Co-production of Lipids and Biopolymers in a single fermentation process – a way to improve sustainability of Microbial lipids – based Biofuels

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Outline

• Lipid feedstock for lipid-based biofuels

• Microbial lipids as a feedstock and sustainability challenge

• Concept of the co-production strategy for solving sustainability challenge
# Lipid feedstock for lipid-based biofuels

<table>
<thead>
<tr>
<th>Lipid feedstock</th>
<th>Lipid content %wt</th>
<th>Oil yeild kg/ha(*m³)/yr</th>
<th>Price €/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Edible plant oils</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canola</td>
<td>40 – 45</td>
<td>590.7 – 663.8</td>
<td>1.23</td>
</tr>
<tr>
<td>Sunflower</td>
<td>35 – 45</td>
<td>517.6 – 663.8</td>
<td>1.52</td>
</tr>
<tr>
<td>Coconut</td>
<td>65 – 68</td>
<td>731.3 – 978.8</td>
<td>0.89</td>
</tr>
<tr>
<td>Palm</td>
<td>45 – 50</td>
<td>3004 – 5006</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Non-edible plant oils</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapeseed</td>
<td>40 – 47</td>
<td>1100 – 1780</td>
<td>0.83</td>
</tr>
<tr>
<td>Castor</td>
<td>40 – 49</td>
<td>259 – 754</td>
<td>1.6</td>
</tr>
<tr>
<td>Physic nut</td>
<td>30 – 39</td>
<td>1200 – 1500</td>
<td>?</td>
</tr>
<tr>
<td>Cooking oil and animal fat rests</td>
<td>95 – 99</td>
<td>???</td>
<td>0.3 – 0.5</td>
</tr>
<tr>
<td>*Microbial lipids from glucose (algae, yeast, filamentous fungi)</td>
<td>25 – 80</td>
<td>251.7 – 3362.4</td>
<td>3.4 – 5.5</td>
</tr>
</tbody>
</table>

A.R. Siranjunnusa et al. (2019) Current and Future Perspectives on Lipid-Based Biofuels. doi:10.1007/978-3-030-14463-0_15

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**Building a sustainable European biofuels industry, Gothenburg 4 – 6 November 2019**
Competition for cooking oils and animal fat
Biofuels vs Bioplastic & high-value products

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30 000 tonn of animal fat rest materials → high-value products:
- microbial biomass for feed in LipoFungi, NFR-BIONÆR project;
- biosurfactants
Microbial lipids feedstock

- Oleaginous microorganisms can accumulate up to 20-80% of the total biomass in the form lipids
- Oleaginous microorganisms are diverse group including microalgae, yeast and filamentous fungi
- Heterotrophic and phototrophic production processes
- The key condition triggering lipid accumulation in oleaginous microbes is high access of CARBON and limited NITROGEN
- For the heterotrophic production a standard fermentation facilities are valid
- Microbial lipids – triacylglycerides (TAGs) and free fatty acids stored in lipid droplets
- Fatty acid profile is similar to plant oils
- Industrial (proved to be economically viable) heterotrophic production of microbial lipids is done by DSM (Netherlands) for high-value lipids
Microbial lipids - a sustainability challenge

Oils and Fats → Oleochemical
Lignocellulose → Thermochemical
Sugar → Biochemical
CO₂, CO → Hybrid

Light gases
Naphtha
Jet
Diesel

Ethanol, butanol, farnesene, lipids, etc.


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Co-production strategy for increasing sustainability of Microbial Lipid-based Biofuels
Chitosan market, need for non-animal origin chitosan

Shrimps wastes are the main source of chitin → chitosan, while filamentous fungi are the only natural source of pure chitosan

https://www.reportsanddata.com/report-detail/chitosan-market
By optimising substrate chemistry conditions, we change the amount of lipids and chitosan.

Different types of lignocellulose hydrolysates

Condition 1

Condition 2
Development of co-production strategy for microbial lipids from lignocellulose hydrolisates

- LIGNOLIPP - From LIGNOcellulose sugars to high-value LIPids and bioPolymers in a single fermentation process (2020-2022, NFR-BIOTEK)
Conclusions

• There is a need for alternative lipid feedstocks, and it is important to make microbial lipids feedstock more available and competitive

• Co-production strategies should be applied when developing microbial lipid feedstock production

• When developing co-production, important to look for high-value co-products and chitosan could be one of them
Thank you for your attention!

Acknowledgments