Raw materials

Wheat dictates DDGS supply in Europe

Only one tonne of ethanol can be produced from 3.3 tonnes of wheat. Many co-products arise from the raw materials used in the process of producing ethanol, the major one being distiller's dried grains with solubles (DDGS). Other products are carbondioxide and glycerine. In August, Adisseo, in cooperation with Ajinomoto Eurolysine, organised a mini-symposium on the subject in Strasbourg, France.

By Dick Ziggers

'Variability and nutritional values of DDGS' was the subject of the presentation made by Cécile Gady, feedstuffs research manager at Adisseo. From an earlier discussion it was already clear that feed millers need a more precise definition of the nutritional content of the DDGS they are buying. This will be a difficult task since the manufacturing process at the ethanol plants is far from uniform. On the one side, DDGS quality depends on the grain quality and/or starch quality that is used.On the other side, ethanol fabrication adds variabilities such as pre-treatment effects, exogenous additions of enzymes and yeasts (to ferment the starch), yeast quality, quality of the recycled solubles, as well as drying temperature and time.

Gady begins her presentation with the conclusion that bioethanol by-products are derived from complex processes involving several sources of variation. "It then looks obvious to qualify DDGS as variable by-products," she said. "But what are the nutritional specificities of these by-products and what exactly do we mean by variation? Are we able to deal with this variability?" Quite some questions to discuss. Research has shown that considerable differences are observed among true amino acid digestibility of corn DDGS samples. Also, the nutrient composition varied substantially among DDGS with the greatest variation being found for the digestibility of lysine.

Also, the metabolisable energy content of corn DDGS in poultry is more controversial. Recent estimates of energy are substantially higher than values reported in the NRC (1994, AME 2480 kcal/kg). Studies in broilers and turkeys show differences varying from 350 to 425 kcal/kg higher values.

Variability in wheat DDGS

DDGS originating from wheat is not different in variability than its corn counterpart. *Table 1* illustrates the differences in wheat DDGS obtained from different parts of Europe. *Table 2* shows the variability in amino acid content and true amino acid digestibility in poultry. Here it can also be concluded that there is a high variability. Data on the metabolisable energy content of wheat DDGS is more controversial. Recent estimates of energy are substantially higher than the value reported by French research institute INRA (2004). Values vary from as low as 1,820 kcal/kg (INRA, broilers) to as high as 2,676 kcal/kg (Arvalis, roosters). However, Gady said that measurements are mainly affected by the methodology applied, as well as the use of unclear and out-of-date product segmentation.

In conclusion, it becomes clear that for wheat and corn DDGS there is large variability in crude fibre, fat, ash, lysine and tryptophan, and also low lysine and cystine digestibilities with high variability. For wheat DDGS there is a lack of work on energy

Table 1 - Variation in wheat DDGS samples

(%)	Standard protein* Mean	SD	CV%	Low protein**
Protein	36.6	2.3	6.3	28.3
Fat	6.6	1.1	16.3	11.6
Crude fibre	7.9	1.3	16.1	10.4
Ash	5.4	0.6	11.0	4.8
Humidity	11.1	2.8	25.5	12.8

*) Seven samples from Sweden (1), Germany (3) and France (3) **) One sample from Finland

Table 2 - Variation in amino acid variability and digestibility in wheat DDGS samples (poultry)

(%)	Standard protein* Mean	SD	CV%	Low protein**
Lysine	1.93	0.36	18.4	1.70
Methionine	1.45	0.07	5.1	1.50
Cystine	1.84	0.11	5.4	1.13
Threonine	3.32	0.57	17.1	3.40
Tryptophane	1.07	0.12	11.5	0.73
True amino acid digestibility				
Lysine	38.2	10.4	27.1	
Methionine	77.7	5.1	6.6	
Cystine	55.8	5.3	9.6	
Threonine	67.9	7.0	10.4	
Tryptophane	71.6	7.5	10.5	

*) Seven samples from Sweden (1), Germany (3) and France (3) **) One sample from Finland

digestibility, and for corn DDGS there is lack of consensus on energy digestibility. "A possible explanation for this is the addition of recycled solubles in different proportions," said Gady. Differences in processing technologies and conditions, such as possible heat damage, also contribute to variation. Furthermore, there could be interactions with enzymes and yeasts that are added during the process. Composing a feed recipe is therefore difficult. "Nutritionists need consistency and predictability in the feed ingredients," she said.

NIRS maybe a solution

A promising technology that could predict variability fast and accurately is NIRS. Here, a coherent database needs to be established that is useable for corn and wheat DDGS. Laboratory data and NIRS data perfectly match in a linear way, with a balanced distribution of outcomes. Adisseo research showed good NIRS calibrations of total amino acids (R^2>95%) and of amino acid digestibility (R^2>80%), except for digestible tryptophan (R^2=66%). Prediction errors associated to the models vary from 2 to 6%, except for digestible lysine (E=9%).

Gady's general conclusion is that although the ethanol process will further evolve, this evolution will have a direct impact on the quality of DDGS both now and in the future. The industry will continue to generate variable by-products, even if efforts are made for standardising production.

Consequences for the market

The shift in market demand for cereals for fuel instead of feed has implications for feed formulators. Figures for 2006 show that cereal utilisation exceeded production. This shortage was then balanced using the cereals in stock, which resulted in a world stock that decreased rapidly. For 2007, utilisation and production are in balance, but stock cannot be replenished, except on a regional level. On the other hand, the world market for protein-rich feedstuffs is in a continuous increase and will reach 250 million tonnes in 2007/08. According to trading specialist AC Toepfer Int., soybean meal is the main source of vegetable proteins followed by rape/canola, and then corn gluten feed/DDGS.

There will be a shift in protein sources in Europe in the coming years. Total oil meal and expellers is expected to increase from 45.2 million tonnes in 2004/05 to 48.8 million tonnes in 2010. Within this group of raw materials there will be less soybean meal, more rape seed meal, less sunflower and a significant rise in DDGS availability (*Table 3*). This shift, together with the developments in the biofuel sector, will have economic consequences. Piet van der Aar, managing director of Schothorst Feed Research in the Netherlands, summarised the effects of the biofuel industry on feed formulation. "Biofuels set the price," he said. "Cereals will be prised at a higher level and starch sources will become scarcer. The availability of protein sources will change and higher feed costs are expected. The energy value of raw materials will become more important and variation in quality should be known," said Van der Aar. He also pointed at the increased availability of rapeseed meal and expellers from the biodiesel industry. Furthermore, glycerol is a new ingredient which the feed industry is unfamiliar with dealing with.

Table 3 - Changes in protein sources in Europe

X million tonnes	2004/05	2010
Total oilmeal and expellers	45.2	48.8
Soybean meal	33.1	25.0
Rape seed meal	7.5	13.3
Sunflower	4.1	3.0
DDGS	0.5	7.2

Expected changes in feed composition

Dairy	More DDGS, especially the wet form at the expense of soybean meal (SBM), rape seed meal (RSM) and molasses.
Pigs	Probably more RSM and to a lesser extend DDGS at the expense of cereals and SBM. Will peas become a starch source?
Poultry	DDGS is interesting in a RSM restricted composition at the expense of SBM. If animal protein (MBM) is allowed, it will replace SBM.

Table 4 - Value of wheat DDGS in different feeds (€/tonne, calc. July 2007)

Dairy	176-210
Gestating sows	164
Finisher pigs	180
Layers	213/182 (rape 2.5%/10%)
Broilers	180/177 (rape 5%/10%)

Source: Schothorst Feed Research

Table 5 - Possible practical incorporation rates of wheat DDGS

Dairy	10-20%
Beef	30-40%
Gestating sows	40%
Fattening pigs	20%
Nursery pigs 0-2 wks	0%
Nursery pigs 3-5 wks	5%
Broilers	10%
Layers	15%

Source: Schothorst Feed Research

Price competition

As we can already see today, there is a strong price competition in raw materials in concurrence with price fluctuations of crude mineral oil. A higher oil price implies a higher price to be paid for cereals to be used for biofuel production. For example, if the oil price is $60 (per barrel) the biofuel industry can pay $4.30 - $4.60 per bushel of maize ($175/t) to make a $0.33 litre of vegetable fuel. If the oil price rises to $70, a bushel of maize can be purchased for $5.40 - $5.70 ($220/t) and vegetable fuel price increases to $0.36 per litre. It goes without saying that this is tough competition for the feed industry.

Nutritional effects

Because the fuel industry extracts a lot of starch from the market, protein will become relatively cheaper. This will result in higher protein concentrations in diets and will also increase the risks of more gastro-intestinal disorders in animals. More protein also has a negative effect on nitrogen and ammonia emissions.

"We are taking the starch away from the feed, but what is the effect of this on the animal?" asks Van der Aar. The level of starch in the diet has an effect on stimulation of protein deposition - the protein-fat ratio in the diet. Also, fertility is affected and yolk-albumen ration in eggs might change if starch levels decrease.

Additionally, feed and food safety will be challenged with the increased use of DDGS, explained Van der Aar. A concentration of contaminants can occur, specifically mycotoxins. Pigs are very susceptible to these toxins. Residues of crop protection agents can also enter the feed chain through DDGS. Furthermore, the US will try to export their surplus of DDGS; however, antibiotics used as production aids in the US might hamper exports to Europe. The EU has a zero-tolerance for in-feed antibiotics. Another co-product of ethanol production is glycerol. Although trials have shown that it can be used as a feed ingredient, glycerol in feed is prohibited in the US due to possible methanol residues from the production process.

The use of these new ingredients can affect husbandry aspects, and can also alter the quality of animal products. Here, one can think of saturation of fat, water holding capacity, litter quality and indirect effects on animal health.

Inclusion levels

In terms of costs, DDGS has different values depending on the feeds it is used in. *Table 4* shows the value of wheat DDGS in different feeds. Nutritionally, research for maximum levels of critical compounds (glucosinolates, unsaturated fatty acid, soluble NSPs) is required. The levels of inclusion depend on levels of critical compounds in other ingredients used. What will the input for least-cost formulations be? There are more restrictions for the use of biofuel products. The use of rape products is limited due to their ANF content (glucosinates, saponins). There is little knowledge about the net energy value of glycerol, and DDGS varies too much in terms of quality, protein digestibility and fermentable NSPs. What about the high P and N excretion? Taken all these factors into account, Van der Aar generated possible practical incorporation levels for wheat DDGS. These are illustrated in *Table 5*.

The availability of protein-rich ingredients and the greater demand for starch for biofuels means that the feed industry is faced with more expensive starch sources. This also results in less starch in the diet. There will also be more pressure on glucose precursors in the diet. Minimum starch requirements need to be re-evaluated regarding physiological requirements, optimal production and energy requirements.