The Plant Protein Landscape

With consumer demand for plant-based products continuing to grow rapidly, a broad portfolio of plant proteins is available for plant-based meat, egg, and dairy products. To meet requirements ranging from consumer sensory preferences to nutrition, functionality, price, availability, and sourcing, manufacturers should consider what different plant protein sources have to offer.

QUICK FACTS: PLANT PROTEIN BASICS
Proteins are made up of different combinations of amino acids. Based on their compositions, proteins have various sizes, shapes, functions, and applications in food. Commercial proteins are often extracted to improve their properties. Extraction methods can influence protein types recovered, properties, and yield. Processing can also influence protein functionality via denaturation, hydrolysis, modification, and cross-linking.

CHOICE PARAMETERS
There are many considerations when choosing the optimum plant protein ingredient, including:

- Protein content & quality
- Nutrition & claims
- Allergenicity, intolerance
- Consumer perception
- Source (geographic, commercial)
- Historical use
- Certifications
- Availability
- Safety
- Regulatory
- Functionality
- Familiarity with use
- Cost
- Aroma, flavor, texture, mouthfeel, color

Protein content in a concentrate is 40%-60% on a dry matter basis, compared to 80%+ for an isolate.
PLANT PROTEIN BENCHMARKING SUMMARY
The below table benchmarks widely available plant protein sources on protein concentration, protein digestibility-corrected amino acid score (PDCAAS), allergen risk, commercial stage, flavor, functionality, cost, and global crop volume. Major crops soy, pea, and wheat are followed by sources organized by protein type (legume/pulse/oilseed; vegetables/fruit/nut/cereal).

<table>
<thead>
<tr>
<th>Protein</th>
<th>Protein Concentration</th>
<th>PDCAAS</th>
<th>Allergen Risk</th>
<th>Commercial Stage</th>
<th>Flavor</th>
<th>Functionality</th>
<th>Cost (kg protein)</th>
<th>Global Crop Volume (MMT)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Excellent</strong></td>
<td>&gt;30%</td>
<td>&gt;0.8</td>
<td>Usually mild, low pop.</td>
<td>Commodity</td>
<td>Flavorless</td>
<td>Low conc. effect</td>
<td>&lt;$2</td>
<td>&gt;100</td>
</tr>
<tr>
<td><strong>Good</strong></td>
<td>20-30%</td>
<td>0.6-0.79</td>
<td>▼</td>
<td>Large</td>
<td>▼</td>
<td>▼</td>
<td>$2-4</td>
<td>10-99</td>
</tr>
<tr>
<td><strong>OK</strong></td>
<td>10-20%</td>
<td>0.40-0.59</td>
<td>▼</td>
<td>Small</td>
<td>Acceptable</td>
<td>▼</td>
<td>$5-9</td>
<td>1-9</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>5-10%</td>
<td>0.20-0.39</td>
<td>▼</td>
<td>Start-up</td>
<td>▼</td>
<td>▼</td>
<td>$10-19</td>
<td>0.1-0.9</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td>&lt;5%</td>
<td>&lt;0.20</td>
<td>Severe in sig. pop.</td>
<td>R&amp;D</td>
<td>Objectionable</td>
<td>Water insoluble</td>
<td>&gt;$20</td>
<td>&lt;0.1</td>
</tr>
</tbody>
</table>

POPULAR PLANT PROTEINS
Due to abundant supply, low price, and functionality, soy, wheat, and pea are the most common plant protein sources in top products in the U.S. market. Soy or a blend with soy is the protein base in 17 of the top 25 plant-based meat products by dollar sales.

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1. Note: For some plants, certain metrics are not available
2. This data is based on custom-GFI plant-based categories that were created by refining standard SPINS categories. Due to the custom nature of these categories, the presented data will not align with standard SPINS categories. Source: SPINSscan Natural and Specialty Gourmet (proprietary), SPINSscan Conventional Multi Outlet (powered by IRI), 52 weeks ending 12-29-2019
Of the top 25 plant-based meat products, dollar sales of the four pea-based products collectively grew at 339% over 2019, while sales of the twenty one other products grew less quickly, at 2%.

EMERGING PLANT PROTEINS

Emerging plant proteins require a competitive value proposition to bring about growth. To compete directly with wheat and soy, one major consideration is how well they texturize. In the below chart, we highlight the characteristics of several plant proteins with significant growth potential.

Additional emerging protein sources include:

- Bambara Bean
- Beach Pea
- Camelina
- Cashew Nut
- Chia
- Duckweed
- Dulse
- Flax
- Hemp
- Jackfruit
- Lima Beans
- Mesquite Bean
- Millet
- Mucuna Bean
- Pennycress
- Pigeon Pea
- Pongamia
- Potato Bean
- Pumpkin Seed
- Sesame
- Spirulina
- Watermelon Seed
- Wheat Grass
- Yam Bean
- Yeast
SYNERGISTIC COMBINATIONS
Blending two or more different plant proteins can help achieve specific product development goals, including:

- **Protein content & quality**
- **Consumer perception**
- **Cost**
- **Nutrition**
- **Availability**
- **Aroma, flavor, texture, mouthfeel, color**
- **Allergenicity & intolerance**
- **Functionality**

Common combinations include:

<table>
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<th>Combination</th>
<th>Description</th>
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<tbody>
<tr>
<td>Pea + Potato</td>
<td>Combines a texturized bulk protein with an emulsifying, heat gelling protein for burgers &amp; other comminuted PB meats.</td>
</tr>
<tr>
<td>Chickpea + Rice</td>
<td>Increases PDCAAS by combining a legume (deficient in Cysteine, Methionine &amp; Tyrosine) with a grain (deficient in Lysine).</td>
</tr>
<tr>
<td>Soy + Wheat</td>
<td>Optimizes a meat-like texture for muscle-structured plant-based meat &amp; fish via high moisture extrusion.</td>
</tr>
</tbody>
</table>

KEY TAKEAWAYS

- There are many potential commercial sources of plant protein—wheat and soy are leaders, with pea rapidly growing.
- There is a lack of systematic data to objectively compare functionality.
- Commercial proteins are complex mixtures, and viability often requires value from non-protein components (e.g. oil, starch).
- Properties depend on plant source and process, and formulations often benefit from protein synergies.
- Process influences purity, extracted fractions, and structural changes.
- Optimizing protein selection is dependent on many factors, including function, cost, and perception.

Manufacturing Toolkit
Download all the resources in the Manufacturing Toolkit to better understand opportunities in alternative protein, consumer insights, and strategies for developing plant-based meat, eggs, and dairy products.

Contact Us!
To request GFI’s services or learn more about our manufacturing resources, contact our corporate engagement team at corporate@gfi.org.