Hemp Seed Protein

A Sustainable Plant-Based Meat Alternative Ingredient

PURHP-75™
organic hemp seed protein by AFS

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Market Facts

For most consumers, the importance of meat alternatives is not about eliminating animal products but rather diversifying their diet. Adopting a flexitarian lifestyle is made easier thanks to the accessibility of many new plant-based options. Impossible Foods, for instance, sells its plant-based line to over 20,000 grocery stores and 40,000 restaurants.[i] The company's 2021 sales are up 85% over the previous year attributing much of its success to consumer curiosity and convenience.

Consumer interest is at an all-time high when it comes to trying meat substitutes (i.e., plant-based proteins, meat analogues, alternative meats, meatless products, etc.). IRI (Information Resources, Inc.) reports that 58% of consumers want to increase plant-based food intake. A recent YouGov survey states that 40% of consumers aged 18–44 eat meat substitutes at least once per month.[ii] The market reflects this trend. Last year grocery sales of plant-based foods that directly replace animal products grew by 27% over the previous year, reaching more than $7B.[iii] Experts anticipate this trend will continue over the next twenty years, with the global market for plant-based foods growing to $450B. As impressive as that sounds, that figure will still only represent a quarter of the $1.8T meat market.[iv]

Make no mistake: taste is king in the food industry, and alternative meat products will only earn consumer retention through successful advances in flavor, texture, and quality of their plant-based ingredients. In short, plant-based analogues must strive to have a mouthfeel and flavor profile that matches the animal products consumers are accustomed to eating. Each year the bar is set higher as ingredient technology rapidly advances to develop new value chains that increase consumer acceptance while focusing on scalability, food safety, and costs. One emerging ingredient in the space is hemp seed protein.

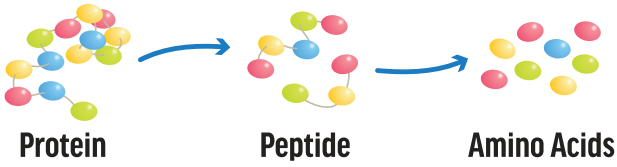
To help inspire innovation in vegan, plant-based meats, Texas-based Applied Food Sciences (AFS) recently launched PurHP-75™, an organic, high-purity hemp seed protein from hemp hearts. PurHP-75™ has excellent binding and gelling properties. As a result, alternative meat manufacturers can get more authentic meat textures with fibrous consistency, desired juiciness, and ideal firmness. Consumers will benefit from the ingredient's concentrated 75% protein, complete with all nine essential amino acids, the near-white color and deliciously light flavor set PurHP-75™ apart from other plant-based ingredients.

Dietary Nutrition of Protein

Why is protein so important? In human nutrition, protein serves as an essential macronutrient.[v] When we consume food, proteolytic enzymes in the gastrointestinal tract hydrolyze the tiny peptides, which are then absorbed by the body. As a result, food scientists primarily define protein quality by two core attributes:

- Amino acid composition
- Digestibility (PDCAAS score)

Amino acids are the building blocks of proteins, but they also play important roles in metabolic pathways, hormone production, signaling molecules, and neurotransmitter production.[vi]



Protein digestibility refers to the bioavailability of a particular source of dietary protein, predicting how many amino acids the body can absorb. The amino acid scoring approach is the preferred index used by FAO/WHO for protein value in human diets.[vii] The most widely used assay is the protein-digestibility-corrected amino-acid score (PDCAAS). Plant proteins are gaining considerable interest over animal proteins for many reasons. Even though animal products are a valuable source of dietary protein, they have complicated ethical and environmental concerns for sustainability, such as animal treatment, consumption of agricultural resources, and increased greenhouse gas emissions during production. While there may not be a perfect solution, recent studies have focused on replacing animal proteins in a diet while still meeting nutritional needs. As a result, there has been a global trend toward substituting animal proteins for plant-based sources.[v-vi]

How Plant Proteins Work in Meat Analogues

Plant-based proteins have a variety of functions in food formulations. For instance, their water and fat binding properties can influence gelling, thickening, and foaming. These functional attributes play a critical role in the emulsion and stabilization of the end formulation. Additionally, many plant proteins offer biological properties, such as antibacterial and antioxidant activity.[viii]

The use of plant-based ingredients in meat substitutes is not a recent development. Historical use of soy protein in tofu and tempeh date back to Southeast Asia circa 965CE.[xi]

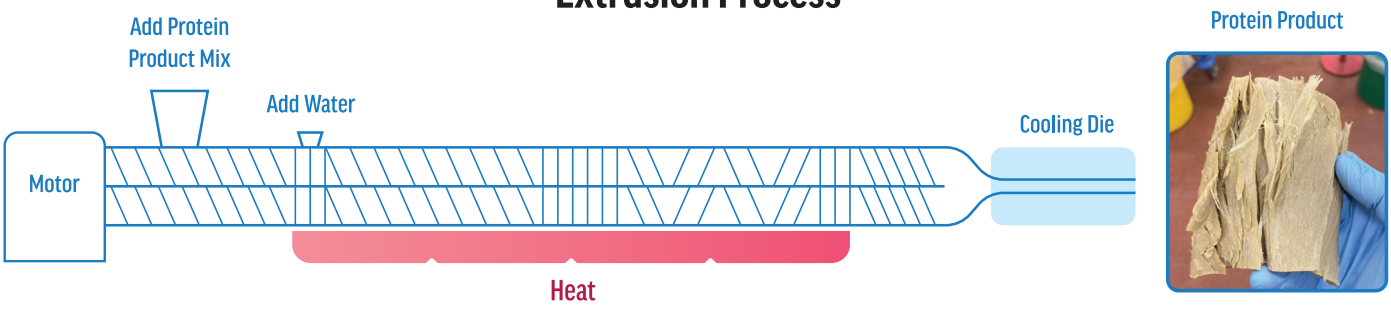
Newer innovations started to rise in the 1960s as textured vegetable proteins emerged along with the launch of Quorn alternative meat products. Since then, formulators have constantly been tuning their processing conditions to mimic animal meat texture and bite more accurately.

Table 1 [xiv]

Main Ingredients For Plant-Based Meat Analogues

Ingredient	Sources	Main Role
Non animal proteins 20 - 50%	Plant-based: Soy, pea, hemp, rice, lupin, legumes, and potato. Novel sources: Microalgae and seaweed.	Nutritional value, structure, color, and texture
Lipids 0 – 5%	Saturated and unsaturated fatty acids: Coconut oil, cocoa butter, sunflower oil, canola oil, sesame oil, and avocado oil. Fat replacers: Oleo gels and fibers.	Flavor, texture, and mouthfeel
Polysaccharide 20 - 30%	Native starches, flours, and fibers.	Consistency and water binding.
Flavoring Ingredients	Savory yeast extracts, paprika, sugar, spices, and herbs.	Flavor
Coloring Agents	Lycopene, beet juice extract or leghemoglobin.	Meat Color
Fortification Ingredients	Tocopherols, zinc gluconate, thiamine hydrochloride, sodium ascorbate, etc.	Nutritional Value

Extrusion Process



Protein Structure Process

Although numerous technological advancements have been made in manufacturing meat analogues (e.g., spinning or/and shear cell techniques), extrusion remains the most extensively used method for plant-based materials. Extrusion is a process that utilizes high heat and pressure to texturize vegetable protein with water into a product with a fibrous consistency like animal meat. The methods of extrusion have three steps:

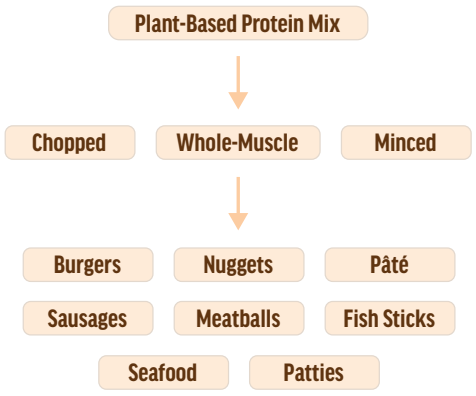
- Mixing proteins and water in a twin-screw extruder.
- Cooking in a chamber at high temperature and pressure.
- Cooling in a cooling matrix.

Numerous parameters can affect the extrusion process and the final product texture, including water content, screw speed, processing temperature, matrix geometry, polysaccharide content, and the raw material type.[x-xii]

Two types of extrusion yield different products. Extrusion with low moisture content (water content up to approximately 30%) is generally used to manufacture textured vegetable protein (TVP)– think ground sausage, burgers, meatballs, and nuggets. The final product has a porous, spongy structure, a high water binding capacity, and low water and fat content. It is necessary to hydrate TVP products made via low-moisture extrusion before additional processing.

The second form of extrusion is high-moisture extrusion (with a moisture content greater than 40%). This process creates meat analogues with a fibrous structure similar to that of whole muscle or restructured meat products.[xi-xiii] Examples of whole muscle meats include chicken breast, steaks, or pork loin, where the consistency is typically denser, chewier, and stringier. Restructured products might comprise lunch meats, fish patties, ham loaf, and many other pressed and shaped meats to ease consumer preparation. As shown in Table 1, plant proteins account for 20–50%, lipids 0–5%, and polysaccharides 2–30% of the overall composition of fibrous meat substitutes.[xiv] Burgers, sausages, and patties are the most popular meat analog products.

Market Products



Hemp seed protein as a sustainable plant-based ingredient.

Hemp seeds are a nutritional powerhouse full of proteins, amino acids, fatty acids, vitamins, and mineral content. Hemp seeds contain more protein wt/wt than almonds, chia, or flax seeds, and are mostly made up of Edestin and Albumin, two forms of easily digestible globular proteins. The fats in hemp seeds are almost entirely polyunsaturated fatty acids (PUFAs) that the human body can't make and are therefore essential in the diet. Minerals can be difficult to obtain in a plant-based diet yet, hemp seeds contain vitamins E, B1 and B6, iron, magnesium, zinc, and potassium.

Hemp seed protein has an elaborate amino acid composition with high quantities of aspartic acid, glutamic acid, and arginine (Arg), with lysine (Lys) serving as the first-limiting amino acid. Hemp protein has an Arg/Lys ratio ranging from 4.7 to 6.1, substantially greater than several well-known protein sources (e.g., soy protein and casein).

Amino Acid	Hemp Seed		FAO/WHO minimum requirements		
	Whole Hemp Seed	Dehulled Hemp Seed	Infants	Children	Adults
Threonine	4.8	3.7	3.1	2.5	2.3
Lysine	4.0	3.7	5.7	4.8	4.5
Leucine	7.0	6.2	6.6	6.1	5.9
Isoleucine	3.8	3.8	3.2	3.0	3.0
Histidine	2.6	2.8	2.0	1.6	1.5
Valine	5.4	5.2	4.3	4.0	3.9
Tryptophan	1.1	1.1	0.9	0.7	0.6
Sulfur Containing Amino Acids (Met and Cys)	4.6	4.6	2.7	2.3	2.2
Aromatic Amino Acids (Phe and Tyr)	8.0	7.9	5.2	4.1	3.8

Table 2. Amino acid composition (%, wt/wt) of hemp seed compared to FAO/WHO requirements.[xiv]

The essential amino acids (EAA) found in hemp are nutritionally sufficient to meet the requirements for adults and adolescents recommended by the Food and Agriculture Organization (FAO)/World Health Organization (WHO) in the PDCAAS score. Removing the hulls (shell) prior to protein extraction has been shown to improve protein digestibility by removing non-digestible fibers.[xiv-xvi]

Sensory attributes have been the main impediment to hemp seed's adoption in the market thus far. Like many other botanicals, hemp seed is traditionally known for its green coloration and pungent flavor. However, unlike pea or other plant proteins, which commonly use isolates to mitigate these sensory challenges, hemp seed has a built-in solution: Remove the outer shell. The shell (or hull) contains most of the tannins and chlorophyll, which contribute to the to green color, pungent odor, and bitter notes. Dehulling reveals the hemp heart, the delicious, white inner core of the hemp seed, and delivers a positive sensory experience for the finished product formulation. Sufficient dehulling results in better flavor and can enable the use of hemp protein concentrates instead of isolates, adding more appeal to being "plant-based" by preserving more of the naturally occurring nutrients.

Use of PurHP-75™ as an Ingredient for Meat Analogue Applications

Applied Food Sciences (AFS) recently launched its branded PurHP-75™ organic hemp seed protein to deliver an attractive option in the growing market for plant-based proteins. The quality of protein in PurHP-75™ is considerably higher in purity than other hemp ingredients due to the latest advancements in dehulling and color sorting technology. The result is a near-white fluffy powder with a deliciously creamy texture, zero odor, and a neutral taste profile. Additionally, the excellent binding and gelling properties of PurHP-75™ help alternative meat manufacturers get more authentic meat textures with fibrous consistency, desired juiciness, and ideal firmness. The ingredient's concentrated 75% protein, complete with all nine essential amino acids, is the ideal addition for food manufacturers to consider for plant-based product innovation.

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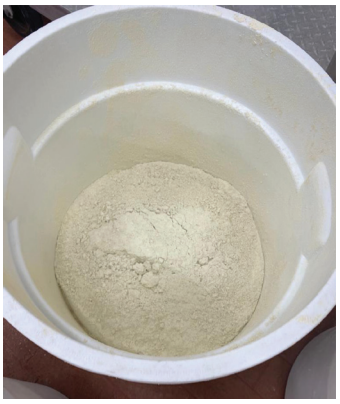
"We wanted to bring a plant-based protein to market that is food-driven, so taste was paramount," explains Brian Happel, Director of Nutrition for Applied Food Sciences. "For hemp seed protein, this means removing the outer shell and ample color sorting to present a clean ingredient that is white instead of green and is void of bitter flavor typically associated with hemp protein."

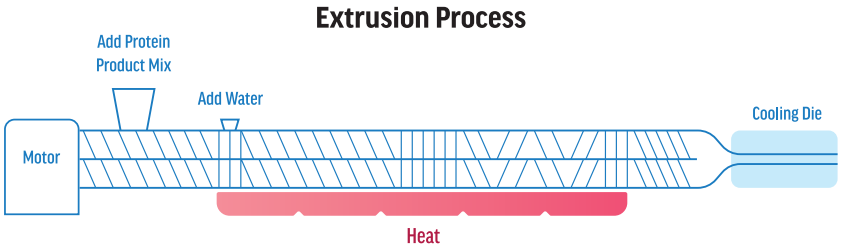
"It is important to remember that the end product's texture goes hand in hand with flavor for meat alternatives," Happel continues. "And what's unique about our organic hemp seed protein is its exceptional emulsification and gelling properties, which results in a juicier, more authentic bite and mouthfeel."

Research on the utilization of PurHP-75™ in producing meat analogues found that it worked exceptionally well with other proteins. Blends of PurHP-75™ and a pea protein isolate were extruded at five levels of barrel temperature (60, 80, 100, 110, and 125°C), screw speed of 394 rpm, and feed moisture content of 40-50% using a twin-screw extruder (TX-57, Wenger). The figure below shows the meat-like texture obtained from the protein product mixture after the extrusion process.

The addition of PurHP-75™ led to improvements in the dietary fiber content compared to the control while not impacting the sensory attributes of the final product. The finished product achieved desirable meat-like texture, taste, and consistency. The results showed that hemp seed protein could be a promising new sustainable plant-based protein to develop more nutritious high moisture meat analogues at different ratios, barrel temperatures, and feed moisture contents.

Extrusion Sample Product Mix With PurHP-75™

Protein Product Mix	Before Extrusion	After Extrusion	Protein Texture
75% Hemp Protein Extract (PurHP-75™)			
4% Canola Oil			
2% Salt			
19% Pea Protein Isolate			



Extruder Process Parameters	
Dry Recipe Feed Rate	32 kg/h
Preconditioner Shaft Speed	394 rpm
Water Addition Rate	40 - 45%

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Think our premium ingredients are a right fit for your next formulation? Submit an inquiry to chat with our team. We are here to answer your questions.

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