Scaling up of savouring compounds from Mussel Cooking Side streams

Mónica Gutiérrez, David San Martin, Jone Ibarruri & Bruno Iñarra
Optimal utilization of seafood side-streams through the design of new holistic process lines

DEVELOPING:
- Technology, infrastructure and logistics
- Efficient and sustainable supply systems for aquatic side-streams
- Nutritional ingredients such as proteins, peptides, savoury ingredients and mineral supplements

QUICK FACTS:
- Project duration: 1 May 2019 to 30 April 2023
- Funding: EC contribution €3.2 million, overall budget €4 million
- Consortium: 3 research institutes/universities, 1 industry cluster and 9 companies from Denmark, Sweden, Belgium, France & Spain

Extended until Sept 2023
THE CONTEXT:
The current exploitation of the aquatic resources is hampered by inefficiency as up to 70% end up as low-value products or waste, unsustainable considering the rising population.

WaSeaBi OBJECTIVE:
Ensure that side-streams from aquaculture, fisheries and aquatic processing industries can be exploited for production of new products and ingredients. By developing storage solutions, sorting technologies and decision tools that will secure an efficient, sustainable supply system for valorization of these raw materials into marketable products.
**WaSeaBi: The project**

### 6 different side-streams:
Representing typical **aquaculture, fisheries and aquatic processing industries** in Europe:

<table>
<thead>
<tr>
<th>Side-stream</th>
<th>Potential use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid side-stream from Cod industry</td>
<td>Food ingredient</td>
</tr>
<tr>
<td>Brine from salted Cod</td>
<td>Protein for reinjection/in-house use</td>
</tr>
<tr>
<td>Solids &amp; process water from herring</td>
<td>Food ingredients</td>
</tr>
<tr>
<td>Salmon solids, mackerel, by-catches</td>
<td>Food &amp; Feed ingredients</td>
</tr>
<tr>
<td>Mussel cooking water</td>
<td>Food ingredients (Savoury compounds)</td>
</tr>
<tr>
<td>Mussel shells</td>
<td>Food &amp; Feed ingredients (mineral supplements)</td>
</tr>
</tbody>
</table>

WaSeaBi will take a whole chain perspective to succeed with **high quality production of**:
- Bioactive peptides for nutraceutical, food and feed application
- Protein-based food ingredients
- Savory ingredients and mineral supplements for food and feed
The context

Some facts about mussel production:
• The EU is the second largest producer after
• In the north-West of Spain, the annual production of mussels is 200 000 tons (35 % of the world)
• The mussel processing requires large amounts of water for its processes.
• The water used is seawater, which is why large amounts of wasted-brine are generated.
Mussel Processing

Mussel cleaning

Steam Cooking

Mussel transport/packaging

300 - 400 liters of wastewaters per tone of mussel
Mussel processing wastewaters

Seawater from mussel cleaning, product transport (conveyor-tray) and factory cleaning

- DQO = 22 000 – 100 000 mgO₂/l
- SS = 250 – 700 mg/l

Sidestream from mussel cooking

- DQO = 22 000 – 100 000 mgO₂/l
- SS = 250 – 700 mg/l

Rest of effluents

- 97% MCW
- 3% Volume of effluents

% COD Load

- 57% MCW
- 43% Rest of effluents

DQO = 500 – 1 000 mgO₂/l
SS = 500 – 1 000 mg/l
Mussel processing wastewaters

Seawater from mussel cooking

Seawater from mussel cleaning, product transport (conveyor-tray) and factory cleaning
MCW recovery

LAB Assays
- Controlled conditions
- Variable study
- Separate Effects

Pilot Plant
- Controlled conditions
- Assays in optimal conditions
- Cross Effects

Semi industrial Pilot Plant
- Real conditions
- High variability
- Adjustment of conditions
- PID specifications

Industrial
- Installation
- Equipment Start up
- Final adjustments / Operation
MCW Concentration

Mussel cooking water → Filter → Nanofiltration (NF) → Diafiltration (DF) → Spray-dryer

Flavour compounds (Ac. Glutamic)

Recovered water

Water for REUSE

NF permeate

DF permeate

Water
**MCW Concentration**

Different assays carried out in the scale-up in Mussel Facility

<table>
<thead>
<tr>
<th>Assay</th>
<th>NF VCF</th>
<th>DF VCF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assay 1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Assay 2</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Assay 3</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

VCF = Volumetric Concentration Factor

**RESULTS:** Comparison between different performance parameters

<table>
<thead>
<tr>
<th></th>
<th>Assay 1 NF 10x - DF 10x</th>
<th>Assay 2 NF 10x - DF 20x</th>
<th>Assay 3 NF 20x - DF 20x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein recovery (%)</td>
<td>0.53</td>
<td>0.67</td>
<td>0.56</td>
</tr>
<tr>
<td>Concentrate Volume l/m³ MCW</td>
<td>10</td>
<td>5</td>
<td>2.50</td>
</tr>
<tr>
<td>Energy (kWh/m³ MCW)</td>
<td>21.42</td>
<td>17.12</td>
<td>21.51</td>
</tr>
<tr>
<td>Final effluent Vol. (m³/m³ MCW)</td>
<td>1.98</td>
<td>1.95</td>
<td>1.49</td>
</tr>
<tr>
<td>COD in final effluent (mg O₂/l)</td>
<td>1013</td>
<td>856</td>
<td>854</td>
</tr>
<tr>
<td>CIP Reagents (€/ m³ MCW)</td>
<td>128</td>
<td>121</td>
<td>136</td>
</tr>
</tbody>
</table>
Production of Mussel savoury compounds

Mussel Cooking Water

MCW concentrate

MCW permeate
Mussel Cooking Water concentrate powder

MCW powder composition

- Moisture 3%
- Protein > 50%
- 20 mg Total Glu / g powder (60% of Free Glutamic acid)
Market applications

**PROCESSED FOOD INGREDIENT**
- Fish & Seafood savor
- Umami flavor

**BEAUTY & COSMETICS**
- MAP (Mussel adhesive protein)
- Skin regeneration
- Nutraceutical ingredients

**PET FOOD**
- Anti-inflammatory properties
- Seafood flavor
Conclusions

A solution for a seafood side-streams recovery was developed and implemented from lab-scale to industrial scale-up.

The main pollution flow was separated and valorized to avoid the organic matter contamination in the final effluent. Treated brine can be discharged to the sea within the regulatory frame or reused.

- The water recovered from the NF and DF processes had the hygienical conditions to use for cleaning purposes in the factory.

New protein source was obtained for savory ingredient industry.
Thank you!
Any questions?

Mónica Gutiérrez

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This project has received funding from the Bio-Based Industries Joint Undertaking (JU) under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 837726. The JU receives support from the European Union’s Horizon 2020 research and innovation programme and the Bio-Based Industries Consortium. This output reflects only the author’s view and the JU cannot be held responsible for any use that may be made of the information it contains.