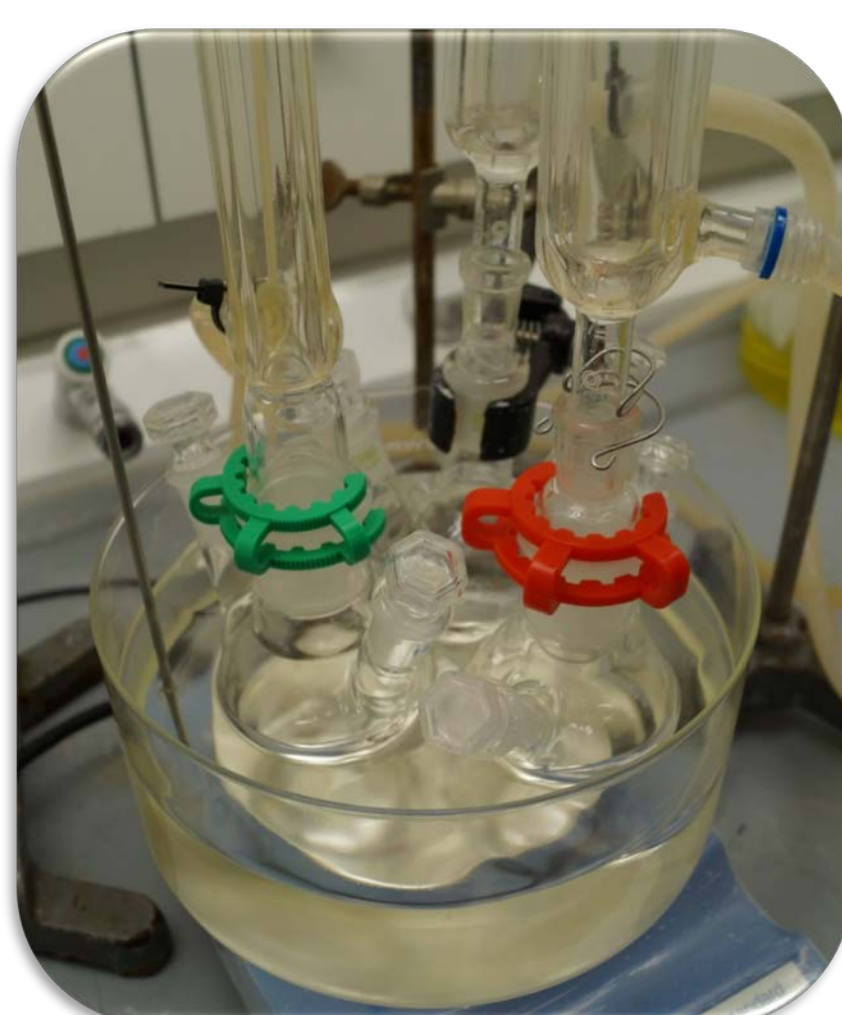
Alcohol stepwise additions to avoid enzyme inhibition

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



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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