Pigs and poultry perform well

The ethanol industry is one of the most rapidly growing agricultural industries in the US. As a result, the amount of production of a co-product - distiller's dried grains with solubles - is increasing at the same speed. The product is increasingly used in animal feed with no adverse effect on performance, but relatively little is known about this raw material.

By Dick Ziggers

The ethanol industry is one of the fastest growing industries in the mid-western United States.

US ethanol production is expected to rise to 12.5 billion litres in 2004, up from 8 billion litres in 2002. The production of distiller's dried grains with solubles (DDGS) has grown parallel to production and is expected to rise to 6.2 million tonnes in 2004 from 4.5 million tonnes two years ago.

Because of the large supply of DDGS available to the feed and livestock industry, researchers at several universities have been conducting experiments to evaluate its nutritional value in order to develop feeding recommendations for dairy, beef, pigs and poultry.

There is considerable variation in DDGS quality, nutrient composition and nutrient digestibility among sources. Research conducted at the University of Minnesota has shown that corn DDGS produced by modern, dry mill ethanol plants in Minnesota and South Dakota is of much higher quality and nutritional value for pigs and poultry than DDGS produced by older, more traditional ethanol plants. DDGS produced by these "new generation" ethanol plants is an excellent source of energy, digestible amino acids, and available phosphorous for pig and poultry diets. Currently, DDGS is an economical, partial replacement for corn, soybean meal, and dicalcium phosphate in livestock and poultry feeds. Historically, over 85% of DDGS has been fed to dairy and beef cattle, and DDGS continues to be an economical feed ingredient for use in ruminant diets.

DDGS obtained from the traditional milling process (left, and DDGS from a modern new generation ethanol plant.

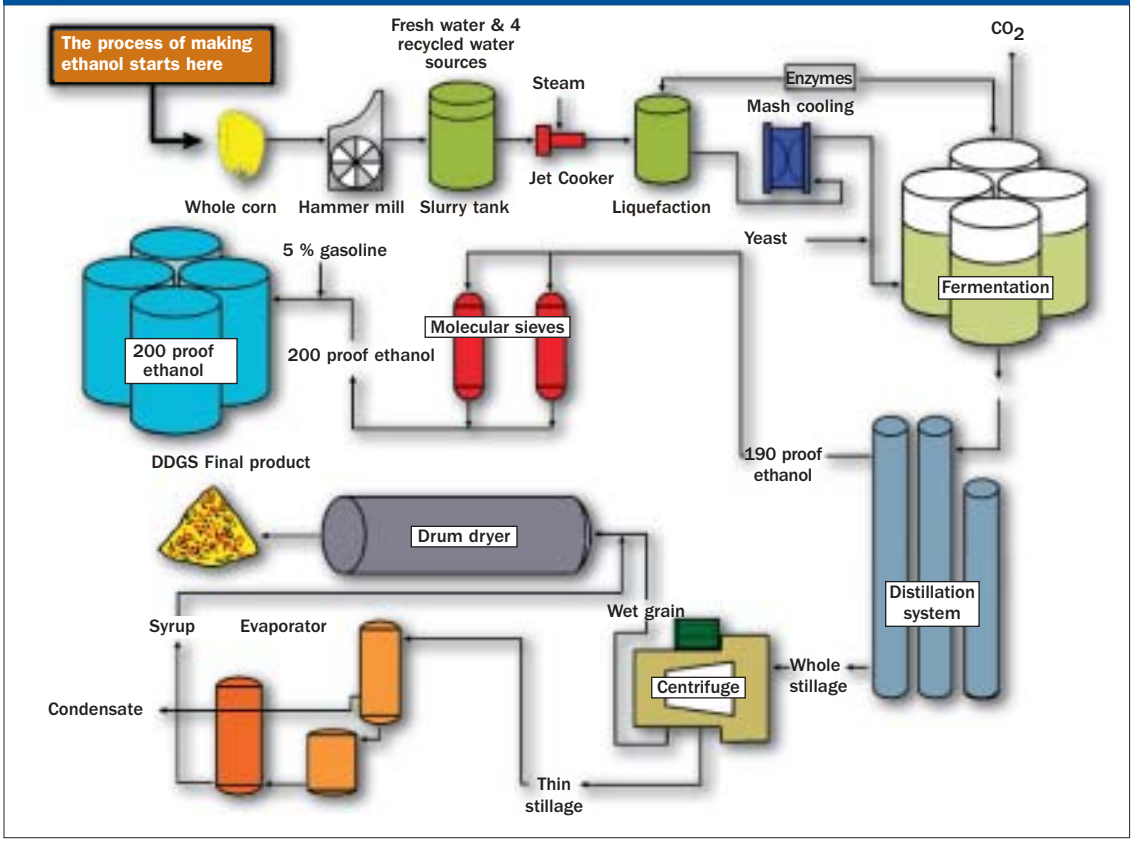
Production and composition

Distiller's dried grains with solubles are the dried residue remaining after the starch fraction of corn is fermented with selected yeasts and enzymes to produce ethanol and carbon dioxide. After complete fermentation, the alcohol is removed by distillation and the remaining fermentation residues are dried (*see Figure 1*).

Historically, three types of residual co-products were produced: distiller's dried grains, distiller's dried solubles, and distiller's dried grains with solubles. Once the fermented mash was distilled, the soluble portion of the remaining residue was condensed by evaporation to produce condensed distiller's solubles. The course material remaining in the fermen-

on distiller's dried grains

Figure 1 - The corn dry milling process to make ethanol and its co-products



tation residues was the distiller's grains fraction. Both of these fractions were subsequently dried to produce either distiller's dried solubles (DDS) or distiller's dried grains (DDG).

Today, ethanol plants blend and dry these two residues to produce distiller's dried grains with solubles, which is the only form available to the feed industry. The DDS fraction has the highest concentration of nutrients compared to DDG and DDGS. It is a rich source of vitamins, and is the lowest in fibre and highest in fat, yielding a DE value that is approximately 91 % of that found in corn.

Since DDGS is a blend of DDS and DDG, one would expect the nutrient composition of DDGS to be intermediate between DDS and DDG. This is generally the case with the following exceptions: crude protein, arginine, histidine, lysine, methionine, cystine, tryptophan, magnesium, sodium, sulfur, selenium, vitamin B12, and folacin. Some ethanol plants use milo (increasing), wheat, or barley in the fermentation process, depending on geographical location and time of the year. As a result, nutrient composition can vary among DDGS sources.

Because of the near complete fermentation of starch, the remaining amino acids, fat, minerals and vitamins increase approximately three-fold in concentration compared to levels found in corn. Despite the significant increase in crude protein, the poor amino acid balance of DDGS must be addressed when formulating pig and poultry diets.

Strong demand

Many US beef and dairy producers struggling with this year's soaring costs for traditional animal feeds have turned to DDGS as a cheaper feed alternative. The boost in production has pressured DDGS prices this year at a time when costs for more traditional protein feed supplements like soy meal have surged to multiyear highs. Cash soy meal prices climbed above $320 per tonne earlier this year, more than double year-ago levels, as a US soybean shortage after last year's drought set futures soaring.

Cash 48% protein soy meal was being offered at $300 to $306 per tonne end of April. In contrast, DDGS at the same time was selling at around $112 per tonne. The wide spread has led many livestock pro-

ducers - both in the US and overseas countries - to turn to DDGS for their feed needs. About 22 to 25% of DDGS is sold into export markets, with Southeast Asia and South America the prime destinations. Vietnam, Malaysia and Indonesia bought DDGS from the United States for the first time this year.

DDGS' protein content is similar to that of soy meal with the only big difference being DDGS' absence of lysine. About 80% of DDGS production is utilised by dairy and beef producers, with an additional 15% used for pig feed and the rest going to poultry, according to the National Corn Growers Association.

Only cattle feed?

DDGS traditionally was been fed only to cattle, because older ethanol plants overheat the DDGS, which makes it less digestible and removes many of the nutrients essential to poultry and pigs. The published nutritional guides have not been updated to reflect the better quality DDGS now being produced at modern ethanol plants and so pig and poultry producers, until recently, have continued to believe that DDGS is unsuitable as a feed ingredient.

Some years ago, a group of five ethanol producers from Minnesota began working together to find new ways to promote DDGS. Minnesota was the third largest pig producer in the US.

First, they conducted informal studies with local pig producers to see if their theory about the high quality of their DDGS was correct. Then they funded research through the University of Minnesota to gather scientific data that could replace the outdated nutritional analysis data in published nutritional guides that pig producers use to formulate pig diets. Since then all ethanol plants in Minnesota joined the DDGS research project.

Dr Shurson, a pig nutrition specialist at the University of Minnesota, discovered that the nutritional content of DDGS is indeed much better for several nutrients than what is typically published in pig nutrition guides. For instance, a phosphorous digestibility study showed that the DDGS product from the Minnesota ethanol plants has more available phosphorous than previously indicated.

The Minnesota Corn Research & Promotion Council is funding studies that include implementing DDGS feeding trials with poultry producers and finding new uses for by-products. For example, the Council is interested in finding ways to separate the oil, fibre and protein from the corn as it goes through these processing plants, and finding profitable markets for those separate by-products.

THE NUTRITIONAL CONTENT OF DDGS IS MUCH BETTER FOR SEVERAL NUTRIENTS THAN WHAT IS TYPICALLY PUBLISHED IN PIG NUTRITION GUIDES

DDGS in pig diets

Growth trials in the US with nine different DDGS sources demonstrated large differences in gain, feed intake and feed efficiency, depending on the source of DDGS in the diet. Therefore, DDGS quality has a considerable – and variable – impact on livestock performance. One of the reasons for this is that nutrient variability of the corn used has a dramatic impact on the variability of DDGS. Since starch in corn is converted to ethanol and removed, the remaining nutrients in corn are concentrated and roughly tripled in the resulting DDGS. Also type of yeast used, fermenting and distillation efficiency, drying temperature and time, and amount of solubles blended with the dry material all affect the nutrient concentration in DDGS.

Table 1 shows large differences in nutrient concentrations for the processing methods (traditional and new generation ethanol plants), especially for two of the most critical nutrients: digestible lysine and digestible phosphorous. The best answer to the question which value to use in formulating pig rations is probably to sample each load of DDGS and analyse for lysine and phosphorous and multiply by their digestibility coefficients (lysine = 0.53 and P = 0.90) to get the amount digestible of each nutrient.

Mycotoxins

Unfortunately, the fermentation process does not destroy mycotoxins. In fact, just as it does for lysine and other nutrients, it concentrates the mycotoxins threefold. If corn containing 1 ppm zearalenone is delivered to an ethanol plant, the resulting DDGS will contain 3 ppm zearalenone. Thus it is quite possible that the maximum inclusion rate of mycotoxins is exceeded and can cause problems, especially in sows.

However, this is more a problem if the ethanol plant is purchasing damaged grains or if it has been a year, which there has been a mycotoxin problem in the corn in the field. Still it is strongly recommended to start conservative when including DDGS in gestation and lactation diets.

Inclusion rates

Corn is a poor quality protein source for pigs due to its poor amino acid balance. In DDGS the poor amino acid balance is concentrated, not improved. To incorporate DDGS in pig diets, the diets must be formulated on a lysine (first limiting amino acid in grain-based pig diets) or digestible lysine basis. When formulated on a crude protein basis the diets will be grossly deficient in lysine and other essential amino acids and pig performance will substantially be decreased.

As DDGS is an excellent source of digestible phosphorous the amount of dicalcium phosphate can be reduced.

When starting with DDGS in pig diets it is recommended to start at a low inclusion level and gradually increase to the maximum inclusion rate (*Table 2*). Work at the University of Minnesota has shown that when immediately was started at the higher levels for sows resulted in an initial reduction in feed intake for about one week before they went back to full feed.

DDGS concentrations up to 30% of the diet have no effect on grow-finish performance. However, this level does result in carcasses that have reduced belly firmness and more soft fat due to the high concentrations of polyunsaturated fatty acids in DDGS. Therefore, 20% is the maximum recommended amount in grow-finish diets.

How about poultry diets?

DDGS are not much used in poultry diets yet. At the University of Minnesota three trials were conducted with three different inclusion rates of DDGS in grow-finish diets for toms. At all three inclusion rates comparable performance in terms of body weight and feed conversion was found for the DDGS test diets in comparison to a corn-soy diet.

In another trial depressed growth in turkey hens was found as inclusion levels increased to 27%. At inclusion levels of less than 10%, performance comparable to the control was obtained. A recent study in broilers indicated that 6% inclusion in starter feed and up to 12% in grower feeds could be used without affecting live performance. Research at Michigan State University showed that DDGS can be successfully fed to layers at levels as high as 15% in post peak diets using a ME value higher than the traditional value without having a detrimental effect on egg production or shell quality. Yolk colour can be enhanced quickly with a ration containing 10% DDGS and will be darker after about two months when 5% DDGS is fed to birds previously fed a corn-soybean meal diet without additional pigments. Research up till now has shown that maximum inclusion rates of 10%, 10% and 15% for broilers, turkeys and layers respectively have no detrimental effect on performance. Higher inclusion levels require more careful adjustment of amino acid and energy levels. ●

Table 1 – Nutrient composition of two sources of DDGS (as-fed basis)

Nutrient	Traditional DDGS (%)	New generation DDGS (%)
Crude protein	27.7	26.8
Total lysine	0.62	0.74
Digestible lysine	0.29	0.39
Crude fat	8.4	9.7
Crude fibre	9.1	7.8
Calcium	0.20	0.05
Total phosphorous	0.77	0.79
Digestible phosphorous	0.59	0.71
ME (kcal/kg)	2826	3599

Source: South Dakota State University extension service

Table 2 – Recommended inclusion rates of DDGS in pig diets*

Phase	Starting point	Max. inclusion rate
Nursery (>7 kg)	5%	25%
Grow-finish	10%	20%
Gestating sows	20%	50%
Lactating sows	5%	20%
Boars	20%	50%

*) Based on high quality DDGS and on diets balanced on digestible lysine and phosphorous.
Source: South Dakota State University extension service

Extended information on DDGS can be found at www.ddgs.umn.edu and www.distillersgrains.org