INCREASING FLEXIBILITY OF FEEDSTOCK USE IN BIOREFINERIES VIA MODELLING:
PRODUCING A TARGETED SET OF OLEOCHEMICALS FROM DIFFERENT QUALITY GRADES TALLOW
EUROPEAN OLEOCHEMICAL INDUSTRY FACES A CHALLENGE

**FEEDSTOCK**

**PROCESS**

**MARKET**

**EUROPE**

**SOUTHEAST ASIA**

INCREASED QUALITY DEMANDS FOR PRODUCTS BUT LOWER QUALITY & VARIABLE FEEDSTOCK
GENERAL GOAL OF MODELLING FATTY ACID PRODUCTION

INCREASE FLEXIBILITY OF FEEDSTOCK USE

FEEDSTOCK
- High-Grade
- Low-Grade

PRODUCT
- High Quality
- Normal Quality

IMPROVE ECONOMIC & ENVIRONMENTAL PERFORMANCE

PROFIT
- NORMAL
- NEW

ENVIRONMENTAL IMPACT
- NORMAL
- NEW
THE COMPLEX COMPOSITION OF TALLOW

1. **TRIGLYCERIDES**
   - Chemical structure of triglycerides

2. **ALDEHYDES**
   - RCHO

3. **ALCOHOLS**
   - ROH

4. **KETONES**
   - R'CO

5. **STEROLS**
   - Chemical structure of sterols

6. **PEROXIDES**
   - ROOR'

7. **& MANY MORE**
   - Additional compounds

**Price Difference**
- HIGH-GRADE TALLOW
  - €40-€100 /ton

- LOW-GRADE TALLOW
CASE: PRODUCING HIGH QUALITY FATTY ACID MIXTURES FROM TALLOW

HYDROLYSIS

\[ \text{TALLOW} \rightarrow \text{CRUDE FATTY ACIDS} \]

\[ \text{H}_2\text{O} \rightarrow \text{GLYCEROL} \]

DISTILLATION

\[ \text{CRUDE FATTY ACIDS} \rightarrow \text{VAPOR} \rightarrow \text{LIQUID} \]

\[ \% \text{ YIELD} \rightarrow \text{SIDE REFLUX} \]

\[ \text{HEAT CONSUMPTION} \rightarrow \text{PITCH} \]
Determine economic and environmental performance of producing High Quality-Fatty Acids from:
- High-Grade Tallow
- Low-Grade Tallow
- Mixed Tallow (0 → 100%)

Price Difference: €40-€100 /ton
MECHANISTIC MODELLING OF FATTY ACID DISTILLATION IN A PROCESS SIMULATOR
PROCESS MODEL IS USED TO DETERMINE OPTIMAL REFLUX RATIO
ECONOMIC AND ENVIRONMENTAL EVALUATION

ECONOMIC EVALUATION

\[
\text{Gross Hourly Profit} = \frac{\text{Revenue} - \text{Costs}}{\text{Production Time}}
\]

ENVIRONMENTAL EVALUATION

Global Warming Potential
LIFE CYCLE ASSESSMENT OF TALLOW PRODUCTION

Product Environmental Footprint (PEF) pilot study for meat (bovine, pigs, sheep) and by-products by the European Commission was discontinued in 2016.
ECONOMIC EVALUATION OF PRODUCING HIGH QUALITY FATTY ACIDS FROM DIFFERENT QUALITY GRADES TALLOW

ECONOMIC ADVANTAGE TO USE LOW-GRADE TALLOW IF PRICE DIFFERENCE IS HIGHER THAN €30/t
ENVIRONMENTAL EVALUATION OF PRODUCING HIGH QUALITY FATTY ACIDS FROM DIFFERENT QUALITY GRADES TALLOW

Using low-grade tallow results in higher global warming potential due to higher energy consumption.
CONCLUSIONS

Economic advantage to use low-grade tallow if price difference is higher than €30/t

Integration of mechanistic modelling and sustainability assessment helps increase feedstock flexibility
OUTLOOK

Include other oleochemical processes and feedstocks

Integrated life cycle sustainability assessment, including impact of the feedstock
Dr. Ir. Pieter Nachtergaele
Postdoctoral Researcher

E  Pieter.Nachtergaele@ugent.be
T  +32 9 264 5918

www.ugent.be