Plant-based bioproduction platforms
Why development should be encouraged and how

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Scientific strategies from recent outbreaks to help us prepare for Pathogen X
WHO August 2022
State of the art

State of the art in plant bioproduction platforms

• *Nicotiana benthamiana* transient expression system is used as standard.

• Successful up to Phase III (e.g., Medicago SARS CoV2 and influenza) established.

• Intense academic research in (i) chassis/platform improvement and (ii) product development.

• Expanding Industrial landscape with several medium-size production companies worldwide
Advantages of plant bioproduction (for pathogen X)

**Sustainability**: lower input requirements

**Modularity**: one plant, one bioreactor

**Scalability**: agricultural production scale

Opportunities for manufacturing repurposing

Potentially lower investment requirements
Repurposing pilot study

Pilot Production of SARS-CoV-2 Related Proteins in Plants: A Proof of Concept for Rapid Repurposing of Indoor Farms Into Biomanufacturing Facilities

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<table>
<thead>
<tr>
<th>Purified protein</th>
<th>Yield (µg/g FW)</th>
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<tbody>
<tr>
<td>CR3022</td>
<td>73.06</td>
</tr>
<tr>
<td>sybody3</td>
<td>122.53</td>
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<tr>
<td>sybody17</td>
<td>153.36</td>
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<tr>
<td>nanobody72</td>
<td>192.63</td>
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<tr>
<td>CR3009</td>
<td>73.38</td>
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<tr>
<td>CR3018</td>
<td>81.24</td>
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<tr>
<td>nRBD:His (Buffer A)</td>
<td>4.31</td>
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<tr>
<td>nRBD:His (Buffer B)</td>
<td>4.02</td>
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<tr>
<td>bRBD:His (Buffer A)</td>
<td>2.94</td>
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<td>bRBD:His (Buffer B)</td>
<td>5.21</td>
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<tr>
<td>His:bN (Buffer A)</td>
<td>30.98</td>
</tr>
</tbody>
</table>

(A)

Upper hexagon

Lower hexagon

Pots

Vacuum chamber
Repurposing pilot study
Repurposing pilot study

TIMING (In this work)

d0  d10  d30  d50  d65

**Build**
- *In silico* design
- Gene synthesis

**Test**
- Agroinfiltration
- Coomassie/ELISA
- Upscale
- Extraction/testing

**Design**
- DNA assembly
- Sanger sequencing

**Produce**

TIMING (optimized)

d0  d10  d20  d30  d45
What is needed

- R&D in platform development with focus in repurposing

  The plant: breeding, genomics, phenomics, and Synbio
  The product: new examples of commercial plant-made biopharmaceuticals (Molecular farming)

  The greenhouse: development of pilot double-use facilities, vertical farming

- Do not jeopardise most advanced successful examples!
  Medicago case
Accelerated breeding of Nicotiana species as biofactories using SynBio and New Plant Breeding Techniques (Newcotiana designer strains)

www.newcotiana.org

Future requirements

Delivering new and innovative high value products using plant molecular farming.

14 partners, 7 countries, 5 SMEs, 3 public research institutions and 6 universities

CAN WE DESIGN TOBACCO PLANTS FOR HEALTH?

5th ISPMF Conference
Rome 2022

https://www.ispmf.org/
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COVIFENZ®
COVID-19 Vaccine (plant-based virus-like particles [VLP], recombinant, adjuvanted)
Thanks for your attention