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The influence of lipids on the fate of nitrogen during hydrothermal liquefaction of protein-containing biomass

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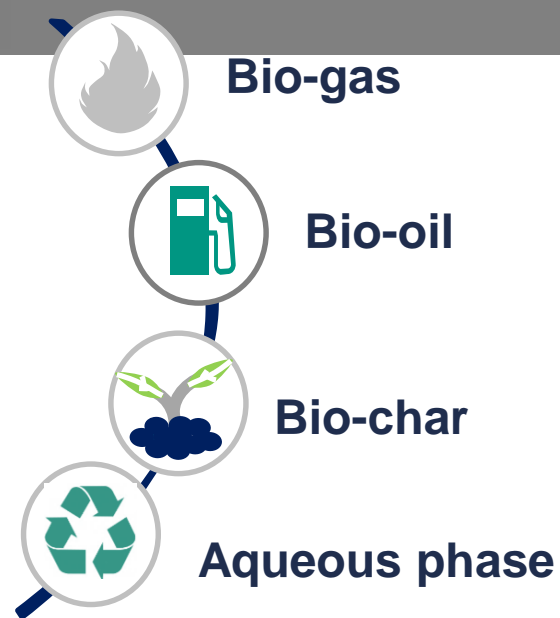
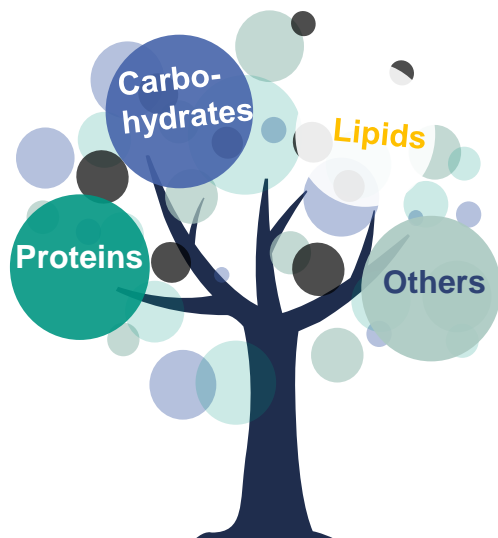
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The influence of lipids on the fate of Nitrogen during Hydrothermal Liquefaction of protein-containing biomass

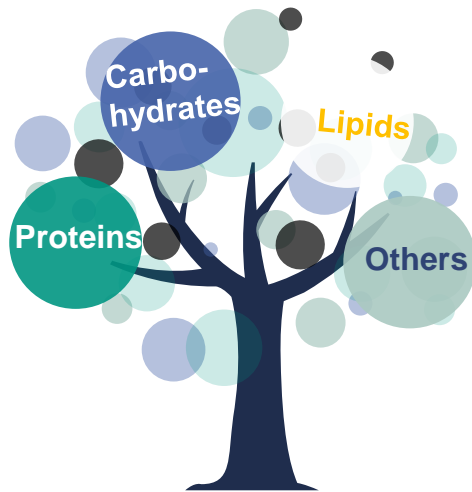
Y. Fan, U. Hornung, N. Dahmen, A. Kruse

Pyroliq 2019: Pyrolysis and Liquefaction of Biomass and Wastes

Institute of Catalysis Research and Technology IKFT



Motivation



Biomass

Wood (W)

Algae (A)

Food waste (F)

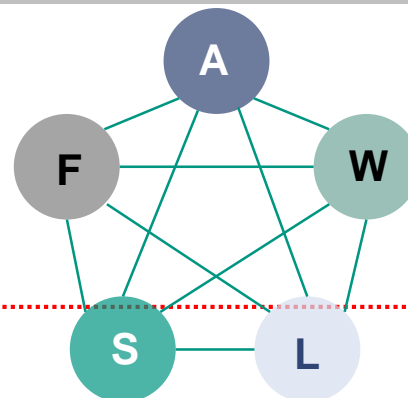
Sewage sludge (S)

Livestock manure (L)

Nitrogen-rich

**Hydrothermal
Conversion**

Co-liquefaction



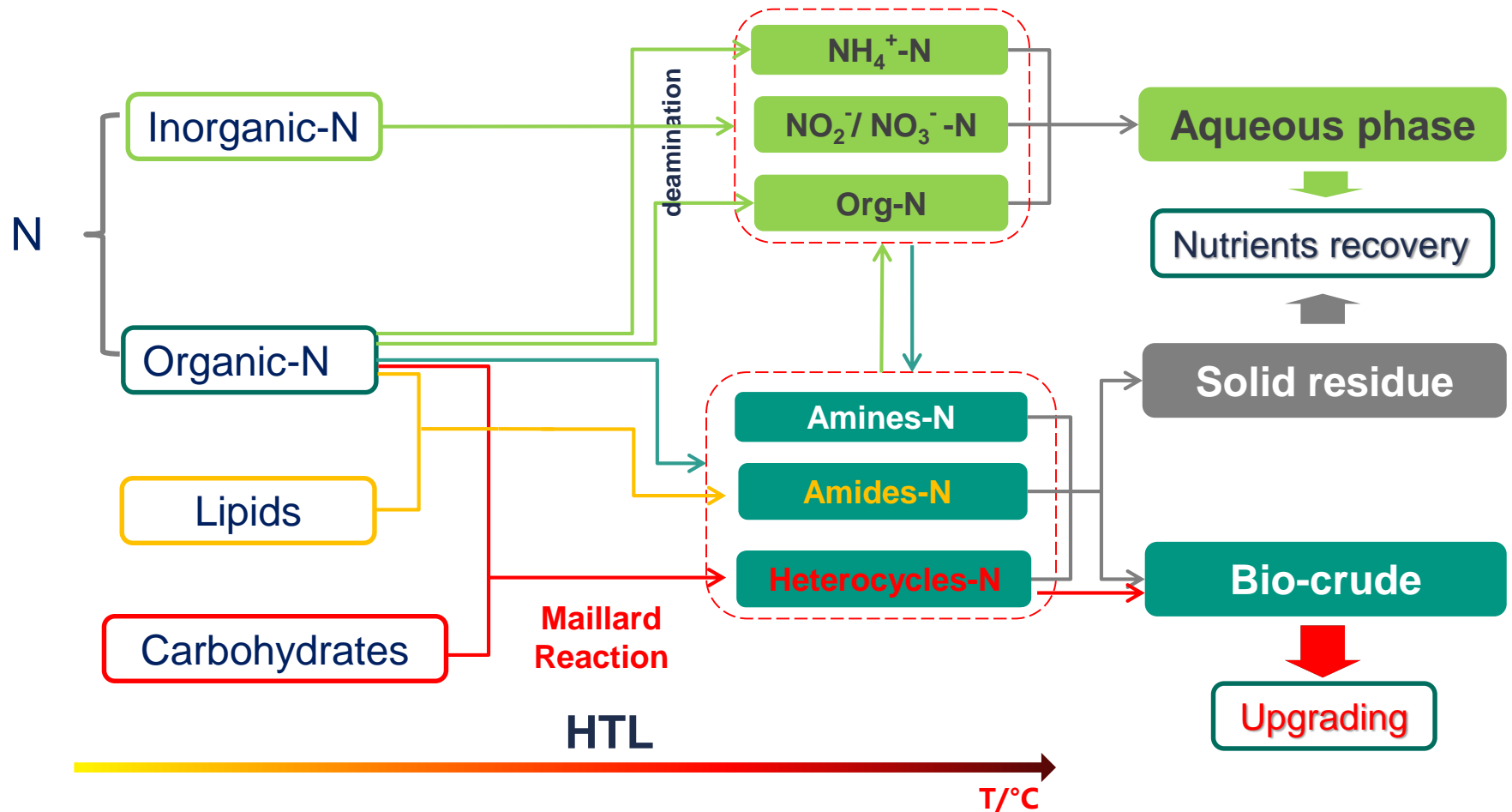
Platform Chemicals

Bio Fuel

N

Introduction

Conversion pathways of N

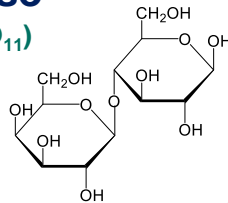


Experiments

➤ Model substances

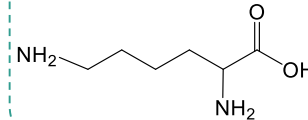
Carbohydrates

Lactose



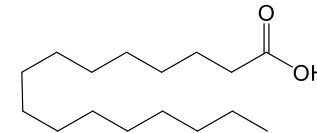
Proteins

Lysine



Lipids

Palmitic acid (PA)



➤ Method



- Individual



- Binary Mixtures



- Ternary Mixtures

250- 350 °C
20 min
10 wt. %

HTL



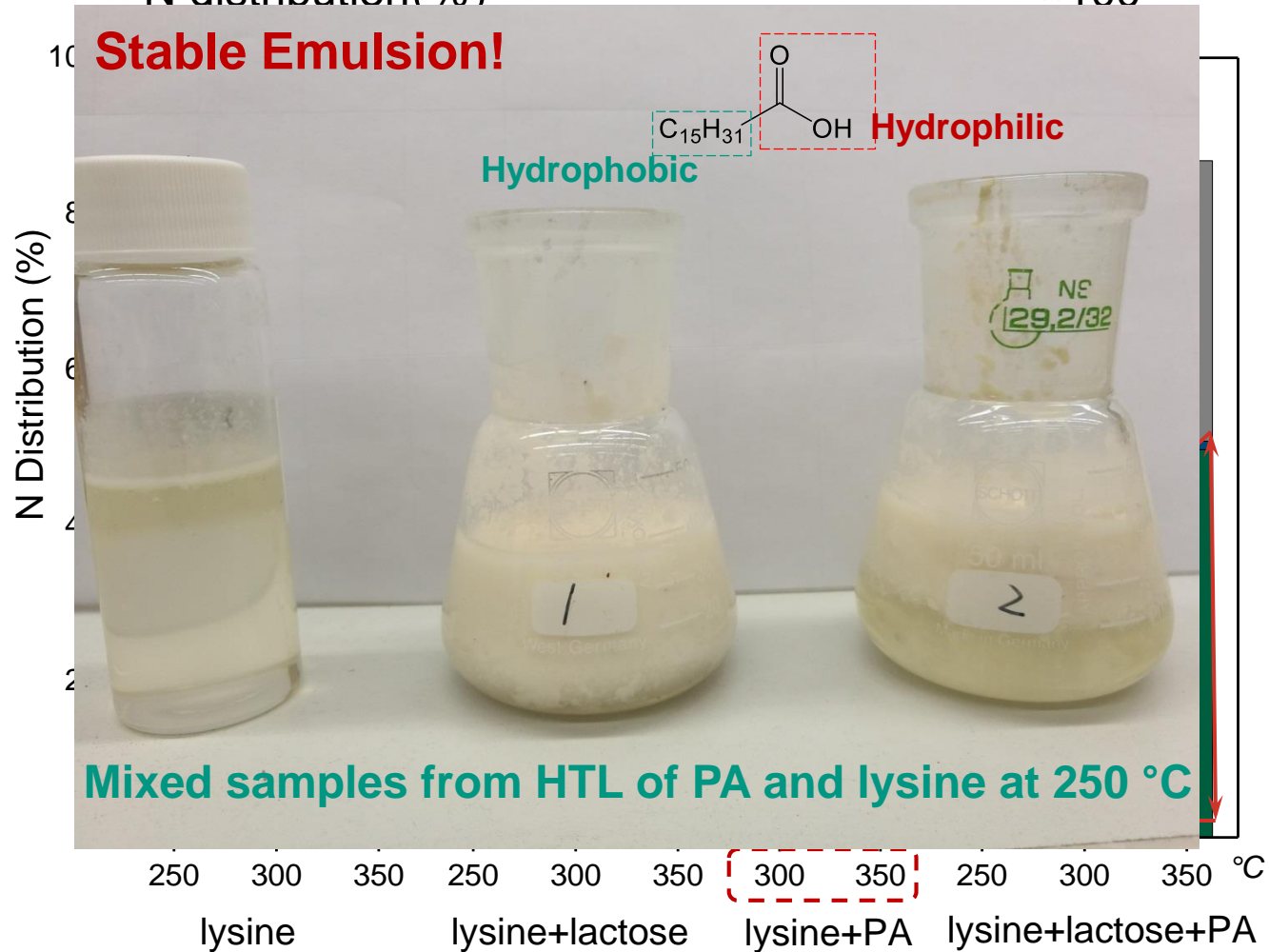
24.5 mL

- Bio-gas
- Bio-oil
- Bio-char (BC)
- Aqueous phase (AQ)

Results & Discussion

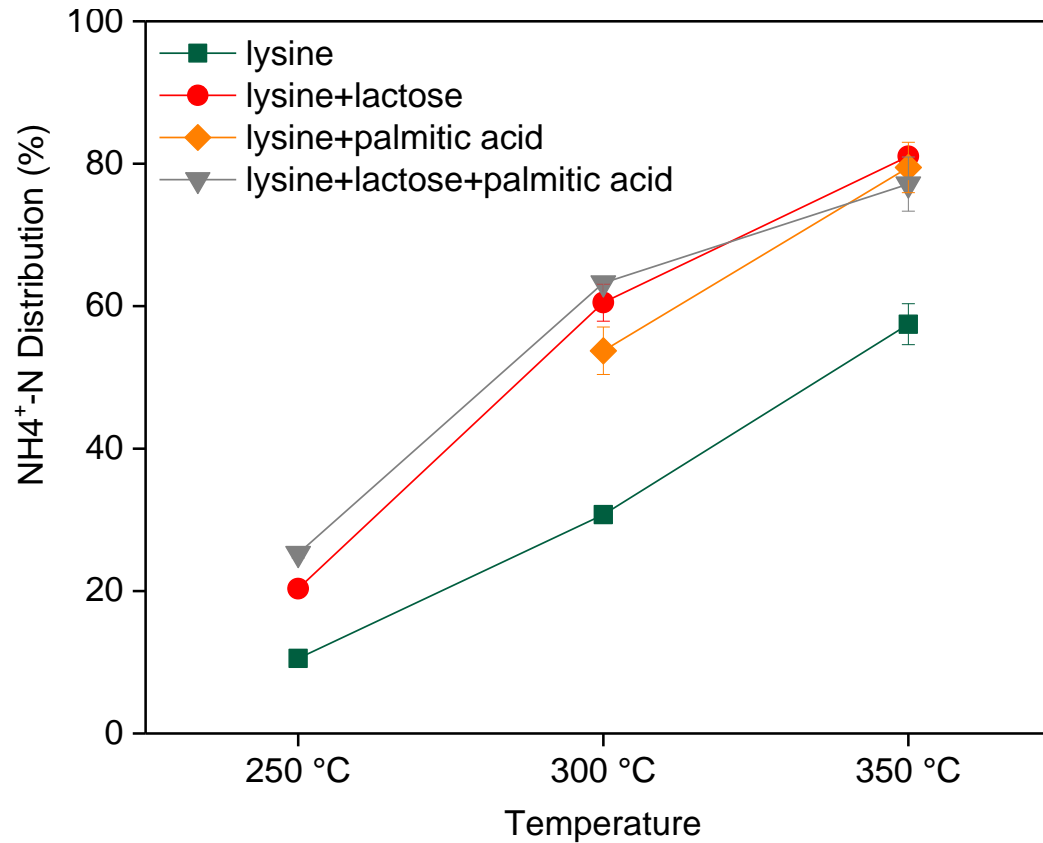
N-distribution

$$\text{N distribution}(\%) = \frac{\text{the mass of N in products}}{\text{the mass of N in products}} \times 100$$



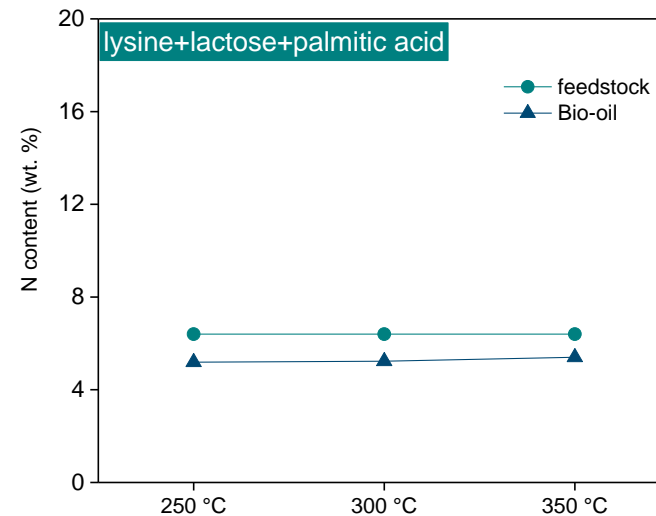
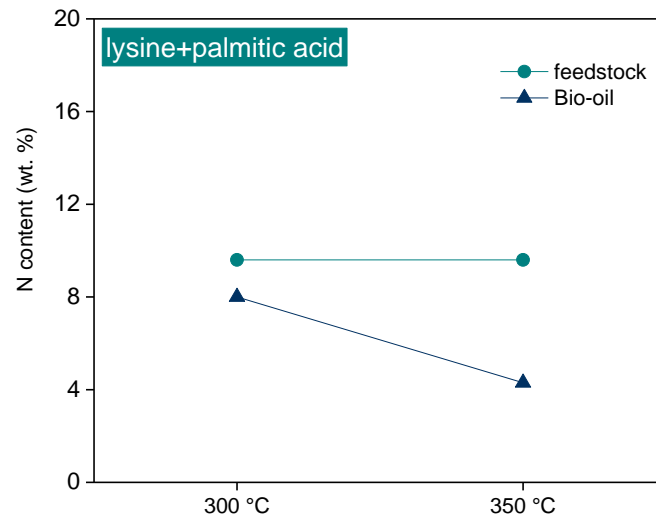
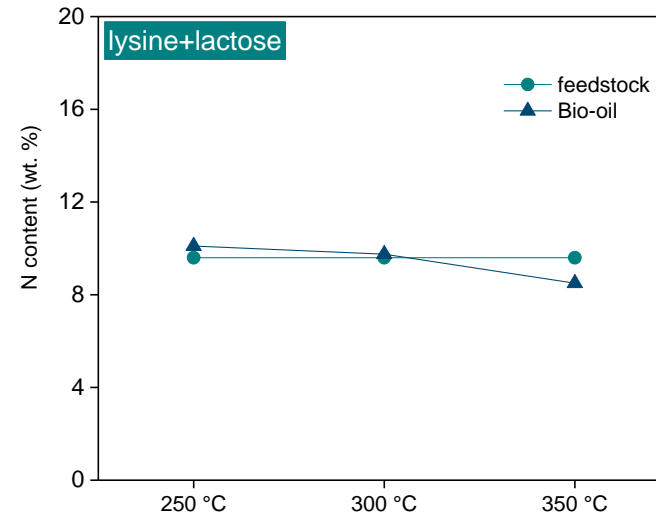
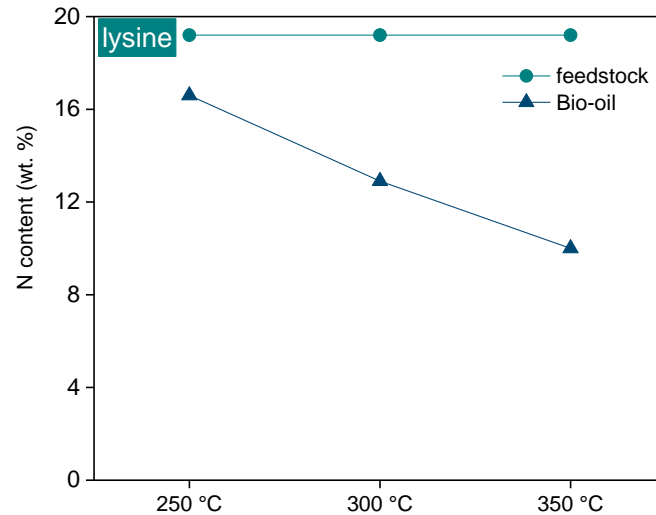
Results & Discussion

➤ N-distribution in aqueous phase



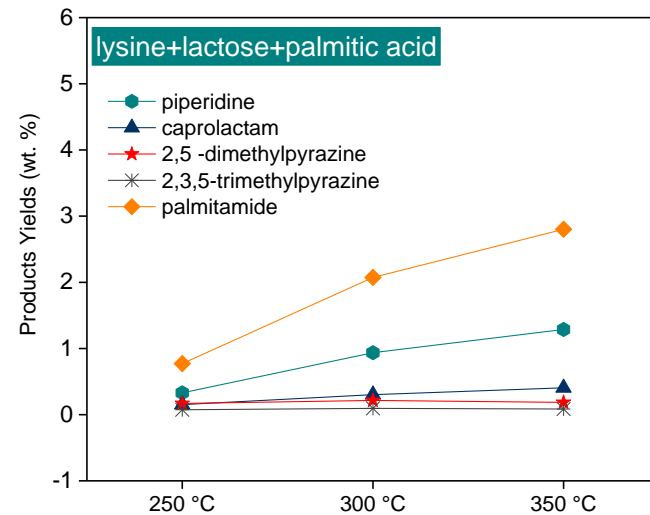
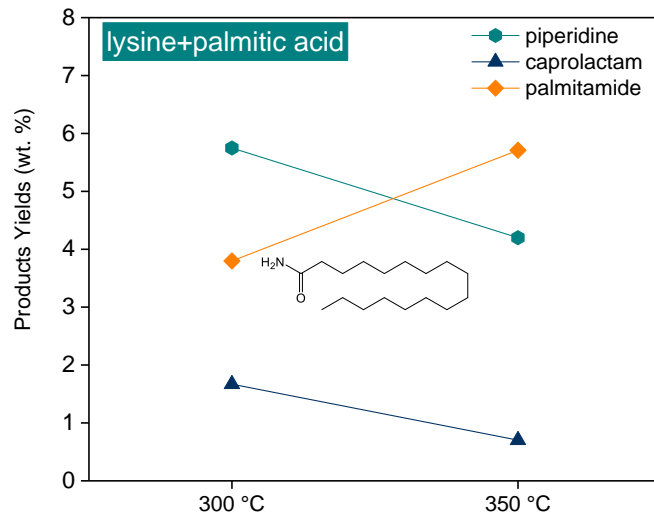
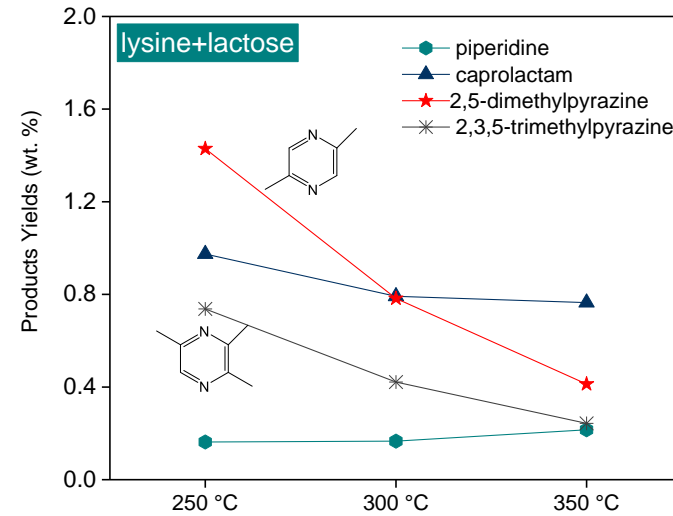
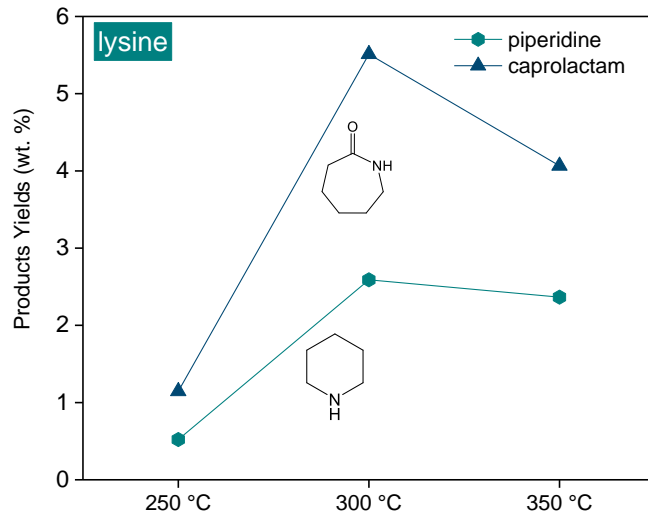
Results & Discussion

➤ N-content in the bio-oil



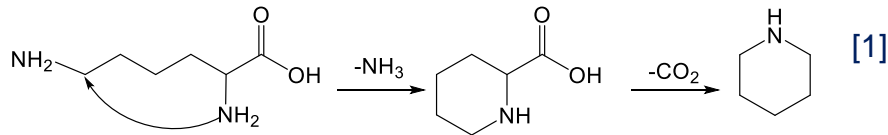
Results & Discussion

N-containing compounds in the bio-oil

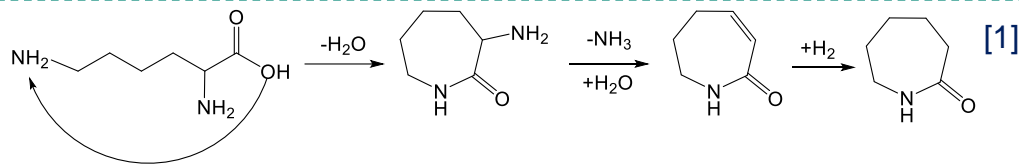


Results & Discussion

➤ Reaction scheme

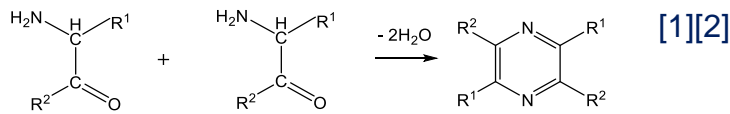
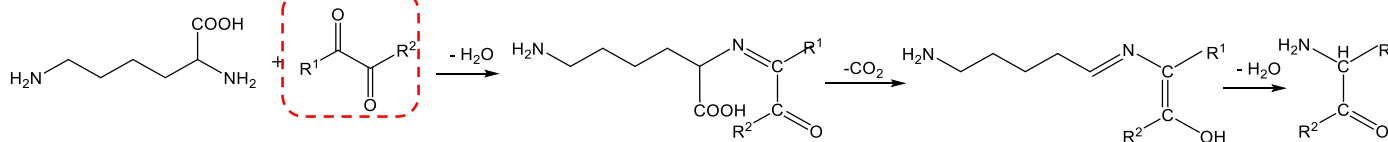


Piperidine

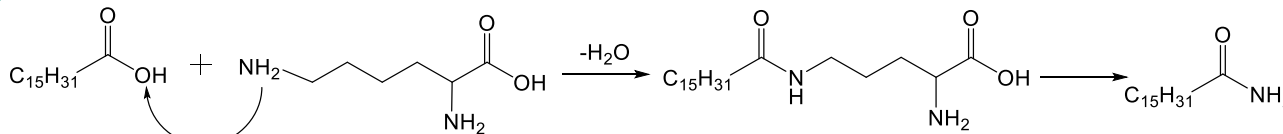


Caprolactam

Intermediates from hydrolysis of lactose



Pyrazines



Palmitamide

[1] Y. Fan. et al. *Biomass* Convers Biorefin. (2018)

[2] Hwang. et al. *J. Agric. Food Chem.*, (1994)

Results & Discussion

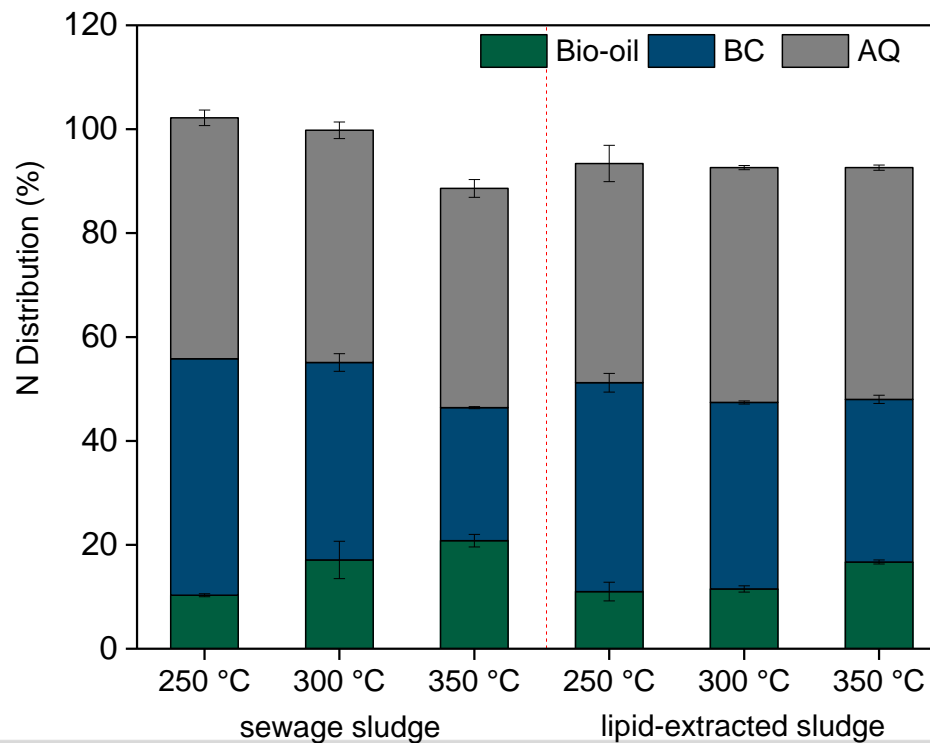
HTL of Sewage sludge

Properties of sewage sludge

Moisture (wt.%)	Ash (wt. %)	Organic compositions (wt. %)			
		Carbohydrates	Proteins	Lipids	Others
78.8	35.6	27.9	34.6	13.9	23.6
Elemental content (wt. %)					HHV (kJ/kg)
C	H	O	N	S	
29.1	5.7	23.7	5.0	0.9	13.8

Mass ratio

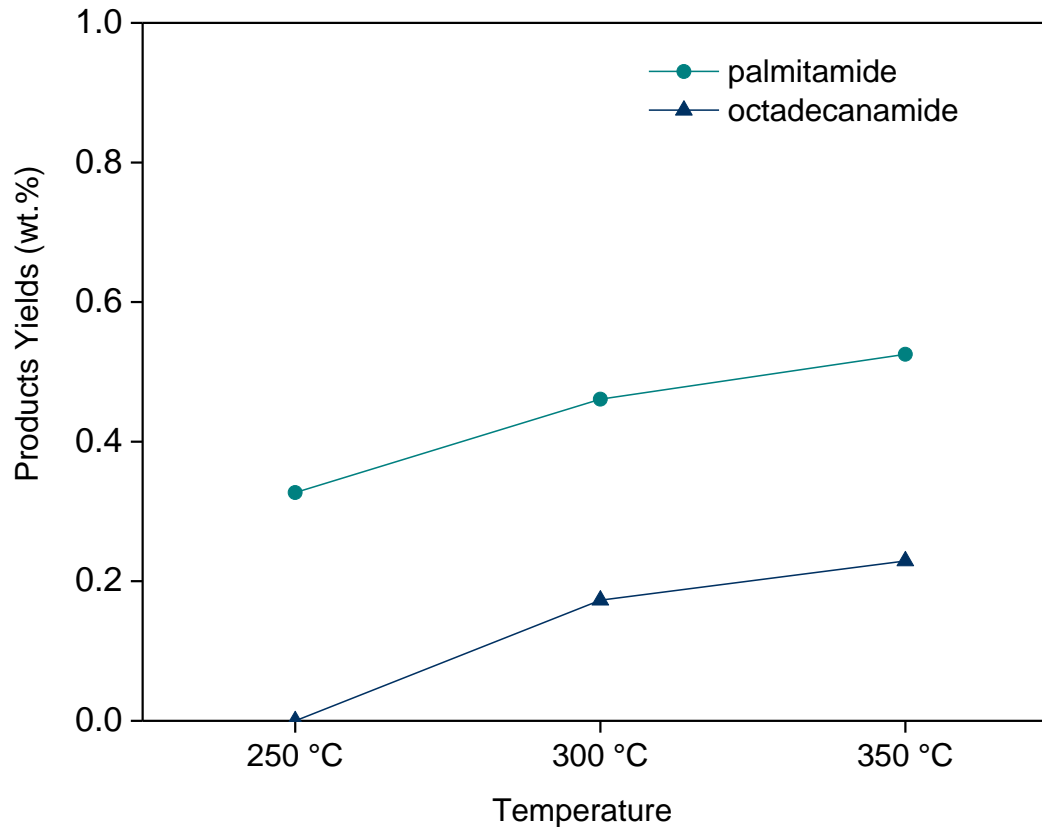
C/P/L=1/2.5/2



■ Results & Discussion

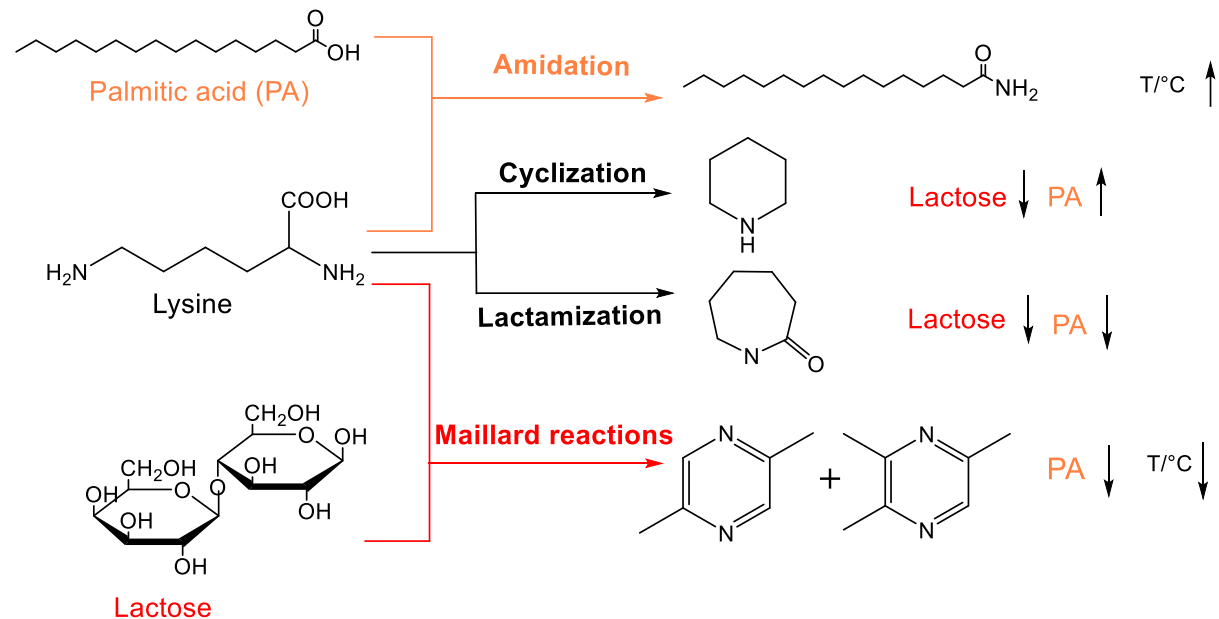
➤ HTL of Sewage sludge

N-containing compounds in the bio-oil



Conclusion

- ✓ Lipids increase N transfer into **bio-oil**
- ✓ Higher temperatures enhanced the formation of **Amides**
- ✓ **Maillard reaction products were decreased** by the addition of lipids



Outlook

- ❑ Control **Emulsion** at low temperatures
- ❑ Clarify **Reaction pathways** in more detail
- ❑ Determine **Reaction Kinetics**



In nature,
nothing is considered as waste,
everything is the resource for
something else.