THE PULSE OF PROTEIN SOLUTIONS

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The word "pulse" is a general reference to the dried seed of plants from the legume family like yellow peas, green peas, chickpeas, lupin, kidney beans, fava beans, fenugreek, mung bean and lentils. Pulses are often chosen for their healthy properties and ecological benefits. Pulses offer great nutritional inputs to the human diet and are devoid of the eight common allergens. Pulses are naturally high in protein and allow simple separation processing into the main fractions for protein concentration or isolation while maintaining good sensory properties.

It can be anticipated that future farming of plant protein ingredients will be more diversified with pulses and beans. Pulse protein ingredients not only have great eco-credentials but also possess qualities like nutrient dense, non-GMO, as well as gluten-free and low allergenicity responses. Today's pulse crops deliver functional properties that happen to be of premium quality, "green, clean and natural", as well as high in quality protein.

• Pulses are known for a low carbon footprint and their roots carry Rhizobium bacteria able to capture nitrogen gas in the air and convert it into nitrogen that is subsequently used by plants.

• Pulses are a legume plant that naturally makes and returns nitrogen as fertilizer back into the soil. These unique properties greatly reduce the need for expensive nitrogen fertilizers, which are universally known as major contributors to greenhouse gas emissions.

Global demand for protein is booming, partly due to rising incomes in emerging markets and -of course- because of the rapidly increasing world population reaching some 10 billion by 2050. Higher income also translates to consumers' demand for improved organoleptic and nutritive quality, while shifting the diet preferences to include more protein. Especially pea protein has become a formidable competitor to soy protein ingredients. Pulse derived protein ingredients have a favorable consumer status, and do not suffer from negative soy protein image that never seems to be far away in the mind of consumers.

The Pulse of Pea

The little pea pulse is rich in high-quality protein and has low allergen responses. Seen as a highly sustainable crop, peas are net-positive for the environment: they put more into the soil than they take out. The pea protein penetration is more than double in the US plant protein market as compared to the rest of the world.

As the world is shifting and accelerating the use of plant ingredients in food products, plant protein is no longer a trend but a key market driver. Consumers in the Western world are becoming more comfortable with plant-based proteins as part of their daily dietary food intake. The surge of processed foods carrying a clean label and less overload of sugary or starchy fillers has translated to increased demand for alternative protein sources. In 2020 and 2021, the demand for alternative plant proteins like rice, oat, canola, potato, fava, chickpea, and mung bean often outstripped availability. In 2021, yellow pea availability in the US and Canada were hit by an exceptionally severe drought that subsequently reduced its harvest by 45 percent and made the pea protein isolate prices significantly more expensive.

Drawing more protein from plants has become a priority for specialty ingredient companies such as Dreyfus, Cargill, Puris, ADM, AGT, Roquette, InnovoPro, Ingredion, and Cosucra. In November 2021, Roquette opened the world's largest hydroelectric powered pea protein facility in Portage la Prairie, Manitoba, Canada and one in Vic-sur-Aisne, France. These two pea protein facilities have a total capacity to process 250,000 metric tons of yellow peas per year: the equivalent of about 40,000 metric ton of pea protein isolate. Merit Functional Foods -with financial backing of Bunge- has also started pea protein isolate production in Manitoba, Canada. ADM has moved into the expanding pea protein market when their North Dakota plant opened in 2019. ADM's pea proteins have a minimum protein content of 80 percent. The side stream products of pea starch and fiber will be secondary ingredients in their portfolio and probably directed towards the animal nutrition market. To service the European market, Cargill sources its peas from Canada, while the protein processing is done in the Shandong province of China.

The Louis Dreyfus Company will become a major competitor to the likes of Puris, Ingredion, Cosucra and Roquette, when they enter the pea protein business once the production facility in Yorkton, Saskatchewan (Canada) is completed by the end of 2025.

Pea flour and pea starch is increasingly used as a functional component in extruded products as a component to simulate meat appearance, texture and fibrosity. These ingredients are also used in batter and breading for coated foods, bakery goods and animal nutrition. Pea starch also find its way as an alternative for tapioca and rice flour. The increase in plant protein-formulated foods is supported by changes in consumer preferences, including demand for gluten-free and clean label nutrition, as well as sustainability and farm-to-fork traceability.

Although the sales of pea protein isolate are trending and becoming a formidable competitor to soy protein, the sales of its by-products like pea fiber and pea starch do not see a similar growth curve. This imbalance is causing some friction in the optimization of return-on-investment calculations and projected profitability for the pea protein category.

The Inside of Pea Protein

Like all proteins of leguminous plants, pea protein also consists of three classes of protein:

- Globulins
- Albumins
- Insoluble protein

The soluble fraction of pea protein is about 85 percent of the total protein, of which the globulins are the main storage proteins of the plant. The albumins consist of molecules that mainly have a functional role in the seed. The balance of 15 percent consists of insoluble proteins. The salt soluble globulin proteins represent between 65 to 80 percent of the total analytical pea protein. The pea protein albumins have a low molecular mass that is soluble in water and rich sulfur-containing

amino acids. Their amino acid composition is more balanced than the globulin protein fraction, thus have a better nutritional status. The pea protein is rich in lysine and tryptophan with naturally occurring high levels of iron.

Much like functional soy protein ingredients, pea protein concentrate and pea protein isolate have an ability to bind water and fat, whereby these proteins show properties like dispersing, solubility, foaming, emulsification, and gelling. Of course, these protein properties depend on processing conditions, including specific designer enzymes triggering protein modulation, temperature, and pH, and drying method.

From Pulse to Powder

In very basic terms, pea protein isolate is made from yellow peas mixed with water and spun at high speed through stainless steel centrifuges, separating the protein from starch and fiber. An example of a method for manufacturing pea protein consists of the following sequences:

• Preparing the pea flour by grinding dry peas that were previously cleaned, sorted, blanched, and dusted.
• Suspending the pea flour in water.
• Cleaning the suspension to isolate the protein fraction.
• Isolating the pea protein component by thermal flocculation at the isoelectric pH and a temperature between 40C and 70C for 5 to 30 minutes.
• Enzymatic treatment of the isolated protein solution to manipulate or modify the organoleptic and/or performance properties of the ingredient.

• Centrifuging the precipitated mixture using a decanter (i.e., Sharples) or plate separator to maximize the yield recovery of the precipitated proteins.

Both wet processing by alkaline extraction, with possible use of sodium hydroxide –NaOH, as well as acid precipitation, plate-frame ultrafiltration, and dry processing of pea protein concentrate by means of fractioning are conventionally used. Especially dry fractioning is a cost-efficient method suitable for the creation of pea protein flour (50 percent) and even pea protein concentrate (65 percent). It is also important to note that the choice of an acidic, alkaline, or neutral extraction and the enzymatic hydrolysis treatment process will directly influence the pea protein properties like foaming and emulsification or extrusion properties, like high moisture extrusion for meat analogs or high protein granules for nutri-bars.

Protein Purification

Pea protein manufacturers source their raw material from non-GMO yellow pea grown in North America, West Europe, and China. The extraction is mainly a solvent-free method based on an enzymatically oriented fermentation process resulting in a high-purity protein produced with no chemicals. Subsequently, the remaining protein contains few anti-nutritional factors like lectins, tannins, lipoxygenases, and protease inhibitors. The yellow pea contains less trypsin inhibitors than soy. The presence of phytic acid is routinely removed when manufacturing pea protein isolate.

Modern protein extraction and isolation allows solvent-free and hexane-free processing, thus maintains the much-preferred natural status. The demand for natural pulse-derived protein ingredients is especially growing in North America, Australia, New Zealand, and the UK.

Pea protein ingredients are available at varying gel strengths for several food applications. For meat applications, pea protein isolate can replace soy isolate on a weight-for-weight basis with little adjustments needed. The main restriction with the use of pea protein is their taste difference, depending on the botanical origin, as well as possible inadequate processing methods to clean up persistent odor and sensory notes.

Chickpea Protein

These types of proteins are soluble and typically minimally processed, while its mild nutty flavor has properties suitable for both savory and sweet product applications. Hence the use of chickpea protein ingredients allows the removal of some unwanted "chemically sounding" additives, which is a bonus for clean label formulations. Chickpea protein has above average emulsifying properties, though can be considered as a poor water binder. These functional characteristics should not be confused with foaming, gelation and adhesiveness. Both fava protein and chickpea protein ingredients date back to the 13th Century and now have come back full circle now that plant-based foods like plant meat have made a resurgence in the last few years.

Wide Range of Usage

The relative world shortage of pea protein started in 2013 and surfaced again in 2021, was followed by an overabundance of supply in 2023 and 2024. This has caused pea protein manufacturers to emphasize its use on more applications including low-revenue generating formulated meat products and renewed focus on premium value applications like high moisture extrusion for plant meat products.

There are still slight barriers to pea protein due to its inherent flavor profile. For flavor-sensitive applications like plant milk, plant yogurt, plant cheese, and protein smoothies, the use of plant proteins is still somewhat restricted due to flavor limitations, though there is R&D progress now that innovative enzymes have become available for pea protein processing.

Pea protein is an ideal plant source to combine with other plant-origin ingredients, such as wheat and rice proteins. These protein combinations work together in great harmony as is proven by the many plant meat products using these combinations in extruded forms. These combined proteins provide superior and easily digestible nutrition at attractive price points.

Textured Pulse Ingredients

Extruded pulse protein meat-fiber analogs with a protein content ranging from 55 to 75 percent (by weight on dry matter) are now available. Textured fava bean, chickpea and mung bean protein are also now finding its way into the plant-based and hybrid-meat formulated products.

Extruded intermediate plant proteins and structured ingredients containing pulse protein, both available in semi-moist or dehydrated forms, are increasingly used as alternatives for soy and have demonstrated unique properties that mimic the fibrosity of meat. For example, FoodFlow's TuraPea (Philippines) has become a dominant force in manufacturing a fibrous-textured pulse protein ingredients, specifically developed to simulate chicken- and fish-like texture, bite, and juiciness. In a straight comparison between extruded soy protein and extruded pulse protein, there is a tendency that pulse protein extrudates typically have an often-preferred softer texture and improved chew characteristics. These variables need to be considered when optimizing the textural and fibrosity characteristics in plant protein formulated burgers, -chicken patties, and -fish fingers.

The Pea Roots

Peas are not only sustainable but also regenerative related to soil health. The yellow pea (Pisum sativum) is a cool season crop that can be grown in many soil types. Compared to soy or corn, the yellow pea tolerates much colder weather conditions and can be harvested before the heat of the summer sets in. The yellow pea is universally considered a "defensive" crop when used in rotation with soy or corn. This is especially true for non-irrigated land with less than 50cm annual precipitation, which indicates that the water use efficiency and tolerance of the yellow pea is a major harvest benefit. There is also anecdotal belief that corn crop yield is much higher for up to two years when followed by the yellow pea harvest cycle.