

Next Generation Texturized Vegetable Proteins

Christoph Bruggler¹, Jean-Philippe Dellemann¹, Carsten Petry¹, Martin Laporte², Nadina Müller¹, Erich J. Windhab²
¹Bühler AG, ²Swiss Federal Institute of Technology (ETH)

Introduction

It is expected that, from 2050, there will be over 9 billion people living on the earth. If these expectations become reality in 2050, the global food demand will increase by approximately 70% in comparison to the current demand (Aiking 2011). In addition, living standards are rising in many parts of the world, and the increasing consumption of processed foods and meat is associated with this. In sum, these developments make it essential to find new ways to sustainably ensure the necessary protein intake. Therefore, food sources with high protein content will be crucial. Animal products from livestock farming must be reconsidered in particular, as this has a markedly negative impact on biodiversity, climate change, drinking water supply and quality, as well as on the spread of antibiotic-resistant pathogens. The food industry can play a major role in the development of new vegetable products rich in protein for sustainable nutrition in the future. (Aiking 2011). New products are required which, on the one hand, are organoleptically attractive and, on the other, can ensure a high level of consumer acceptance. Consumers expect a part of

such new sufficiently protein-rich products to have similar properties to those found in animal products made of lean meat. More precisely, this means similar colors, aroma, texture and taste (Hoek et al. 2011)

Textrudates

Textrudates is the term used for vegetable proteins which are texturized using extruder technology. These proteins have strong potential as an alternative to meat and fish. They are often produced through a High Moisture Extrusion Cooking process known as HMEC. HMEC is becoming increasingly popular in industrialised countries. At present, soybeans are the dominant raw material for corresponding textrudates. The main reason for this is its generally high level of availability, its acceptable price and its good texturizing capacity. However, in addition to soybeans, other attractive vegetable proteins exist for textrudate production. Further investigation into the processing and optimization of these proteins is required in order to offer an alternative to soybeans in the future.

In co-operation with the Swiss Federal Institute of Technology in Zurich, Bühler AG

carried out a study into such alternatives, investigating their sustainability, availability, texturizing capacity, nutritional value and taste. Promising raw materials were texturized either individually or as part of a mixture in a twin shaft heat extrusion process, and the properties of the end product were compared to those of soybean textrudates.

Choice of raw material

Various oilseeds, pulses and cereals were assessed as potential raw materials. Figure 1 shows the protein content of different raw materials.

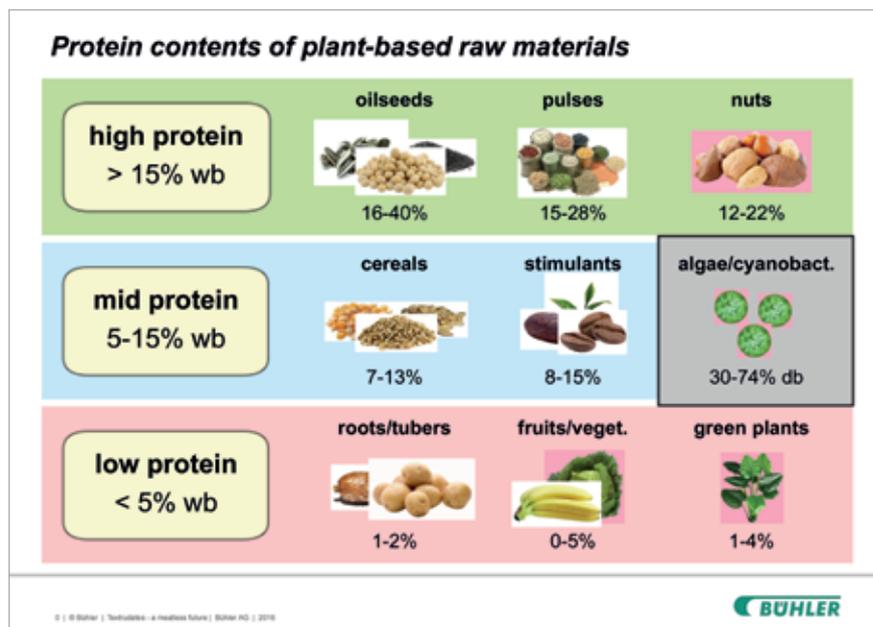
For the purposes of this study, only raw materials with a protein content of over 15% were extensively taken into account.

Representatives from the oilseed, pulses and nuts groups were investigated for their global availability, production capacity, allergens, price, amino acid profile and fat, fibre and protein content. The raw materials specified in table 1 proved to be promising alternatives to soybeans. Due to its existing

Table 1: pre-selection of alternatives to soybeans

Raw materials	Types of plant
• Soybeans	• Oilseed
• Rapeseed	
• Peanuts	
• Sunflowers seeds	
• Dry beans	• Pulses
• Chickpeas	
• Dry peas	
• Cow peas	
• Lentils	
• Pigeon peas	
• Broad beans	
• Lupin seeds	• Cereal
• Wheat	

Figure 1: comparison of protein content in different raw materials



ACHIEVE NEW LEVELS OF PERFORMANCE.



VERYX™

Food processors around the world depend on Key Technology's innovative solutions to increase product quality, efficiency and yield.

We offer the broadest range of sorting platforms on the market including VERYX™, the new standard in digital sorting. VERYX offers advanced levels of performance with sustained all-sided viewing, an intuitive user experience and intelligent automation.

Our industry leading lineup also includes custom-designed conveying systems to feed, transfer, align, collect, distribute, grade, and more.

Learn how Key can advance your business at www.key.net.



Horizon™



SORTING EXCELLENCE | PROCESSING KNOWLEDGE | CONVEYING EFFICIENCY



consumer acceptance, wheat was also included in the investigations, although its protein content is slightly less than 15%.

Materials and methods

All the tests were carried out using a Bühler AG PiloTwin - BCTM-type laboratory extruder (see figure 2 for the systematic set-up). This system is equipped with seven process unit segments (each L/D approx. 4) and an adjoining cooling die to texturize and cool the freshly produced warm product. The protein or protein mixture is introduced in powder form into the first extruder segment via a dosing device. A water content of over 50% is required for the wet texturated and this is added via a pump in the second segment of the extruder. (Bühler AG 2016)

Standard laboratory devices/methods were used to analyse the texture, moisture and color of the texturated. Organoleptic tests were also carried out by a panel of in-house Bühler employees whereby the quality of the products (color, taste, texture and feeling in the mouth) were subjected to the scrutiny of the human senses.

Findings

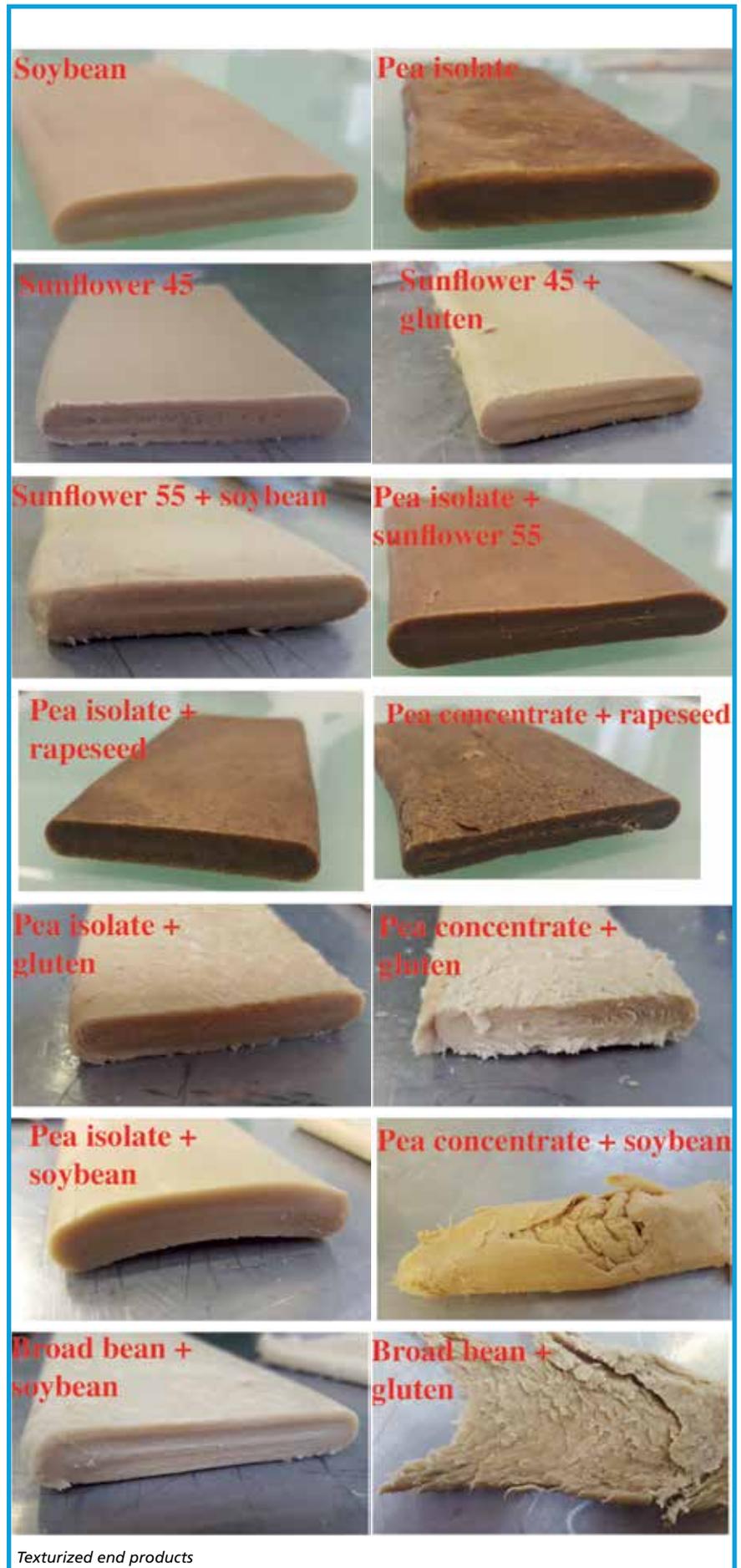
Choice of raw material

The level of availability of pulses and cereals, determined on the basis of USA and European import/export trends, is on a similar scale to that of soybeans. However, rapeseed is less available and has to be imported into the USA and Europe. Due to their low production capacity, lupin seeds are only available on a regional level.

Isolates and concentrates differ in terms of their availability. Whereas wheat and pea protein can be found on the market with a high protein content and a comparable quality to that of soybeans, chickpea and bean protein can only be found with a lower protein content in the form of flour. Cow peas and pigeon peas are not available in Europe in the form of protein powder.

Out of the raw materials investigated, peanuts, lupin seeds, wheat and soybeans contain food allergens.

Today, genetically-modified organisms (GMOs) do not receive wide acceptance, therefore, non-genetically modified raw materials should be selected where possible. For soybeans and rapeseed, this must be ensured through accurate sourcing.



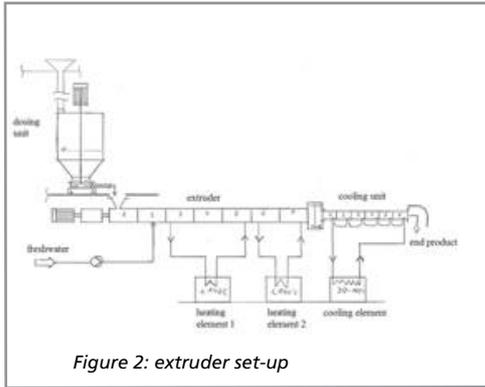


Figure 2: extruder set-up

The supplier price of wheat, rapeseed and pea protein is marginally lower than that of soybeans. Quotations for all other raw materials are clearly higher.

As regards the different essential amino acids, the amino acid profile of peas and rapeseed is similar to, or better than, that of soybeans. The nutritional profiles can be complemented by combining different raw materials.

Specific fat, fiber and protein content is necessary to achieve texturizing which bears comparison with lean meat.

Lentils, rapeseed, peas and lupin seeds have similar fiber content to that of the soybean reference.

Most of the protein raw materials analysed are available with different levels of quality in terms of protein content or particle size. No protein concentrates or isolates for chickpeas, pigeon peas, beans or cow peas can currently be found on the market.

Subsequently, when selecting raw materials, it can be noted that the protein found in peas, rapeseed, sunflower seeds, wheat and broad beans presents an alternative to soybeans. A few of these products are more suitable for mixtures so that the advantages of two or three components can be combined to achieve optimum protein, fat and fibre content or amino acid profile.

Texturate end products

The photos opposite show 18 texturized end products which could be used as an alternative to soybeans or as a partial substitute for soybean texturates. It can be clearly seen that the products differ in terms of color, structure and shape. An

analysis of the individual quality criteria – protein content, amino acid profile, price, texture, feeling in the mouth, taste and color – is shown in table 3. Where the quality of the analysed criteria matches that of the soybean reference, this is highlighted by a white field. Properties which are better than the soybean reference are highlighted in dark blue, and properties which are worse are highlighted in light blue (see table 3).

The protein content of the analysed alternatives is the same as, or better than, the soybean reference. Thus, for example, all soybean alternatives made up of pea isolate, or pea isolate combinations have higher protein content.

A similar trend can be observed with the amino acid profile, where pea isolate combinations produce a better result than the soybean reference (dark blue field). However, in contrast to protein content, as far as the amino acid profile is concerned, certain mixtures also achieved a poorer result.

None of the end products were able to undercut the price of the soybean reference (no dark blue field in table 3). Only three mixtures made up of either wheat or soybean can obtain similar prices to that of the reference. As, for example, the price of pea isolate and sunflower seed concentrate is relatively high, end products made up of these mixtures are also more expensive.

The texture of the soybean reference could only be achieved using products made of pea isolate with sunflower seed concentrate, broad bean concentrate with soybean concentrate or sunflower seed concentrate. This is expected to be further optimized by finely adjusting the process parameters.

The feeling in the mouth of the end products was also tested. Here, the tasting panel established that only the mixture of broad bean concentrate with gluten was able to produce a better feeling in the mouth than the soybean reference. Five additional end products were deemed similar to the reference.

As regards taste and color, pea isolate with gluten achieved a better result than the reference. With the other mixtures, similar or, in some cases, darker product colors were achieved.

DER ANTRIEB

■ Reliable ■ Versatile ■ Global



The Gear Unit

- Strong bearings
- High corrosion protection
- High power density

The Motor

- High efficiency
- Global standards
- All operating conditions

The Drive Electronic

- Compact design
- Easy implementation
- Protection class up to IP 69K

Worldwide available

Subsidiaries in 36 countries

Agents in 52 countries



DerAntrieb.com

Headquarters:

Getriebebau NORD GmbH & Co. KG

Fon +49 (0) 4532 / 289-0, info@nord.com

Member of the NORD DRIVESYSTEMS Group



Key No. 89603

Ranking	End product
1	Pea isolate + gluten
2	Pea isolate + soybean concentrate
3	Pea concentrate + gluten
4	Broad bean + gluten
5	Pea isolate
5	Sunflower seed concentrate + gluten

Table 2: promising texturates as alternative raw materials

Conclusions

Texturized soybean protein is currently available and accepted as a meat substitute. The aim of the study was to find raw material alternatives to soybeans which are also widely available as wet texturates and which can be texturized using extruder technology. These products could exhibit better or at least equal properties in terms of sustainability, compatibility and nutritional value.

In this study, promising alternatives were found which could partially or completely replace soybeans (Table 2).

The mixture of pea isolate and gluten scored highest and exceeded the soybean reference in terms of protein content, amino acid profile and taste. In the future, feeling in the mouth and texture could be further improved upon by optimizing the process parameters.

The second best result was achieved by the mixture of pea isolate and soybean concentrate. This mixture achieved better results than the soybean reference except in the case of texture which was given particular weighting in this assessment. However, further improvements can be expected by optimizing the extruder parameters. Having said that, this end product served only as a partial replacement for soybeans.

Pea concentrate with gluten also achieved a good result. Here, the fact that the product color and protein content are better than the soybean reference is especially noteworthy. In addition, soybeans can be completely eliminated with this mixture. The amino acid profile could be further optimized by a third component. The combination of broad beans with gluten stands out as the only alternative through a better feeling in the mouth than the reference. Here too, the amino acid

profile could be improved upon by adding other sources of protein.

Future prospects

Bühler and the Swiss Federal Institute of Technology (ETH) in Zurich plan to further intensify the research work in the area shown here. Building on the findings of this study, they intend to perform a follow-up study during which meat substitutes, completely wheat- and soybean-free, will be produced and tested. Further tests will also be carried out following an upscaling in the near future at the company's own application center using extrusion systems with cooling dies for a throughput of up to 700 kg/h. It is possible for customers to hire these facilities for product developments according to their specific requirements.

Key No. 90236

References

- Aiking, Harry (2011): Future protein supply. In: Trends in Food Science & Technology (22 (2-3)), S. 112–120.
- Bühler AG (2016). Online verfügbar unter www.buhler-group.com, zuletzt geprüft am 05.08.2016.
- Hoek, Annet C.; Luning, Pieter A.; Weijzen, PASCALLE; Engels, Wim; Kok, Frans J.; Graaf, Cees de (2011): Replacement of meat by meat substitutes. A survey on person- and product-related factors in consumer acceptance. In: Appetite (3), S. 662–673.

end product	protein content	amino acid profile	price	texture	mouthfeel	taste	color
soy concentrate							
pea isolate							
pea isolate + rapeseed flour							
pea isolate + sunflower concentrate							
pea concentrate + rapeseed flour							
sunflower concentrate							
pea isolate + wheat gluten							
pea isolate + soy concentrate							
field bean concentrate + soy concentrate							
field bean concentrate + sunflower concentrate							
field bean concentrate + wheat gluten							
pea concentrate + soy concentrate							
sunflower concentrate + soy concentrate							
sunflower concentrate + wheat gluten							
pea concentrate + wheat gluten							

Better than the soy reference
 Comparable with the soy reference
 Inferior to the soy reference

Table 3: promising texturates as alternative raw materials