Integral valorization of grapevine shoots from the variety Grüner Veltliner: A techno-economic assessment

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Agenda

• Introduction
• What we did?
• Results
• Conclusion
A transition into sustainable societies is urgent!

Key for shifting into a bioeconomy:
Focus on both products and energy/fuels used in industry and daily-life applications
Introduction

Context

➢ Grape production
  • ~78 Mtonnes, 6.9 MHa (2020) (FAOSTAT)

Data taken from: FAOSTAT (Consulted June 2022)
Context

- Wine production
  - ~27 Mtonnes (2019) (FAOSTAT)

Data taken from: FAOSTAT (Consulted June 2022)
Introduction

Context

➢ Residues

- Residues
  - Taken from: (Contreras et al., 2022)
  - ~1-3 t/ha
  - 1 t grape
    - 30-40 kg stalks
    - 130-200 kg pomace
    - 15-60 kg lees
Context

- **Residues**
  - Grapevine Shoots (GVS): Lignocellulosic residue
    - Results from the pruning of the grapevine
    - Multiple studies focusing on:
      - Bioactive substances
      - Biofuels
      - Biochemicals

Taken from: (Contreras et al., 2022)
Introduction

Context

- Residues

  ➢ Taking from: (Contreras et al., 2022)

  ~1-3 t/ha

  Single grapevine shoot branch
Problem Statement

- Most of studies (in Europe) regarding GVS valorization have been done for Portuguese, Italian, French, and Spanish grape varieties

- Austria:
  - Grape production (2017): 330k tons
  - Variety: Grüner Veltliner – 48% wine area (15k ha)

- No differentiation between leaves and stem

- Evaluating possible integration scenarios and determining the techno-economic feasibility of a biorefinery to valorize the Grüner Veltliner’s GVS is still necessary to be performed
Previous Study: Grapevine Shoots - Leaves and Stem

Previous Study: Grapevine Shoots - Leaves and Stem

What we did

Previous Study: Grapevine Shoots - Leaves and Stem

This Study: Scenarios and Techno-Economic Assessment

- Leaves

Sc. 1

Leaves → Pressurized Liquid Extraction (PLE) → Extractives → Biogas Production → Solids

Sc. 2

Leaves → Pressurized Liquid Extraction (PLE) → Extractives → Liquid Hot Water (LHW) → Hemicellulosic sugars

Biogas Production → Solids 1 → Solids 2
This Study: Scenarios and Techno-Economic Assessment

Stems

Sc. 3

Stem → Liquid Hot Water (LHW) → Hemicellulosic sugars
   Solids 1 → Organosolv (OS) → Lignin
   Solids 2 → Biogas Production

Sc. 4

Stem → Pressurized Liquid Extraction (PLE) → Extractives
   Solids 1 → Liquid Hot Water (LHW) → Hemicellulosic sugars
   Solids 2 → Organosolv (OS) → Lignin
   Solids 3 → Biogas Production
This Study: Scenarios and Techno-Economic Assessment

- Leaves + Stems

Sc. 5

- Pressurized Liquid Extraction (PLE)
  - Extractives
  - Solids 1
    - Liquid Hot Water (LHW)
      - Hemicellulosic sugars
      - Solids 2
        - Organosolv (OS)
          - Lignin
          - Solids 3
            - Biogas Production
This Study: Scenarios and Techno-Economic Assessment

Feedstock flows

<table>
<thead>
<tr>
<th>Vineyard residue production</th>
<th>Planted vineyards (Austria)</th>
<th>Estimated residue production</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton/ha</td>
<td>ha/year</td>
<td>ton/year</td>
</tr>
<tr>
<td>5</td>
<td>48000</td>
<td>240000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assumed use of residue</th>
<th>Mass flow WET</th>
</tr>
</thead>
<tbody>
<tr>
<td>(%)</td>
<td>(kg/h)</td>
</tr>
<tr>
<td>10%</td>
<td>2737.85</td>
</tr>
</tbody>
</table>

### Aspen Process V10
AP Economic Analyzer

<table>
<thead>
<tr>
<th>Plant fraction WET</th>
<th>Mass flow WET</th>
<th>DM content</th>
<th>Mass flow DRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>(%wt)</td>
<td>(kg/h)</td>
<td>(%wt)</td>
<td>(kg/h)</td>
</tr>
<tr>
<td>Leaves</td>
<td>60.5</td>
<td>37.68</td>
<td>624.64</td>
</tr>
<tr>
<td>Stem</td>
<td>39.5</td>
<td>47.48</td>
<td>512.84</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1137.47</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Technical Assessment: Product streams

- Leaves: PLE, Biogas (Sc. 1)
- Leaves: PLE, LHW, Biogas (Sc. 2)
- Stem: LHW, OS, Biogas (Sc. 3)
- Stem: PLE, LHW, OS, Biogas (Sc. 4)
- L+S: PLE, LHW, OS, Biogas (Sc. 5)

Yield (g/kg Wet FS) *Biogas (L/kg Wet FS)

- Concentrated extractives
- Sugars (without water)
- Dried lignin
- Biogas
Technical Assessment: Reagent consumption

Reagent consumption

<table>
<thead>
<tr>
<th></th>
<th>Yield (kg/kg Wet FS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves PLE, Biogas Sc. 1</td>
<td>4.5</td>
</tr>
<tr>
<td>Leaves PLE, LHW, Biogas Sc. 2</td>
<td>8.0</td>
</tr>
<tr>
<td>Stem LHW, OS, Biogas Sc. 3</td>
<td>14.0</td>
</tr>
<tr>
<td>Stem PLE, LHW, OS, Biogas Sc. 4</td>
<td>10.5</td>
</tr>
<tr>
<td>L+S PLE, LHW, OS, Biogas Sc. 5</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Water consumption  Ethanol consumption
Technical Assessment: Energy consumption

- Leaves:
  - PLE, Biogas Sc. 1: 36%
  - PLE, LHW, Biogas Sc. 2: 42%
- Stem:
  - LHW, OS, Biogas Sc. 3: 21%
  - PLE, LHW, OS, Biogas Sc. 4: 49%
- L+S:
  - PLE, LHW, OS, Biogas Sc. 5: 47%
Economic assessment: Total cost and costs distribution
Economic assessment: Total cost and costs distribution
Upcoming work

✓ Sequential processing (biorefinery) improved the extraction of compounds of interest (bioactive compounds, hemicellulosic sugars, and lignin)
✓ Mass integration did not increase the specific consumption of reagents and energy.
✓ Total specific costs decreased, while increasing the output of products.

- Scenario evaluation:
  • Market costs for intermediate products (?)
  • Prospective LCA
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Bioactive Project

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Thank you for your attention!

Questions