Maximising energy and protein utilisation in poultry nutrition

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Modern animal production has been extremely successful in establishing food security, which is the production of large quantities of low-cost food such that it is practically taken for granted by the human population. In order to achieve the high performances that producers currently require for food security high density diets are formulated containing high levels of proteins and fat.

However, modern developments have now resulted in feeds that increasingly depend upon vegetable protein sources. Soybean meal remains still the major source of plant proteins, although alternative oilseed meals, such as sunflower meal and rapeseed meal and also leguminous seeds such as peas, beans and lupines, gain more interest. This will inevitably yield feeds with higher fibre contents and low digestible proteins. This can result in various health problems such as scouring syndromes and heart failures with modern poultry breeds, and sudden death syndrome and ascites specifically in broilers. However, dietary fibre may also have a beneficial effect upon the health of poultry by acting as a substrate for the intestinal micro flora.

The short chain fatty acids (SCFA), predominantly acetic, lactic and butyric acid that are produced, decrease the pH in the large intestines and this leads to a healthier microbial live.

Optimising dietary fibre, maximising energy and protein utilisation must ensure a healthy gastrointestinal microflora termed as 'eubiosis'. 'Eubiotic nutrition' is a key strategy and may be achieved with the judicious use of multi enzyme systems.

Multi enzyme systems

When formulating feeds with high inclusions of plant proteins, we must consider possible anti-nutritional factors (ANFs) as well as non-available carbohydrates (NAC) which comprise non-starch polysaccharides (NSPs) and non-digestible oligosaccharides (NDOs). The various sources of NAC can be broken down by supplementary enzymes and those carbohydrates will eventually enter the large intestine as NDOs where they will be fermented into various organic acids and probably some amino acids.

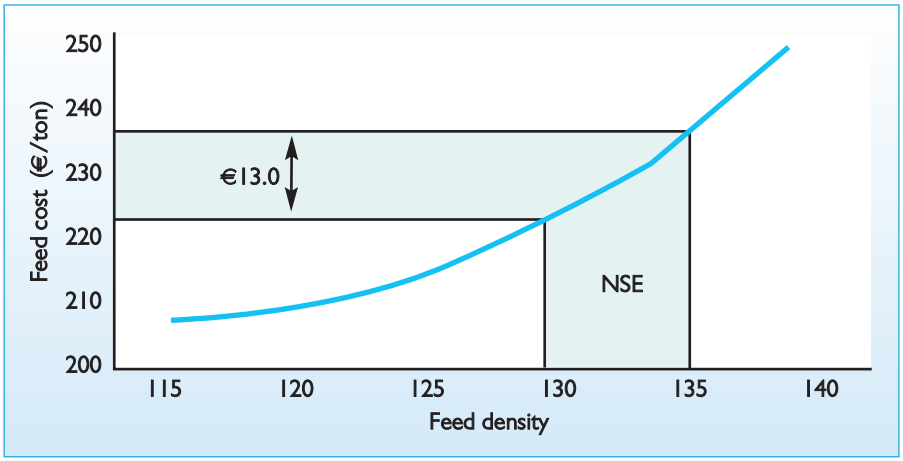

Fig. 1. Feed cost, feed density (= ME (MJ/kg) *D. Lys-po (g/kg)) and the nutrient sparing effect (NSE).

Fibre degrading enzymes play a very important role in poultry nutrition, modulating the microbial fermentation from the upper to the lower digestive tract. That is why fibre levels in feed must no longer be seen as a maximum constraint in formulations.

'Optimising fibre' becomes the new challenge in modern poultry nutrition.

The variation in the overall content and bioavailability of carbohydrates, fats, proteins and amino acids in feeds has led to the development of various enzymes designed to liberate unavailable nutrients.

Given the many biochemical processes involved in nutrient digestion, it is likely that a multiple enzyme system would play a greater role in digestion, particularly in energy and protein utilisation.

Feed enzymes improve digestibility of feed ingredients. They lower the viscosity of intestinal contents and unlock nutrients that are entrapped in the plant cell structures.

More energy is released from the feed resulting in an energy sparing effect and more proteins become available, resulting in an amino acid sparing effect. Both can be attributed to the digestive enzymes and can be used in least cost feed formulations. Enzyme products based on xylanase and β-glucanase, frequently also containing cellulase are known to improve litter conditions, particularly with wheat and barley based feeds.

Liberation of nutrients

Maize diets are highly digestible, however, the variation in the overall content and bioavailability of carbohydrates, fats, proteins and amino acids in maize-soybean diets has led to the formulation of various enzymes designed to liberate unavailable nutrients.

Maize starch is made up of amylose and amylopectin, the first being poorly digestible. It has become interesting to supplement maize-based diets with α-amylase, an enzyme produced at too low levels in young animals, such as broiler chicks. Even though the gross energy value of soybean meal is considerably higher than the metabolisable energy (18.83 MJ/kg vs. 10.25 MJ/kg), it was commonly accepted that enzyme supplementation to a maize-soybean diet would not improve broiler performance to an extent that would offer any economic benefit.

Soybean meal contains non-starch polysaccharides, including arabinoxylans,

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Fra MZ (g/t)	FCR	Final weight (g)	FCR corrected*	Improvement
Schothorst Feed Research, The Netherlands, 2012				
0	1.44	2349	1.32	
50	1.43	2414	1.29	2.47
University of Debrecen, Hungary, 2012				
0	1.69	2268	1.60	
50	1.58	2346	1.46	8.50

*FCR corrected to 2000g @ 0.01 per 30g

Table 1. Broiler performances with and without Fra Multizyme MSC.

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pectins and beta-glucans but legume seeds in particular contain also important amounts of the α-galactosides: raffinose, stachyose and verbascose and some minor levels of β-mannans that negatively affect nutrient absorption.

These oligosaccharides appear to be indigestible in the stomach and the small intestine. However, bacteria in the lower intestinal tract are able to metabolise these sugars to CO_2, H_2 and CH_4 provoking digestive disorders.

Further research has shown the impact on zootechnical performances and the cost effectiveness of breaking down these oligosaccharides with enzymes such as α-galactosidase and β-mannanase.

Moreover, the NSPs in pulses and oilseeds are mainly pectic polysaccharides consisting of galacturonans or more commonly rhamnogalacturonans.

Other sugars attached as side chains include D-galactose, L-arabinose and D-xylose. Multi-activity enzymes including pectinase targeting the pectic polymers as well as the other neutral NSP's are certainly of great interest.

Poultry diets have high protein levels. However, an excess of dietary proteins may shift the intestinal microflora to a more proteolytic population (i.e. clostridia, E. coli). Poorly digestible protein sources may lead to the fermentation of non-digested proteins in the hindgut that leads to potential toxic metabolites.

These are biogenic amines and other toxic compounds that can adversely affect gut health. It may be assumed that exogenous protease enzymes solubilise proteins and increase the protein availability, especially when it comes to vegetable protein sources in diets for young animals that do not sufficiently produce this enzyme.

Table 2. Fra Multizyme MSC Dry.

α-galactosidase	80 GALU
mannanase	24000 IU
pectinase	2100 IU
α-amylase	21000 IU
protease	6000 U
xylanase	160000 BXU
β-glucanase	20000 BU
cellulase	3200 IU

Maximising the utilisation of dietary proteins is important and this can be achieved using an enzyme system including protease enzymes.

Good results have been obtained with Framelco Fra E-line, a multi enzyme system, with broilers on a maize-soybean meal diet, increasing overall performances by 2.47% on top of a high density diet in the Netherlands up to 8.5% on top of a lower density diet in Hungary (Table 1).

It is obvious that less is to gain when diets and performances are already at the highest level (law of diminishing return).

Conclusions

Now one must go beyond conventional nutrition where feeds have traditionally been formulated to high density and least cost. Formulating lower density and lower cost feeds offers a practical strategy that combines the health benefits of reduced nutrient density of feeds with the addition of a multi enzyme system to maintain good zootechnical performances. The biological processes brought about by a multi-enzyme system (Framelco Fra E-line) allow more energy and more amino acids from feed to become available to the animal. This is termed the nutrient sparing effect (NSE), which can be attributed to the enzyme system to formulate lower density feeds.

Lower density feeds are economically very attractive. Indeed, feed cost increases exponentially as nutrient density increases, especially when they are formulated with all-plant materials (Fig. 1). In this example reducing feed density from 135 to 130 (NSE) gives a cost saving of €13.0/tonne.

High density diets can be reformulated, reducing feed cost. This requires that feeds are formulated on digestible amino acids and fibre is optimised including such a multi enzyme system to modulate the microbial activity in the GI tract, termed eubiotic nutrition. The challenge is to formulate feeds for good animal health, optimal performances and lower cost, giving the maximal return. ■

References are available from d.snijders@framelco.com