Relevant crops for protein extraction

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Demands for crops for protein extraction

- **Low production cost at farm**
- High protein production per hectare
- Low production cost
- Fit well into cropping systems

- **Low extraction cost and high value product**
- High protein yield per unit biomass processed
- High protein quality, amino acid composition
Protein for organic farming

• Easy to produce protein in ley crops with legumes
  • But only for ruminant animals

• Difficult to produce seed protein in organic farming
  • Grain legumes = weed and rotation problems
    • Field bean, field pea, lupin
  • Oilseed crops = high N fertilizer demand

• Stockless organic farms need ley crops with legumes!
  • Soil fertility
  • Nutrient management
  • Weed management
Protein quality of extracted protein
- leaf protein less variable than seed protein

• Seed protein is mostly storage protein
  • Function does not restrict the composition
  • Often unbalanced amino acid composition
  • Strongly variable among plant species

• Leaf protein consist of functional proteins
  • Function in photosynthesis determine composition
  • More balanced amino acid composition
  • But relatively constant among plant species
Protein production from organic farming

• Species
  • Amino acid composition and productivity

• S fertilization
  • Amino acid composition and maybe productivity

• Harvest strategy
  • Balancing production cost vs.
    • Protein production and extractability
    • Biomass production
Dry matter content in fresh biomass

- Brassica napus
- Brassica oleracea
- Isatis tinctoria
- Raphanus sativus
- Sinapis alba
- Dactylis glomerata
- Lolium perenne
- Phleum pratense
- Poa pratensis
- Poa trivialis
- Anthyllis vulneraria
- Lotus pedunculatus
- Medicago sativa
- Onobrychis vicifolia
- MTrifolium repens
- Vicia villosa
- Carum carvi
- Cichorium intybus
- Plantago lanceolata
- Rumex rugosus
- Sanguisorba officinalis
Crude protein content in fresh biomass

![Graph showing crude protein content for various plants]
Crude protein recovery in green juice
Protein recovery, effect of dry matter content

\[ y = 73 - 1.15x \]

\[ R^2 = 0.28, \ P \leq 0.0001 \]
Protein recovery, effect of protein content

Protein recovery in green juice (%) vs. Crude protein content in fresh biomass (%)

\[ y = 38 + 0.75x \]

\[ R^2 = 0.18, \ P \leq 0.01 \]
## Species and amino acids - % of crude protein content

| Species                      | 16 amino acids analysed for as percentage of crude protein content (%) | Min | ALA | SE  | ARG | ASP | CVS | GLU | GLY | HIS | ILE | LEU | LYS | MET | PHE | PRO | SER | THR | VAL | CYS | ME |
|------------------------------|------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Brassica napus               | 75                                                                      | 2.9 | 4.5 | 0.2 | 4.5 | 0.2 | 7.8 | 0.4 | 1.1 | 0.0 | 13.3 | 0.5 | 3.9 | 0.2 | 1.6 | 0.0 | 3.6 | 0.1 | 6.1 | 0.3 | 5.1 | 0.2 | 1.4 | 0.1 | 3.8 | 0.2 | 5.7 | 0.4 |

**Significant difference between species**

- *** indicates significance at the 0.001 level
Histidine, % if crude protein
Cystine, % of crude protein
Conclusions on species

- Limited differences in amino acid composition
  - But may be enough to be important

- Important differences among species in
  - Protein content
  - Protein extractability
  - Non-protein N
Harvest time and dry matter content

Dry matter content in fresh biomass

- W. clover / ryegrass
- Red clover
- R. clover / O. grass

20 May, 1 June, 21 June, 20 May, 27 May, 7 June
Harvest time and extracted protein yield

![Graph showing crude protein yield in green juice for different dates and species.]

- **W. clover / ryegrass**
- **Red clover**
- **R. clover / O. grass**
Harvest time and cysteine content

1st year
- W. clover / ryegrass
- Red clover
- R. clover / O. grass

2nd year

- W. clover / ryegrass
- Red clover
- R. clover / O. grass

20 May | 1 June | 21 June

20 May | 27 May | 7 June
Conclusions on harvest strategies

• Frequent harvesting necessary
  • Protein yield and extractability
  • But also higher cost
  • No effect on amino acid composition
  • 500 kg extracted protein per ha per harvest?

• Balance between value of protein and biomass
**S fertilization and amino acid composition - red clover / grass mixture**

<table>
<thead>
<tr>
<th>S level (kg ha(^{-1}))</th>
<th>Cysteine</th>
<th>Lysine</th>
<th>Methionine</th>
<th>Threonin</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>0.63(a)</td>
<td>5.01(a)</td>
<td>1.41(a)</td>
<td>3.91(a)</td>
</tr>
<tr>
<td>30</td>
<td>0.67(a)</td>
<td>4.93(a)</td>
<td>1.4(a)</td>
<td>3.91(a)</td>
</tr>
<tr>
<td>60</td>
<td>0.75(a)</td>
<td>5.65(a)</td>
<td>1.58(a)</td>
<td>4.48(a)</td>
</tr>
</tbody>
</table>

**MSD**

<table>
<thead>
<tr>
<th></th>
<th>0.14 (n.s.)</th>
<th>1.12 (n.s.)</th>
<th>0.31 (n.s.)</th>
<th>0.90 (n.s.)</th>
</tr>
</thead>
</table>

*Note: MSD values are not significant (n.s.)*
Effects of S fertilization

• No effect on yield
• Increased protein content
• Some effect on amino acid composition
Crops for protein extraction in organic farming

• Stockless organic farms need ley crops with legumes
  • Nitrogen supply to the rotation
  • Weed management
  • Soil fertility

• Annual crops 🙄
  • One early harvest

• Non-legumes 😞?
  • Need high N input for protein production
  • Only in mixtures with legumes

• Cover crops ?
• Vegetable crop residues ?
Relevant crops for protein extraction

Questions?

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