A Finger on the Pulse of the Pea Protein Market

Although the sale of pea protein isolate is trending and has become a formidable competitor to soy protein, the sales of its by-products does not see a similar growth curve.

by Henk Hoogenkamp

Drawing more protein from plants is an activity that has become a priority for specialty ingredient companies such as Cargill, ADM, DowDuPont, Roquette and Cosucra. Global pea protein isolate sales are expected to quadruple by 2025. A huge part of this sales increase is due to its use in plant-based meat products.

ADM will be moving into the fast growing pea protein market when their North Dakota plant opens up in 2019. ADM's pea proteins will have a minimum protein content of 80 percent, while pea starch and fiber will be secondary ingredients in their portfolio, probably directed towards the animal nutrition market.

The global demand for plant-based protein in formulated foods is growing significantly and forecasted to increase by 8-10 percent per year. The rapid increase in plant protein ingredients is supported by changes in consumer preferences, including demand for healthier allergen-free and clean label nutrition, as well as sustainability and farm-to-fork traceability. Although the sale of pea protein isolate is trending and has become a formidable competitor to soy protein, the sales of its byproducts – pea fiber and pea starch – does not see a similar growth curve. This imbalance is causing some friction in the optimization on return-on-investment calculations and projected profitability for the pea protein category as a whole.

The Pea Roots

The yellow pea (*Pisum sativum*) is a cool season crop that can be grown in many soil types. Compared to soy or corn, it tolerates much colder weather conditions and can be harvested before the heat of the summer sets in. The yellow pea is universally considered to be 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 of the yellow pea is much greater. 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. It is also true that, when calculated in isolation, the yellow pea will not yield as well or as profitable as other main crops such as wheat, barley or canola. In India and China, the yellow pea is often grown in rotation with rice.

Ahead of the Curve

Pea protein offers excellent water-lipid linkage properties. Unlike soy protein, the yellow pea grown in Northern Europe and North America is neither genetically modified nor is it on the list of major allergens requiring label warnings. Pea protein isolate has an amino acid profile close to that recommended by the Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO). This is because of its high levels of branched amino acids, glutamic acid and arginine, as well as its richness in lysine. The little yellow round pea is highly digestible because of the elimination of anti-nutritional factors during its manufacturing process. Hence, pea protein isolate and textured products are an environmentally-friendly source of food protein, which is ideally suitable for sustainable or "green" food production.

Flour Power

At the lower end of the pulse spectrum is pulse flour, which typically contains protein ranging between 15-25 percent. These pulse flours are mainly used in food products like pastries, snacks, cereals, coatings, crackers, sauces and (gluten-free) cookies, while maintaining a more nutritious and natural profile. Higher in the hierarchy, there are pulse protein concentrates (65-70 percent) and pulse protein isolates (80 percent+) which are mainly used for protein enrichment, though also serve as organoleptic improvements like crispiness and color diversification. Pulse protein is free from the nine major allergens.

Pea protein is a popular choice due to the non-GMO status, as well as the hypoallergenicity and natural hexane-free processing. Pea protein ingredients offer a range of sustain-

› The Mocving Mountains burger is made from 100 percent plant-based ingredients, including pea protein.

▼ A Pea Protein Manufacturing Process

A method for manufacturing pea protein consists of the following sequences:

- Preparing the pea flour by grinding dry peas (previously cleaned, sorted, blanched and dusted);
- Suspending the pea flour in water;
- Fractioning the suspension to isolate the protein fraction;
- Isolating the pea protein component by thermal flocculation at the isoelectric pH and a temperature between 40°C and 70°C for 5-30 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.▼

ing advantages, including no nitrogen fertilizers, ideal rotation crops, less irrigation and uniquely allow natural water extraction protein isolation processes.

Meeting the Demand

It is estimated that the total world market for novel plant protein ingredients (pea, rice, potato and oat) will reach approximately 240,000MT in 2018. Pea protein processing is quickly growing with new facilities prepared for significant capacity increase in France, Belgium and especially Canada, with China ready to join the club at any given moment.

Of all the novel protein ingredients introduced since 1990, only pea protein and rice protein (38,000MT/year) can be currently considered a successful business model for the mainstream market. Potato protein production is estimated to be around 8,000MT per year. However, the manufacturing of both rice protein and potato protein ingredients will continue to increase in the next few years.

Pea protein is particularly used in premium-formulated foods that target affluent consumers who are pro-actively looking for "natural and clean label" products. These foods include (dry blended) beverages, cereals, nutri-bars, meat-free products and bakery products.

The sudden rise in demand by both specialty and multi-national food companies has taken the pulse agri-growers and pea protein manufacturers off guard: AGT Food (Canada), Roquette (France), Cosucra (Belgium) and Emsland (Germany) have all added pea protein manufacturing capacity. But pea protein growth doesn't stop here. Global powerhouses such as Cargill – including its partnership with Puris breeding pea crops for higher protein content – ADM, Verdient Foods (Saskatchewan, Canada), Anchor Ingredients and Canadian Protein Innovation are boosting pea protein capacity too. Soy powerhouse DowDuPont has also gotten into the act and now introduced Trupro 200, a pea protein concentrate.

Mothballed Soy Facilities

A number of soy processing facilities have been transformed to produce protein concentrates and protein isolates from pea and other high-protein ingredients from pulses. Ingredion has entered a joint venture agreement with Verdient Foods to make pulse-based protein concentrates and flours from lentils and fava beans for food applications.

Non-soy plant proteins are rapidly growing and extending beyond North America. The global market for non-soy gluten-free plant-based proteins is projected to be worth US$1.5 billion by 2022. Most likely, one or two mothballed soy protein facilities in China will be redesigned and commissioned to further increase the availability of pea protein isolate. For now, Yantai Shuangta and Jianyuan are the leading pea protein manufacturers in China.

Canada will likely emerge as the premier base for pea protein manufacturing. To capitalize on the growing demand for plant-based food ingredients for human nutrition, additional manufacturing facilities are required. For pea protein isolate, Canada will claim the number one spot by 2020, accounting for around 30 percent of the total global production. Canada is the world's powerhouse of the yellow pea production totaling some 1.5 million hectares, compared to 0.6 million hectares for the US, 3.1 million hectares (2018) globally. In comparison, the US state of Montana has become the largest producer of crops like peas, lentils and chickpeas. The hectares of pulse crops harvested there has tripled (2010-2018), making it the largest crop. Both China and India cannot meet their domestic demand, hence, they need to rely on imports from the US and Canada.

Despite all the positive agricultural benefits of the yellow pea crop, there are a few negatives that occasionally do come into play. Compared to soy and corn, the yellow pea is more difficult and time-consuming when harvesting. The pea plants often die within 24-48 hours during heavy rainfall, when waterlogged conditions are created. Saline soils should be avoided, and seed rot in the field can occur due to fusarium fungicide (fungus), mildew, and insect (grasshopper) infestation.

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 drums, sep-

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arating the protein from starch and fiber. While the market, when compared to the soy protein industry remains relatively small, pea protein has become America's poster child as a plant-based favorite and gluten-free ingredient for the health conscious consumer. The once lowly yellow pea from the middle classes in China has become the moneymaking ingredient for companies in search of higher profit margins, compared to the bigger commodity crops such as corn, wheat and soybeans.

For food formulators, the term "high protein content" typically identifies ingredients with a protein content ranging from 60-95 percent by dry weight. Examples are soy protein concentrate and soy protein isolate.

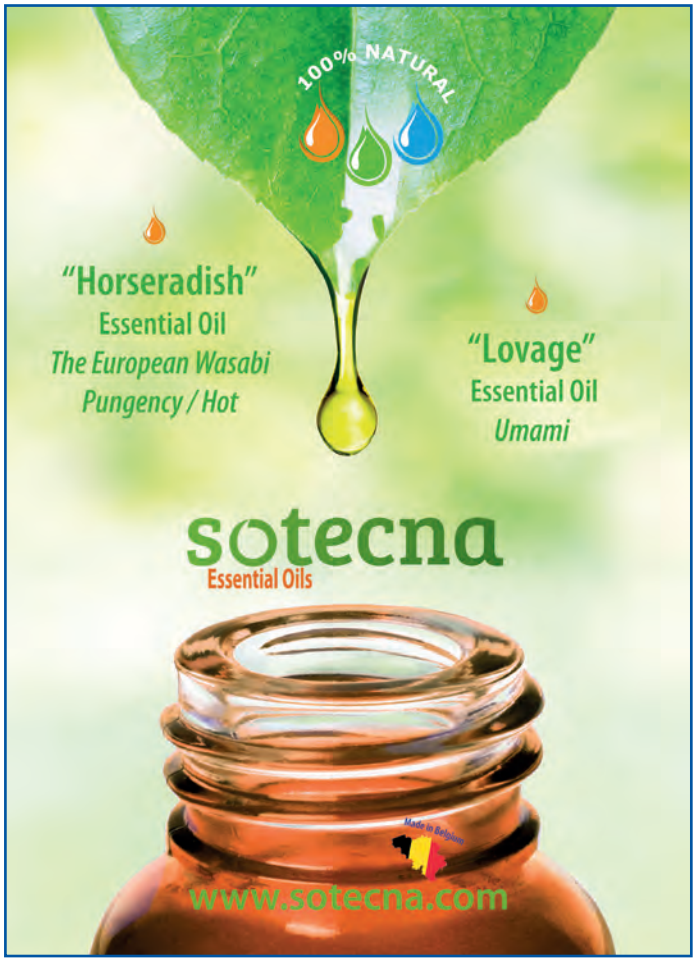
Like all proteins of leguminous plants, pea protein also consists of three classes of protein:

- 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 – 15 percent – consists of insoluble proteins.

The salt soluble globulin proteins represent between 65-80 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 they have a better nutritional status. The pea protein is rich in lysine and tryptophan and, in addition, has naturally-occurring high levels of iron.

Much like functional soy protein ingredients, pea protein concentrate and isolate has an ability to not only to bind water and fat, but also to assist or create properties such as dispersing, solubility, foaming, emulsification and gelling. Of course, these protein properties are dependent on processing treatment – including the influence of specific enzymes – temperature and pH. These parameters can be manipulated or modified to achieve the most ideal protein characteristics for the given application (see box on page 46).



Both wet processing by alkaline extraction (including the use of sodium hydroxide –NaOH) and 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 concentrate.

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 or emulsification or extrusion properties, including high moisture extrusion for meat analogs.

Protein Purification

Pea protein manufacturers source their raw material from non-GMO yellow pea grown in North America and West Europe. The extraction is mainly a solvent-free method. This is 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 trypsine inhibitors than soy. The presence of phytic acid is routinely removed when manufacturing pea protein isolate.

Modern protein extraction and isolation allow solvent-free and hexane-free processing while maintaining an all-natural status. The demand is especially growing in North America and the UK. Pea protein concentrate or isolate is 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 to no performance or organoleptic differences. The main restriction with the use of pea and lupine protein is their taste difference, depending on the botanical origin, as well as the inadequate processing methods to clean up persistent odor and sensory notes. There are still slight barriers to pea protein due to its inherent flavor profile. For flavor-sensitive applications like plant milk products, yogurt, cheese-analog, formulated beverages and protein shakes, the use of plant proteins is still somewhat restricted due to flavor and odor limitations.

Premium Opportunities

Ever since the relative world shortage of pea protein started in 2013, pea protein manufacturers have started to de-emphasize its use in formulated meat products. They are focusing instead on premium value applications like high moisture extrusion for vegetarian foods, powdered or ready-to-drink and sports nutrition.

Pea protein is ideal when combined with other plant origin ingredients, such as wheat and rice proteins, although a blend using whey protein, egg protein and soluble rice protein is a better solution to improve nutrition profiles.

Another interesting development is the combination of pea protein and rice protein, which is fermented using shiitake mushrooms. These emerging proteins –made by Myco-Technologies (US) can serve as an ingredient to reduce bitterness in coffee and chocolate, as well as improve emulsification in formulated meat products. These combined proteins provide superior and easily digestible nutrition at attractive price points.

Textured Pea Ingredients

The pea pulse not only delivers high-quality protein, but also gives functional dietary fiber and starch for clean label and wholesome food products. Taste and texture are the attributes with which to convince consumers that they can find appetizing plant meat solutions and this trend in plant-based foods is not slowing down any time soon.

Extruded intermediate plant proteins and structured ingredients containing pea protein, both available in semi-moist or dehydrated forms, are increasingly used as alternatives to soy and have demonstrated properties that mimic meat. For example, Roquette's Nutralys T70S (France) and FoodFlow's TuraPea (Philippines) are fibrous textured pea protein ingredients, specifically developed to simulate meat-like texture, including in the best-selling Moving Mountains Burger 12 in the UK.▼

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