Improving feed economics with advanced enzyme concepts

by Erik Vanderbeke, Aveve Biochem, Belgium.

With increasing costs and fluctuations of availability of raw material quantities, feed producing companies are looking for more flexibility in raw material choice and increased usage of less common grains and by-products, without negative influence on animal performance parameters.

Beyond the usage of raw materials unfamiliar to certain geographic areas, also maximising incorporation levels of raw materials can bring economy in the feed formulation and becomes a major quest of feed companies today.

Direct parameters influencing feed cost are the available mix of raw material and their cost at delivery, their nutritional content and the nutritional needs of the target animals. Indirect parameters influencing the feed cost are for example amongst many other, the maximum incorporation levels limits used for different feed raw materials, minimum and maximum values of nutrients in the total feed, frequency of formulation, available production technology, digestibility enhancing additives.

Flexible feed formulation

Strategic additives generally recognised today for their potential to enhance digestion in animal nutrition are enzymes. More specific, advanced enzyme concepts allow large changes in feed formulation with positive impact on feed economics. Due to the proximity of sea ports, the traditional raw materials used before 1995 in our geographical area consisted of a large quantity of different by-products imported from all over the world, with special focus on Asian origins. Using many by-products combined with a high frequency of recalculations of the animal feeds requires good data about the quality as well as detailed information about the digestibility of these by-products.

This particular situation has been a drive to explore the potential and use of enhanced enzyme concepts for more flexibility in feed formulation and of course also for cost optimisation.

After 1995 the Gatt/McCharry agreements on raw material trade have led to a higher usage of locally available cereals in Europe in feed formulation, because their price became more competitive compared to imported by-products. Again this resulted in increased use of enzymes.

Today, large raw material price volatility worldwide of traditional grains and protein sources leads to the same situation in Asian countries looking for the use of higher levels of local raw material potentially available as an alternative. Additionally, also large amounts of raw materials from new industrial activities like liquid fuel energy production, reach the feed producers.

There are many enzymes available on the feed market. A large quantity of feed enzymes today consist of fibre degrading enzymes ranging from mono-component to multi-component enzyme products. There is a large quantity of trial data available and many products are offered on the feed market.

Of special importance is the enzyme concept, which means the level and type of enzyme activities, and the enzyme dosage to the feed. The enzyme activities should reach the threshold level above which significant impact on animal performances has been correctly and well documented through animal trials.

Fibre degrading enzymes not only act on feed fibres but indirectly also influence the place and time of release of nutrients like proteins, which need to be available at their optimal site of absorption in the animal.

Table 1. Isolation of the NSP-fibres and analysis of their sugar composition after total hydrolysis.

Raw material	NSP sugars	Fibre types	Soluble fibre	Enzyme activities	Special enzyme
Wheat	glu, xyl, ara	glucan, cellulose, arabinoxylan	<25	glucanase, xylanase	xylanase
Corn	glu, xyl, ara	glucan, cellulose, arabinoxylan	<5	glucanase, xylanase	xylanase
Tapioca by-product	glu, uron, gal, xyl, ara	cellulose, glucan, arabinoxylan	<5	cellulase, glucanase, xylanase, pectinase	cellulase
Palm kernel meal	man, glu, gal, uron	mannan, glucan	<10	mannanase, glucanase, cellulase	mannanase
Copra meal	man, glu, uron, gal	mannan, glucan	<10	mannanase, glucanase, cellulase	mannanase
Rice bran	glu, xyl, ara, uron	glucan, arabinoxylan	<10	xylanase, glucanase	xylanase
Cottonseed meal	glu, xyl, ara, uron	cellulose, glucan, arabinoxylan	<20	cellulase, glucanase, xylanase	cellulase
DDGS (corn)	glu, xyl, ara, uron	cellulose, glucan, arabinoxylan, pectin	<30	cellulase, glucanase, xylanase, pectinase	cellulase
Sunflower meal	glu, xyl, ara, uron	cellulose, arabinoxylan, pectin	<20	cellulase, xylanase,	cellulase
Soybean meal	glu, gal, uron, ara, xyl	glucan, pectin, xylan	<20	glucanase, pectinase, xylanase	pectinase
Rapeseed meal	glu, ara, uron, gal, xyl	glucan, pectin, xylan	<15	glucanase, pectinase, xylanase	pectinase
Peas, lupins	glu, ara xyl, uron	glucan, arabinoxylan, pectin	<20	glucanase, pectinase, xylanase	pectinase

Alleviate negative effects

Well designed enzyme concepts adapted for raw material components like very specific fibre types can alleviate negative effects of adapted feed formulations and even result in better animal performances compared to the traditional feed composition used.

A powerful technique to determine the enzyme activities needed for the specific fibre types present in a raw material is the isolation of the NSP-fibres (Table 1) and subsequent analysis of their sugar composition after total hydrolysis (based on Theander, Englist, Hoebler & Harry methods). Specific by-products available to the feed industry contain many different types of fibres.

In general, it can be stated that glucan/cellulose fibres are predominant together with (arabino)xylans and pectins. The solubility of the fibres differs considerably among raw materials, influencing the minimum threshold level of the enzyme activities in the enzyme concept needed

Continued on page 16

Continued from page 15
after dosage to the feed. Soluble fibres need less enzyme activity (lower threshold level) to be hydrolysed as compared to the more insoluble fibres.

As viscosity is less important in pig nutrition, the main goal of enzyme addition is hydrolysis of the feed matrix to avoid nutrient inclusion by the fibres present.

When some particular by-products containing unusual fibre types are used, specific enzyme activity addition to the enzyme concept is needed, at least when high inclusion of that raw material is the purpose of the feed formulation.

To design enzymes to enhance formulation flexibility and to obtain higher incorporation levels of raw materials, the total fibre composition of the final feed has to be taken into account as well. Indeed, the enzyme does not distinguish between raw materials and it is not uncommon that the basic raw materials in the feed are responsible for 50% of the total feed fibres present.

By choosing the right broad spectrum enzyme concept and enzyme activity level in the feed to act on all raw materials, animal performances can be improved significantly.

An example of an animal trial with use of high levels of tapioca by-product in growing pigs shows that only specific designed enzyme concepts and dosages are able to allow high level of incorporation of this specific raw material, resulting in substantial improvement of pig performances as compared to different other enzyme concepts.

Many animal trials with high incorporation levels of specific raw materials and by-products using adapted enzyme concepts have been documented in our feed company, resulting in significant improvement of the pig performances.

Also replacement of protein sources of animal origin by protein sources of plant origin in piglet diets is a particular way of reformulation which results in large economic advantages, without impairing animal performances.

Parameterisation of the formulation cost with high inclusion levels of palm kernel meal in a finisher pig diet leads to economy in feed cost of -6 US$/ton depending on the finisher pig feed type. It is clear that the different nutritional constraints of each feed will influence the economic advantage.

Parameterisation on high rapeseed meal inclusion in a finisher pig diet leads to economy in feed cost of -7 US$/ton feed depending on the feed type tested. Feed reformulation economics will also depend largely on the local cost and composition of the raw materials and on the general context in which the feed formulation is calculated.

By-product usage

Economics of by-product usage will depend on their content of protein (amino-acid), energy, and fibre content along with other limitations. Availability at the production site of higher energy grains and fat sources will improve for instance the economy of protein rich byproducts with lower energy.

When using raw material costs as available in Asian countries our calculations result in improvement of the reformulation economics by a factor up to 2.5 higher than the calculated cost in our local conditions with our local constraints on the feed (phosphorus max levels, max levels of corn).

As a conclusion it can be stated that by-products will be increasingly used in animal feed formulation, necessitating good quality assessment. Careful selection and use of advanced enzyme concepts matching the fibre composition of the total feed and specific raw materials used at high inclusion level will result in more flexibility in feed composition formulation, in substantially lower cost and in improvement of animal performances. ■

Table 2. Raw material cost calculations.

Animal	Raw material	Inclusion level (%)	Replacement	Net/ton feed (US$)
Piglets	soybean meal	25	milk and fish protein	-25 to -50
G/F pigs	soybean meal tapioca	25	fish protein, corn	-5 to -10
G/F pigs	tapioca by-products	35	corn	-15 to -30
Growing pigs	palm kernel meal	15	wheat, soybean meal	-5 to -10
Growing pigs	copra meal	17	cereal, protein sources	-5
Finisher pigs	rice bran	12	corn, soybean meal	-5
Growing pigs	DDGS corn	20	corn, soybean meal	-5 to -10
Finisher pigs	rapeseed meal	25	cereal, soybean meal	-5 to -10