Pea protein isolate as key ingredient facilitates innovation in meat and milk substitutes with profound value chain implications

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Abstract: Traditionally, peas were a food in Europe with high nutritional value for humans. Despite this, they have appeared in markets mainly as an animal feed and were gradually replaced by soya due to its higher protein content and continuous availability. Nevertheless, the increased demand and the use of regional (food) products has led to a rise in home-grown pea production recently. Although peas are still predominantly used for feed, the current development towards a less animal-protein based nutrition enhances the revival of peas in human nutrition. Peas are processed to provide protein isolate used in convenience foods. Peas have become a quality-determining ingredient and sometimes they are used in considerable quantities. This trend could be an important lever for the increased cultivation of legumes. The aim of this study was to give an overview of perspectives on the use of legume grains - especially of peas - in food products for human consumption, and to demonstrate how product development helps drive increased cultivation of grain legumes.

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Introduction

Over the last 20-30 years, home- or European-grown peas were nearly replaced entirely by soybeans, often as genetically modified organism (GMO), as a feedstuff due to its higher and consistent protein content, protein qualities, and continuous availability (1). The new trend demanding GMO-free foods and feeds, and regional trends have promoted growth of pea cultivation and pulse-based industries across Europe, and globally. Thus, while the use of peas as a raw material in animal nutrition has risen, this is less lucrative for farmers than their use as food ingredients i.e., for human food consumption (2). Examples of markets for processed peas include meat alternatives (Figure 1) as well as milk alternatives (3).

The production of meat and milk alternatives are prominent examples of how added market value may be achieved from home-grown peas and other grain legumes. This work investigated several commercial innovative pea-based products, which have been introduced in the German market. Product websites were first surveyed, and this was followed-up by phone calls and e-mail exchanges to discuss open-questions

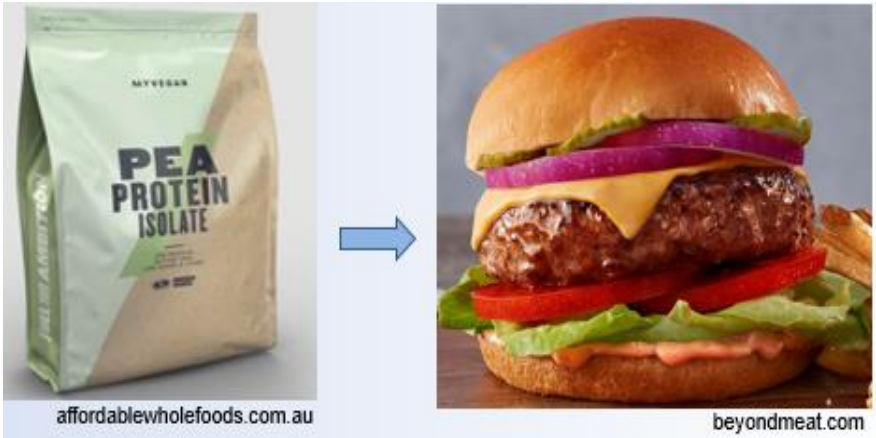

Figure 1. Burger patty based on pea protein isolate.

regarding how the product was brought to the market (market-entry point), and the origin of the raw materials. The results of the data collection were compared with information from the literature and were discussed as follows.

An increasing number of companies are bringing pulse-based meat and milk alternatives into the market. In the meantime, this is almost valid for all grain legumes such as soya, pea, lupin, field bean, lentil, and chickpea. Due to improved technical processes, it is possible to achieve higher protein yields and better protein enrichment to be used in a food, especially for peas (4). Separating the components enables the full utilisation of pea grains, because fibres and starch can also be used in diverse food applications (5). Protein isolates from peas also offer improved organoleptic properties compared to other legume-protein isolates. The following table shows an exemplary overview of companies and products made from pea protein isolates. The number of companies and products is constantly increasing.

Table 1. Companies that create products from pea protein isolates. Overview of some companies producing products from pea protein isolates. The protein content of the products per 100 g as well as the percentage of the pea protein isolate is indicated.

Companies	Product Name	Protein Content (g/100g)	Pea protein isolate (%)
Meat Alternatives			
Rügenwalder Mühle	Sliced sausage	3.9 – 4.4	2.0 – 5.0
Rügenwalder Mühle	Spreadable sausage	2.6 - 2.7	2.4 - 2.9
Endori	Burger	23	
Endori	Bratwurst	16	
Endori	Vegan balls	13	
Endori	Vegan Meatballs	16	
Vossko	Vegan Burger	15.5	81 (rehydrated)
Veggie Meat	Vegini Burger	16	
Veggie Meat	Vegini Bratwurst	14	
Beyond Meat	Vegan Burger	18	18
Like Meat	Vegan Curry Chicken	18	24
Milk Alternatives			
Vly Foods	pea-drink	2.5 | 3.5 | 5.2	2.1 | 4.1 | 6.2
Princess of the Pea	pea-drink	3.2	3.9

The content of pea protein isolates used as an ingredient in these products varies from 2 to 24 %. For sausage products listed in Table 1, the average protein content is lower than for traditional animal-meat based sausages. For the remaining plant-based meat and milk alternatives in Table 1, the protein content is in a similar range as compared to conventional animal-based products. Consequently, even a meatless and milkless diet can provide protein uptake sufficiently, including a balanced amino acid composition. Legume-based products made from processed peas are favourable alternatives to soy-based foods because they have lower levels of potential allergens. Thus, they are acceptable to a wider range of consumers, and it is not necessary to use specific dietary warning labels. Another advantage of pea protein isolate is the short cropping cycle of pea, from the sowing to the harvest compared to the other grain legumes. This aspect is very attractive to farmers and processors. For the latter, they can start sooner with the processing to gain protein isolate. As pea variety selection processing purposes might become more important in the future, decision cycles are shorter for peas. Furthermore, beside the expansion of crop rotation due to their introduction, grain legumes store better than oleaginous. These advantages (regionality, complete utilisation of the pea components, very low/no-allergenic potential, short cycle, expansion of crop rotation and better storage) are probably the main reasons for German food manufactures to use pea protein isolates as basis for their meat and milk alternatives. The generally higher environmental sustainability credentials of pea and tied marketing potential of an innovative product are the most important marketing levers for all legume-based products (6).

The market-entry of pea-based products is often limited due to their relatively high purchase price, as customers prefer the less expensive meat alternatives made from soya or wheat. A decreasing price over time can be expected because of increased competition among suppliers, and the increasing product range of plant-based meat alternatives (7). Due to efficiency processing improvements, cost of processing will become better and will reduce too. Model calculations show that decreasing prices of plant-based meat alternatives lead to decreasing animal meat demand and a reduction in greenhouse gas emissions (8). This is confirmed by comprehensive life-cycle assessments that included land use for feeding beef cattle and the respective carbon opportunity costs (9). For Europe, Pilorgé *et al.* (10) illustrated that if pea protein isolates and rapeseed oil, as the main ingredients of plant-based meat alternatives increase, land currently used for animal feed production would become partly available. Imported proteins from deforested regions could also be decreased: a substitution of 25% of meat consumption would allow supply of equivalent food protein without extending the cultivated areas in Europe, while avoiding soya and maize imports for feed.

Information about the supply chain of peas and pea protein isolates in the food sector is often characterised by a lack of transparency. Thus, information about the origin of the processed peas is usually not provided by the producing company. According to our investigation, it can be assumed that the raw material for the pea protein isolates used, is mostly grown in Europe. Various companies purchase their protein isolates mainly from France or Eastern Europe. Other countries of origin are Germany, Belgium, Scandinavia, and India. However, the pea proteins used are also partly sourced from peas grown in Canada and China (6).

The biggest companies processing peas in Europe are the Roquette Group (with production sites in France and the Netherlands), Cosucra (Belgium and Denmark) and Emslandstärke (Germany). Contract farming is the common means to source domestically (i.e. European grown) peas (11), though often no detailed information is given on products of raw material provenance. The companies keep their supply chain relationships confidential and have confidentiality agreements in their

contracts with the farmers. This lack of value chain transparency among product suppliers highlights a high degree of information asymmetries between the players in the legume-based niche.

Currently, small quantities of peas processed for food can easily be produced domestically. When the demand for pea-based meat and milk alternatives continues to increase, new cultivation and marketing opportunities for peas could continue to rise. This could have a positive impact on the farmers as they could sell their peas to the processing companies in the food sector (3). Marketing to the food sector enables farmers to potentially achieve a higher profit than selling only in the animal feed sector. However, this will depend on the specific business developments in those supply chains. Equity and power asymmetries have still to be addressed for the financial potential to materialise at the farm level. Farmers can also benefit agronomically though: as expanding, their crop rotation with peas serves a renewable source of nitrogen, and other complex soil function enhancing provisions, as a positive side effect for the farmers.

Protein or starch content and qualities should also be a new differential quality features for plant breeders which processing companies could turn into purchasing criteria. In total, the use of peas for food is more valuable than use in animal feed, though the latter current offers larger market volumes. For this purpose, pea breeders should collaborate more closely with the food industry in order to integrate food quality specifications and techno functional requirements of the food industry with breeding goals – more comprehensive and integrated breeding programs forming part of future sustainable value chains. This will lead to new value chain collaborations, and business models among breeders, food processors and technologists, and consumers.

Elaborating the potential and opportunity offered by peas can be transferred to other grain legumes. So far, lupins, soybeans and especially field beans are already being used in the food sector to increase the protein quality (12). It should be noted that the different grain legumes offer a diverse range of functionally distinct forms, whether processed completely or in fractionate forms. Therefore, each ingredient type demands a specific knowledge, a certain quality specification, and industrial capacities for application of best-processing methods.

The interest in legume-based food is increasing as the recent activities of existing food processing companies, large ones, small and medium-sized enterprises (SMEs), as well as start-ups show. This is leading to a transformation of the food systems, affecting the farming sector, though the extent to which the potential benefits are realised locally and increasing demand for regional legumes, and development of local food cultures and farm-profitability, remains to be seen. Thus, farmers and breeding companies should be sufficiently prepared to embrace new expertise, cropping grain legumes, including a wider range of varieties, to take full advantage of the environmental benefits, and align these with consumer expectations.

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