PUFACChain: Socio-economic evaluation of PUFAs based on phototrophic algae

October 17th, 2017, Hellen Elissen / Marcel van der Voort
About us

- **ACRRES** = Application Centre for Renewable Resources in Lelystad, the Netherlands

- Close to practice & collaboration with companies

- Expertise:
  - Aquatic biomass
  - Biorefinery
  - Green gas value chain
  - Smart energy
  - Circular economy

The research leading to these results has received funding from the European Commission’s Seventh Framework Programme (FP7-KBBE-2013-7-single-stage) under the grant agreements n° 613303
Contents

- Background of PUFAChain
- Macro-economic assessment
- Micro-economic assessment
- Socio-economic assessment
- SWOT analysis

The team:
Goal of PUFACChain

Evaluate a mature PUFA supply chain based on phototrophic algae

Wageningen Research partner in Work Package 9
WP9.4: Socio-economic assessment
Integrated assessment of sustainability (=IFEU)
The collected data and experience used

A Joint effort by:

[Logos of various organizations]
The main focus of the PUFACChain is on purified EPA or DHA or EPA/DHA mixtures containing high EPA/DHA levels (P)

Extraction cake (E) is a secondary product

Potential markets
  ● Consumer market (P)
  ● Aqua feed market (P/E)
  ● Livestock feed market (E)

IFEU, 2017
The consumer market – In general

- Market outlook for algae based PUFAs is positive
  - Growing rapidly last years and expected to keep growing
  - Drivers: Clinical research outcomes, regulatory recognition, increasing consumer health awareness and improved living standards across continents

Grebow, 2012
The consumer market – for PUFAs

- Absence of fishy taste/smell
- Appealing labelling options like 'vegetarian/vegan/organic’ distinguish algal oil from fish oil
- Algae have higher production costs than their fish oil based EPA/DHA equivalents
- Only five companies have about 75% of the EPA/DHA market share (DSM, Epax, Croda Health Care, BASF, Cargill)
Feed markets

Aqua feed market:
- More than half of the fish we consume is farmed rather than wild caught
- Therefore increasing aquaculture feeds demand
- Increasingly looking into other ‘alternative’ ingredients to reduce the sector’s dependence on fish meal (FM) and fish oil (FO)

Livestock feed market:
- To compete with soybean as protein source, the production price of algae must be decreased
Micro-economic assessment

- **Goal:** a potential PUFA supply chain for 2025
- **Three regions assessed:**
  - Southern Europe (Lisbon)
  - Central Europe (Munich)
  - Northern Europe (Oslo)
- **Least expected (10 ha) or an Optimistic (100 ha) scenario**
- **Strains of algae:**
  - *Prorocentrum cassubicum*
  - *Thalassiosira weissflogii*
  - *(ACR) Chloridella simplex* and *Raphidonema nivale Lagerheim*
Overall results

Economically viable

- Market price range of €400 – €1,500 per kg EPA/DHA (€5,500/kg DHA)
- Scenario price range of €470 - €2,340 per kg EPA/DHA
Production costs

are 62 % to 80 % of kg EPA/DHA cost price

Main elements:

- **CAPEX:**
  - Land (71 % - 80 %)
  - Production installation (10 % - 17 %)

- **OPEX:**
  - Labour (33 % - 65 %)
  - Water (19 % - 29 %)
  - Electricity (7 % - 15 %)
  - CO₂ (1 % - 9 %)
Improvement options

- Based on sensitivity analysis
- Yield:
  - Yield increase – a nearly 1-to-1 effect
- Yield is influenced by:
  - Algae composition (% oil / EPA / DHA)
  - Algae biomass yield (g DW / m² (PA) / day)
  - Losses during process steps
  - Disruption efficiency
Sensitivity analysis – Land costs

- Land (CAPEX)
  - Land prices based on metropolitan areas (high)
  - Investor could already have land or

- A shift to more rural area has a significant impact!
  - Southern Europe – around 20% (e.g. €704 → €558)
  - Central Europe – around 27% (e.g. €1022 → €725)

= Reduction in cost price (€/kg EPA/DHA)

(example based on Prorocentrum – Optimistic scenario)
Sensitivity analysis - Electricity

- Electricity (OPEX)
  - Electricity prices based on current market prices

- Alternative
  - Develop PV solar park next to algae production
  - Southern Europe – around 8 % (e.g. €704 → €650)
  - Central Europe – around 7 % (e.g. €1022 → €932)

= Reduction in cost price (€/kg EPA/DHA)

(example based on *Prorocentrum* – Optimistic scenario)
Other improvement options

- Cost savings:
  - CAPEX: Land costs and installation costs
  - OPEX: Labour costs, inputs (water, electricity, CO₂)

- Multiple improvement options should be possible as indicated with sensitivity analysis

An economically viable PUFACChain is possible for 2025
The research leading to these results has received funding from the European Commission’s Seventh Framework Programme (FP7-KBBE-2013-7-single-stage) under the grant agreements n° 613303.

### Socio-economic assessment

<table>
<thead>
<tr>
<th>Indicator</th>
<th>South</th>
<th>Central</th>
<th>North</th>
<th>Het</th>
<th>C</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local community</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour conditions (Health)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Labour conditions (Safety)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Employment opportunity</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Access to material resources</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Living conditions</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>General society</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumers' health and safety</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Public commitment to sustainability issues</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>Legal regulatory barriers</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Public perception</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Socio-economic assessment

- A mature PUFAChain can perform equal or slightly better than competing sources

Based on:

- Employment in Southern Europe scenarios
- Food safety and consumers health in all scenarios
- Fish based sources linked to unsustainable fisheries and therefore less public commitment
- Heterotrophic sources already authorised, but expected to be less advantageous due to demand for material resources
A SWOT-analysis as a guide to a mature PUFA Chain

- Transparency in elements for success and failure
Concluding

- The market outlook for PUFAs is positive
- PUFA production from (phototrophic) algae is economically viable based on calculations in the PUFACheck project
- PUFACheck could perform better on social issues

- Overall the Southern Europe scenarios prevails
  - Slightly higher yields
  - Overall lower costs (land, labour, etc.)
  - Social impact (better employment)
Value of socio-economic assessments

- Socio-economic assessment is valuable for a project
  - Insight in market developments
  - Insight in economic performance
  - Insight in sociological developments

- Offering
  - Criteria for business development
  - Criteria for scientific and technological development
  - Criteria for social objectives, employment, nature
Any questions?

Thank you for your attention

Contact:
marcel.vandervooort@wur.nl or hellen.elissen@wur.nl