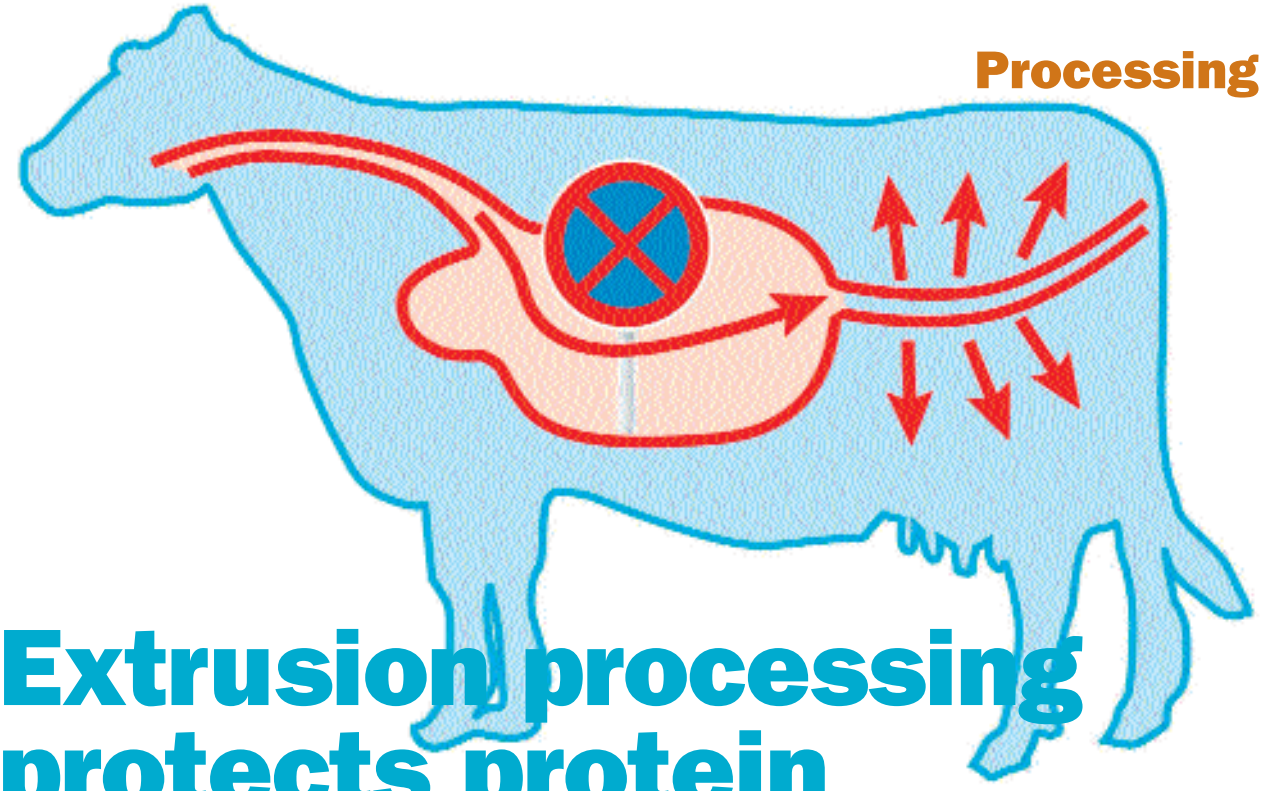


Extrusion processing protects protein

High yielding cows need quality feeds of which the proteins become available in the intestines without being degraded by the microbes in the rumen. Several techniques are presently used, but German feedmiller deuka has patented an extrusion process that promises good results.

By Dr. Heinrich Kleine Klausing and Dr. Katharina Pfeil, deuka Deutsche Tiernahrung, Düsseldorf, Germany

Deuka Deutsche Tiernahrung GmbH & Co. KG has been among Germany's leading feed producers since 1928. With a market share of some ten per cent and a turnover of approx. €350 million, deuka takes first place in compound feed production and marketing in Germany. In nine feedmills spread strategically through Germany the company produces about 1.8 million tonnes of feed for productive livestock as well as for pets and hobby animals each year.

Deuka currently employs more than 500 staff at the head office in Düsseldorf and in the eight further plants, of whom 80 work in the field service department. deuka also provides training for over 30 apprentices.

Core business

Deuka's core business is rearing and performance feed for productive farm livestock such as pigs, cattle and poultry. In this segment deuka produces both single and supplement feed that is additionally enriched on the farms with farm-produced components. A key area of production lies in the consultancy-intensive pig-feeding sector. Here the demand is not only for high quality feeds, but also for recommendations on feeding management. The business area of pet food is becoming increasingly important. deuka markets a broad animal feed range throughout Germany for horses, hobby poultry, rabbits, dogs and cats.

The company has invested over ¤30 million in its production plants in the last five years. Currently deuka is installing a plant to produce feeds with a higher content of protected proteins for high-yielding cows in several of its factories. The purely plant raw materials are broken down gently using a patented process. This feed with the brand name 'deukalac UDP' has met great interest in the market. The product line will be introduced throughout Germany. "We shall continue to spend large amounts on quality assurance and product innovation in the future too," explains Bern Fink, managing director and joint owner of deuka together with Dieter Tewes.

Deukalac UDP 39

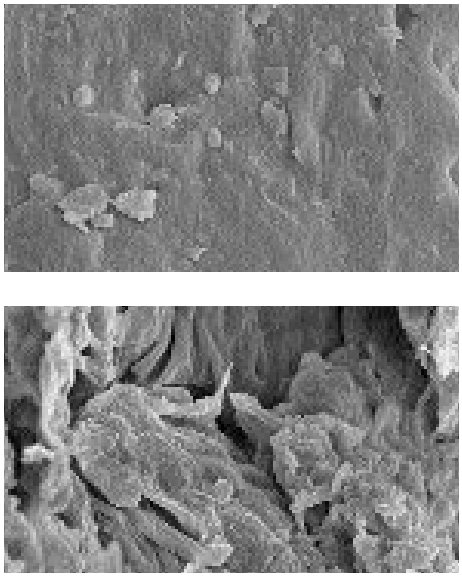
Deukalac UDP 39 is made up of 50 % HP soybean meal and 50 % 00 rape-seed meal. The components are ground and mixed in the usual fashion. After this the mixture is treated in the opticon® production plant and the content of rumen-stable protein ("UDP share") for supply covering the needs of high-yielding cows is increased to 50 % (basic passage rate 5%/h from the rumen). The content of sulphurous amino acids in the product is secured via the share of rapeseed meal.

This protein protection is achieved by purely physical

means without the addition of chemical substances. The product also contains per kg: 7.0 MJ NEL (net energy for lactation), 390 g crude protein, 300 g nXP (usable protein in the duodenum) and 14 g RNB (ruminal nitrogen balance).

By means of this treatment deukalac UDP 39 acquires a unique crumbly structure. Treatment also lends the product a pleasant, baking-type odour and taste. That is why high-yielding cows absorb deukalac UDP 39 very well.

The product is used directly on the farm for targeted upgrading of the basic feed ration, as a protein supplement in mixed rations (MR) and total mixed rations (TMR), and as an additional protein supply for high-yielding cows in the "top dressing". In compound feed plants deukalac UDP 39 is used in special compound feed varieties for high-yielding cows. The exact quantities and processes are addressed to the individual on-farm feeding situation.



Electron microscope image of untreated (top) and opticon treated (bottom) rape seed meal (magnification 1,000 fold).

Production process

All known treatment methods for producing rumen-protected protein (thermal pressure, addition of chemical products) essentially have the same target mechanism to start with – a "blockade effect" for the proteases produced by the rumen microbes. This is common to all methods – but the details of technical/physical realisation are crucial.

In the production process the physical parameters of temperature, pressure, moisture content, dwelling time and shear forces applied must be very precisely coordinated. The goal is to achieve a change of the tertiary and quaternary structure of the proteins ("texturing") in the treated product – in other words a certain "protein denaturation". A change in the protein structure can be shown with the aid of photos taken with the scanning electron microscope. For this untreated rapeseed meal and the material treated accordingly via the opticon-production plant were examined. The photos document that the opticon treatment results in a change in the protein structure ("texturing") that is visually evident with 1000-fold magnification.

Reversible intestinal process

On treatment, however, care must be taken to ensure that the digestibility of the protein - or rather of the amino acids in the protein - in the small intestine is not reduced sustainable. The process should be more or less reversible. "Texturing" (folding up and refolding in the tertiary and quaternary structure) should only go so far that the protein molecules are 'unfolded' again at low pH value (pH 2-3) in the stomach and the bonding places for the body's own proteases in the stomach and further down in the small intestine are fully accessible again. The degradation per time unit in the rumen is

Table - Practical results with deukalac UDP 39

Farm	No. cows	kg milk/year 2000	kg milk/year 2001	Fat %	Protein %	Fat-protein kg	Ration type maize;grass silage	deukalac UDP 39 kg/ cow/day	% UDP in crude protein
Da	140	11,300	12,300	3,49	3,30	839	74/26	4.5	33
Di	130	10,100	10,400	4,20	3,44	789	0/100	2.8	27
MS	400	10,500	10,500	3,89	3,33	775	63/37	4.6	35
St	1000	9,700	9,700	4,17	3,36	750	72/28 + beet pulp	2.0	32
GR	460	8,800	8,800	4,16	3,48	749	74/26	3.0	34
F	1500	9,000	9,000	4,04	3,37	724	79/21 +hay	4.5	35

Deukalac UDP 39 with 50% rumen protected protein.

reduced. Then the proteases formed by the rumen microbes are less able to attack each other in the time unit.

Scientific proof

When looking more closely at process technologies to protect proteins prior to degradation in the rumen, and the resulting UDP content in the treated products, the question naturally arises as to how the forecast data can be verified. Up to the end of the 90s the UDP content in a product could only be estimated via expensive live experiments with rumen-fistulated ruminants (primarily oxen or cows).

In the second half of the 90s a working group under Dr. Karl-Heinz Südekum at the Institute for Animal Nutrition and Metabolic Physiology of the Christian Albrecht University in Kiel, addressed the task of developing a laboratory method and validating this with the aid of live animal examinations. The result is a process for estimating crude protein degradation in the rumen and hence the UDP share in the overall protein of a feed with the aid of chemical fractioning of the feed protein in accordance with the "Cornell net carbohydrate and protein system (CNCPS)".

This new estimation process has the advantage of achieving well-validated data on the UDP content of a feed relatively quickly and at reasonable expense. These data are stated as a function of a ruminal passage rate of 2.5 or 8%/h. This method was first used during the development of the opticon process technology to assess the degree of substance change achieved and hence the UDP content in the single feed treated.

The special product deukalac UDP 39 was repeatedly examined during development and within the framework of quality assurance to assess the UDP content achieved using this method too. The data show that deukalac UDP 39 has a mean UDP 5 value of over 50% for all samples examined. In the calculation of rations for dairy cows with deukalac UDP 39, a UDP share in total protein of 50 % is taken on the basis of this results (basis: passage rate 5%/h from the rumen).

50% UDP is the limit

A further question that arises is whether a rumen-protected protein carrier component lying well above 50% UDP share in total protein would be better. It is known from literature that a very high degree of rumen protection (UDP share in total protein of 70 % and more – basis: passage rate of 5%/h from the rumen) can be achieved by very intensive treatment of protein carriers (physical, chemical and a combination).

However, this can then very quickly result in a distinct reduction of the small intestine digestibility and hence in lower protein value for the animal. This is also pointed out in a wide variety of papers in relevant international literature.

Such intensive treatment is known as "overcooking". The main feature responsible for reduced protein digestibility in the small intestine in such "overcooked" products is a very far-reaching reaction between reducing sugars and the amino acid lysine – the Maillard reaction. This chemical process is only reversible to a very limited extent even under the pH conditions prevailing in the stomach. It leads to the reduction in small intestine digestibility already described.

Consequently it is not the absolute level of achievable degradation protection in the rumen that is of prime importance, but instead the quantity of digestible protein that reaches the small intestine with one kilogram of protected protein component. To put it more clearly, a "high level of rumen protection" does not necessarily help a lot if the treatment reduces digestibility in the small intestine.

Results in practice

The high performance capability of deukalac UDP 39 was tested comprehensively in practice. A selection of the performance testing farms that used the product successfully in 2001 is set out in *table 1*. The farms had stocks ranging between 130 and 1,500 cows and a yield range between 9,800 and 12,300 kg milk per cow and year. The shares of deukalac UDP 39 in the rations (all farms fed TMR) were oriented to the relevant basic feed situation. The rumen-protected protein carriers used so far on the basis "nXP", "RNB" and "MJ NEL" were replaced with deukalac UDP 39 and adaptations in the to-

Opticon production facility at the deuka plant in Höltlinghausen, Germany.

tal ration equivalent. Depending on the ration composition between 2 and 4.5 kg deukalac UDP 39 per cow and day were thus used. By comparison with the year 2000, all farms were able to increase yields.

The opticon process

Opticon® is a hydrothermal pressure process technology developed and patented by deuka, aimed largely at refining single and compound feeds for productive livestock in agriculture. The process consists of an invention-specific configuration of the screw geometry in the barrel of the extruder and the appropriately developed process parameters (temperature, moisture content, pressure, shear forces, dwelling time, energy dissipation, expansion and product structure).

A specific high level of substance conversion (distinctly elevated UDP share in the total protein) is achieved in the treated product by purely physical means without using additives and with avoiding large-scale Maillard reactions (irreversible bonding between lysine and reducing sugars) in the product.

The opticon technology can be described as an important further development of known extrusion technologies for producing animal feed. By comparison with known methods, a distinctly lower energy input is used in the process to achieve a certain substance conversion.

The very energy-intensive drying of treated product necessary in conventional extrusion is not needed thanks to selected moisture extraction in the flash phase. This contributes substantially to conserving resources and lends the process a correspondingly high environmental soundness and high economic viability. ●