



TRansition paths to sUustainable
legume-based systems in Europe



Book of abstracts – poster presentations

“Enabling Legume Processing: opportunities and barriers”

**2nd Legume Innovation and Networking (LIN) Workshop
for the Atlantic and Boreal Region**

Nyborg, Denmark, Tuesday 7th May 2019

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1) Enabling legume processing: opportunities and barriers – TRUE

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Agri-food systems supported by locally-grown and -processed legumes offer a sustainable alternative to the damaging environmental, health and socio-economic paradigms which characterise our time. Paradoxically, while European food systems are legume-reliant the many benefits of legumes (such as: the provision of nutritious foods and premium-feeds; encouraging natural nitrogen cycling; improved soil qualities; lower greenhouse gas emissions; biodiversity and food-culture provisions;) are forfeited, as the legumes are not home-grown or therefore processed, and so are rarely realised as high value local-food products. Nevertheless, consumer-citizens are driving the shift towards greater consumption of legume-based foods, but are they home-grown and -processed? This consumer led demand deserves more support *via* improved policies and good-governance to help develop smaller- or craft-scale supply chain capacities to nurture good food culture and reconnect producers with consumers.

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2) Production of proteins for feed and food from lucerne and clover grass

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Production of proteins for feed and food from lucerne and clover grass in green biorefineries is a suitable solution for local, climate-friendly and sustainable protein production. Lucerne, clovers and clover grasses have numerous advantages for the environment and climate compared with traditional food and feed crops such as cereals, and is ideal in crop rotations if they can give a sufficient contribution margin to the farmers. Our results based on more than 10 years of research have shown that harvesting and processing fresh crops into a protein concentrate, a fiber-rich press cake, and a residual stream of soluble nutrients is feasible for a solid business plan. The protein-concentrate has been evaluated in experimental feed formulations for egg-laying hens, broilers and pigs with very promising results. Furthermore, ensiling the fiber-rich press residue and using it as feed for dairy cows can result in a 5-10% increase in milk production compared with a traditional silage. In addition, the solid and liquid residues from protein refining has good biogas potential and the digestate is valuable as a fertilizer. In parallel, we work with refining of food-grade proteins from lucerne. We have co-founded a start-up company BiomassProtein Aps together with commercial partners. BiomassProtein starts production trials summer 2019 with the aim of building the first production unit in 2020.



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3) Blue lupin for white shrimp (*Litopenaeus vannamei*) - TRUE CS 15

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Formulated feeds used for the growing production of carnivorous fish and crustaceans generally have a high protein content still met mostly by fish meal supply. Maintaining the steady and enormous growth of aquaculture production requires practical alternative protein sources. Terrestrial protein sources have been the focus of feed research for more than twenty years. Many studies test legumes like field peas, lupin and faba bean. Several different cultivars of lupin have been tested with different fish species mainly in Australia. The results of these studies are promising for example for salmon and seabass but. Lupin diets with a relevant replacement level for high value crustaceans are tested in the present study.

An experimental diet (Basis) with 30% fish meal as main protein source was formulated. *Lupinus angustifolius* kernel meal was added as 10, 20 and 30 % of the diet, incrementally replacing fishmeal. All diets were balanced to meet the requirements of *L. vannamei* in the grow out phase, concerning energy content, protein and amino acid profile, lipid and fatty acid composition, vitamins and minerals. These diets were compared with a commercial control.

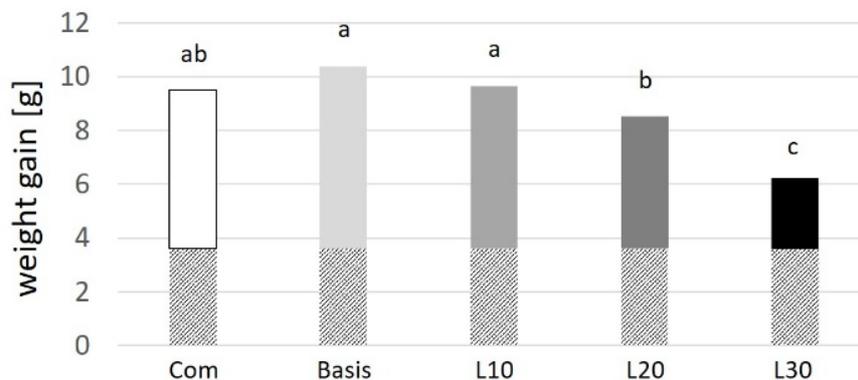


Figure 01: Weight gain of *L. vannamei* within 8 weeks

Feeding experiments were conducted over 8 weeks in a RAS device, with 18 separate 50 l tanks. Mean survival rate of the shrimps was 65% across all treatments. Mean biomass of animals fed with high lupine levels (L30) was significantly lower than in control diets (Basis and Commercial control) and L10 after 8 weeks. Metabolic analyses showed malnutrition of animals fed the L30 diet concerning glucose and triglyceride levels, although appropriate protein provision was attained with all experimental feeds.



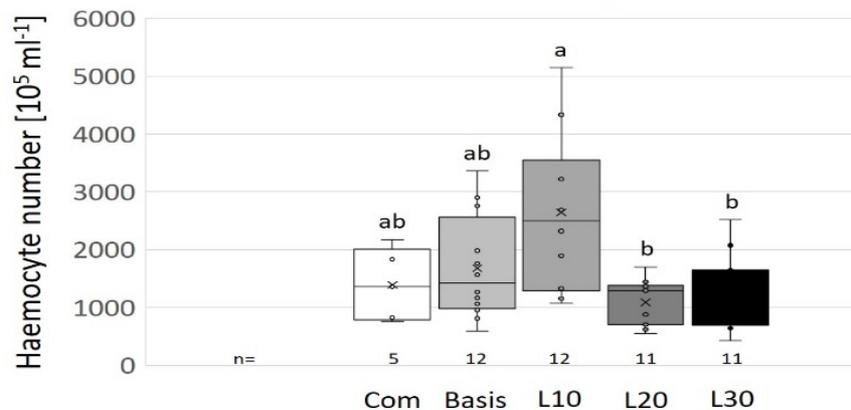


Figure 02: Total haemocyte counts show feed dependent variation

The total haemocyte count showed significantly higher counts in animals fed the L10 diet, which hints at an elevated immune capacity of these animals. This is an intriguing result concerning immunostimulation in cultured animals and needs further investigation. Untreated lupine meal can be used as an alternative protein source at rates of up to 10% (-20%) of the total feed (= **30-40% of animal protein**).

4) Market model for legume-based feed for organic pig production - TRUE CS 10

Karen Hamann

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This case study will address the challenges of meeting the increasing demand for organic pork and the constraints experienced herewith. The work focuses on North Europe with Denmark as a model country. Imported organic soy beans from China and Ukraine are the most frequently used protein source for organic pig production in the EU. Due to the upcoming removal of the EU option of including 5% non-organic protein in the feed ration for the pigs, the need to identify alternative and competitive organic protein sources becomes urgent and, this paves the way for legume-based feeds such as peas, lupines, and fava beans.

The case study builds on desk research, interviews with organic pig producers and, a workshop in Denmark. To ensure that the practical challenges and routines in organic pig farming are brought forward and taken into account, the case study collaborates with the association Organic Denmark.

Today, Denmark lacks 30,000 tons of organic protein feed and the market gap will increase further in the coming years. By 2020, it is anticipated that 200,000 organic pigs will be slaughtered in Denmark compared to 160,000 in 2016. But, increasing the cultivation and application of legume-based feed such as fava beans will not be a sufficient solution, as the amino acid profile of the fava beans does not fulfill the pig's nutritional requirements. Danish farmers grow organic fava beans already for the feed industry but the economics and efficiency of the supply chain needs further improvement if the cultivation of organic legumes is to be increased.





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Furthermore, legumes are experiencing competition from alternative organic protein sources such as processed starfish, seaweed or clover grass but, the production and use of the alternative protein sources have not yet taken off in industrial volumes. The conclusion is that the market for organic legumes for feed is growing but to exploit the opportunities for legumes in this context requires new ways of collaboration within crop production and logistics.

5) Fava bean Protein Isolate - Production, Properties, Utilization

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Fava bean (*Vicia faba*) is one of the oldest crop of the world. It belongs to the legume family. The high protein content and nutritional value predestine fava bean to be a new alternative protein source. PPM developed a new process in order to produce fava bean protein isolate characterized by high purity (> 90 % protein) and exceptionally high yield (> 60%).

The resulting fava bean protein isolate is of light yellow colour, tastes neutral, is almost completely soluble at pH7, has excellent stickiness and binding behaviour and shows good emulsifying and film forming properties.

Therefore, there is a wide range of utilization possibilities for fava bean protein isolate both in food and in non-food applications.

FAVA-NET is a network of German SME and R&D institutions aiming to establish a new value-added chain based on fava bean protein isolate production and utilization.

7) Extrusion of pea and oat ingredients to produce a healthy expanded snack

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Consumers and the Food industry are demanding healthier and tasty snacks. Legume seeds have high nutraceutical appeal and they can produce foods with a balanced amino acid composition when mixed with cereals. The aim of this study was to investigate the production of an expanded snack entirely based on pea- and oat-ingredients using extrusion technology. The effect of the die temperature and feed moisture content were investigated aiming at maximizing expansion, texture and sensory perception. Higher expansion and higher crispiness of snacks were obtained at a die temperature of 160 °C and a blend moisture content of 11.2 %. The snacks processed at optimum conditions also presented positive sensory attributes, highly correlated to the parallel parameters determined by texture analysis. The feed moisture content was the parameter that most influenced final extrudate properties/responses. The gross composition of the raw-material was not modified by extrusion.



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6) Overview of breadth and diversity for peas - TRUE CS 12

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The purpose of the case study is to provide an overview of the breadth and diversity given for peas and, as such, the case study will serve as a model for the (unexploited) opportunities for processing legumes. The case study will list the many options available for processing of peas, and by this point to the difficulties of policy making towards larger pea acreage in EU. The case study will map assortment and innovations within peas for human consumption (green peas and dried peas) by fresh, frozen and processed products; peas for food ingredients (including the range of pea-based ingredients, their applications and potential); and peas for use in feed. Market shares for organic pea products are estimated. In addition, the case study will investigate the assortment of pea seeds available and the characteristics of the varieties thus providing an understanding of how different varieties links to different purposes. This includes heritage crops.

The case study will provide an overview of how peas and processed pea-products are traded in the local and international markets emphasizing the role of Canada (as Canada is a major supplier in the global market). The case study will investigate the role of technology in driving the demand for peas, particularly in relation to food ingredients. An overview of the by-products from pea processing will provide insights to yet unexploited sources that could be used for building new value chains. The case study's findings will be compared with the diversity of high protein non-legume based feeds, such as wheat and oil seed mixtures. The case study will provide conclusions about the need for and challenges related to policy making, and for market and value chain integration to accommodate a larger agricultural area with pea crops in Europe.

8) Retailer-producer quality chains and innovations - TRUE CS 9

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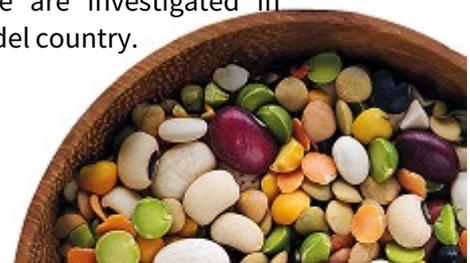
The assortment of food and drink products made with legumes is very wide and with traditional products such as canned, fresh and frozen legumes as the main traded goods. New products play a key role in driving market dynamics. Bringing new products (food and drink) made with legumes into the retail market can provide a big challenge for large as well as small producers. A thorough understanding of the supply chain, market power and, market drivers are crucial for decision making about entering the market with a new legume-based product. By analyzing the food retail markets in Denmark, Germany, the UK, the Netherlands and Greece, this case study provides detailed findings about retailer-producer quality chains for legume-based products.

The case study builds on interviews with key market actors; observations of assortment, prices, brands and products in retail stores; and analysis of retail market structures and market dynamics. To identify and understand the differences between countries under study, additional interviews are gathered from the market sessions at the regional Legume Innovation Network meetings. Challenges related to product development and marketing in practice are investigated in collaboration with North Jutland Food Cluster, thus using Denmark as a model country.



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Across the EU, the key market driver for having more legumes in the food chains is health. This is instigated primarily as a growing demand for plant based protein to reduce consumption of animal protein, and secondly as a choice of food to match the consumer's lifestyle such as a flexitarian diet with a convenient access to relevant products. Food manufacturers aim to launch new or reformulated products into the retail market that cater to consumers' motivations for food choice making "health" a key quality criterion for marketing new products. Health is not a "one-size-fits-all" quality criteria, as health may be defined by attributes such as vegetarian, vegan, organic, low-fat, fresh or otherwise. An important conclusion is that the market for innovative legume-based products is driven by a strong interest in plant-based diets and a continuously widening of the assortment of products to meet the consumers' lifestyles especially targeting the segments of health and convenience.

9) Legumes in public and private food service - TRUE CS 11

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Food service accounts for approximately 25 % of the food consumed in the EU. Food service includes the public sector (hospitals, school meals, army etc.) and the private sector (company canteens, restaurant chains). Procurement of food items for the public food service market is subject to government regulations and plans including the Green Public Procurement Criteria of the EU.

Procurement strategies for food in private and public food service outlets can be influenced by schemes such as the Danish Organic Eating Label. This case study investigates how government regulations and, public and private schemes can impact the procurement strategies in the food service sector towards a greener purchasing of food. The Organic Eating Label was introduced by the Danish government in 2009 and the aim was to promote organic food in the private and public food service outlets. By 2018, nearly 2,500 public and private outlets were certified with a Gold, Silver or Bronze status within this label. The status refers to the share of organic food in the total food purchase, so a Gold label equal an organic share of 70-100 % organic food. Outlets that are certified have developed more green menus, reduced food waste, and purchase more seasonal produce.

The case study builds on desk research, interviews with key market players and regulators and, observations of menus, purchasing lists, and procurement criteria. Denmark and the UK are used as model countries, and the Green Public Procurement strategies are investigated at EU level and for the model countries. Green Public Procurement (GPP) is an EU initiative instigated as a management tool to increase sustainability through the outlining of framework conditions for government procurement. Food is included as one of the categories in the Green Public Procurement initiative in line with building materials, medical devices etc. The GPP lays down the detailed requirements for public procurement contracts and for food, the GPP includes specifications for numerous food categories. Yet, legumes are not mentioned at all. This paves the way for investigating how legumes are used in the public food service sector, how legumes are mentioned in procurement contracts, the drivers for sustainability as a purchase criteria and the role of schemes in driving the food service market. The findings will point to policy issues to be addressed to achieve greener food procurement strategies with legumes playing central role.



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