THE GOOD FOOD INSTITUTE

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.

Protein content in a **concentrate** is 40%-60% on a dry matter basis, compared to 80%+ for an **isolate**.

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

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).[1]

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

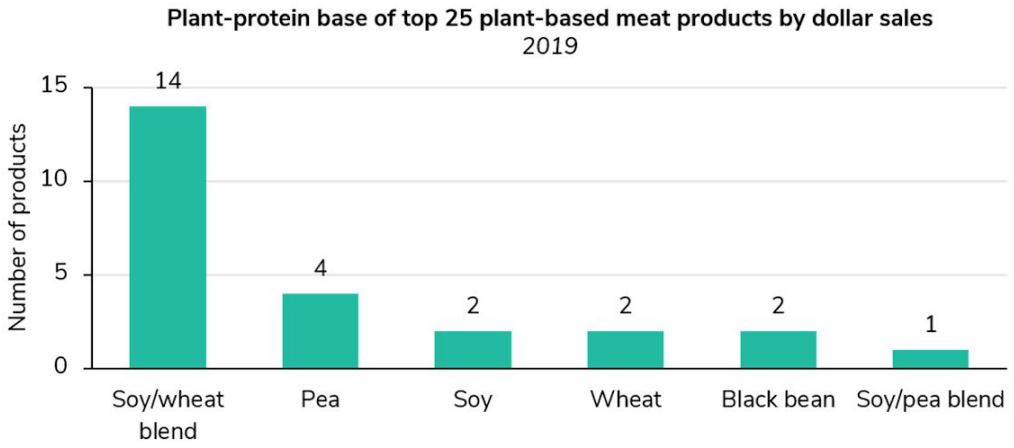
Protein	Protein Concentration	PDCAAS	Allergen Risk	Commercial Stage	Flavor	Functionality	Cost (/kg protein)	Global Crop Volume (MMT)
Soy								
Pea								
Wheat								
Canola								
Chickpea								
Fava Bean								
Lentil								
Lupin								
Mung Bean								
Navy Bean								
Peanut								
Sunflower								
Almond								
Corn								
Oat								
Potato								
Quinoa								
Rice								
Sorghum								

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.[2]

[1] Note: For some plants, certain metrics are not available

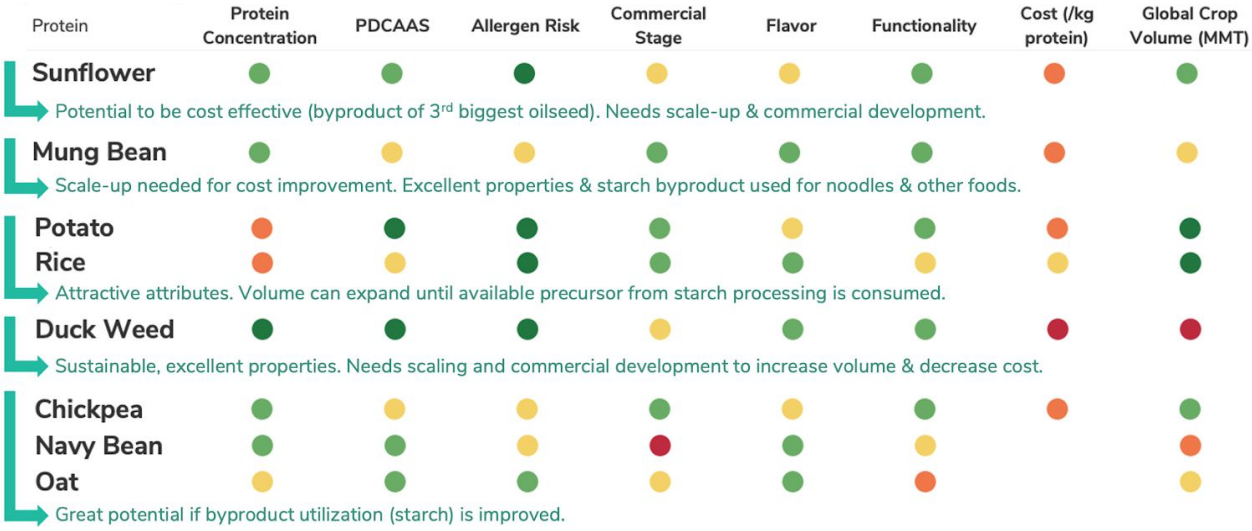
[2] This data is based on custom-GFI plant-based categories that were created by refining standard SPINS categories. Due to the custom nature of these categories, the presented data will not align with standard SPINS categories. Source: SPINSscan Natural and Specialty Gourmet (proprietary), SPINSscan 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	Duckweed	Lima Beans	Pigeon Pea	Spirulina
Beach Pea	Dulse	Mesquite Bean	Pongamia	Watermelon Seed
Camelina	Flax	Millet	Potato Bean	Wheat Grass
Cashew Nut	Hemp	Mucuna Bean	Pumpkin Seed	Yam Bean
Chia	Jackfruit	Pennycress	Sesame	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:

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

KEY TAKEAWAYS

- There are **many potential commercial sources of plant protein**—wheat and soy are leaders, with pea rapidly growing.
- 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**.
- There is a lack of systematic data to **objectively compare functionality**.
- 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.