

Use of By-Products from the Biofuels Industry and Other Alternatives to Replace Corn in Poultry Diets

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It is not surprising that the poultry industry is questioning the impact of biofuels production on animal feed. As the ethanol industry continues to grow, there is and will be increased competition between the ethanol and the poultry industry for corn supplies. This competition for corn has already resulted in increased corn prices and has many in the poultry industry worried about the future corn prices and availability. Feed cost remains the largest portion of poultry production costs, to control feed cost, poultry nutritionist continue to look for alternative feedstuffs. Traditionally, when there is a reduced supply or increase in the price of one feed ingredient (as with corn), nutritionists seek alternative sources of energy and nutrients.

When formulating feed for poultry, the two most critical nutritional components are protein and energy. The current increase in diet cost is not due to increased protein costs but rather due to increased energy (corn) costs and in poultry diets, energy remains a highly limitative factor. Some of the alternative feed ingredients, fats and oils, bakery meal, milo, wheat and barley, are not especially promising as meaningful alternatives to corn. The supply of bakery meal is unlikely to increase. Alternative grains such as milo, wheat and barley can also be employed to produce ethanol, are in general, lower in energy than corn, and in any case their cost would parallel that of corn. Fats and oils, which are popular feed ingredients, contain about 2.5 times more energy than corn, but are increasingly being converted to biodiesel, thus their costs are increasing as well (another reason that energy prices are going up) and corn cannot easily be replaced with soybean oil or animal fat. Pearl millet may be one ingredient that has some promise as an alternative to (or replacement for) corn in poultry diets. Distillers dried grains with solubles (DDGS) may be used as a possible alternative feed ingredient if it is cost effective. Sectors of the ethanol industry are starting to use a new bio-refining production technology which separates the corn into three fractions: fiber, germ and endosperm, prior to ethanol production. These fractions are then converted into new co-products, high protein distillers dried grains (HP-DDG) and corn germ which may be used as alternative feed ingredients in poultry diets. Currently, glycerin (the by-product from bio-diesel production) is being evaluated as a possible energy source in poultry diets and may be a less expensive energy source. However, it would have many of the same drawbacks as fats.

Distillers Dried Grains with Solubles:

Many believe that all the feed problems created by the use of a substantial amount of the nation's corn supply for ethanol production will be solved with the feeding of DDGS. However, DDGS does not directly replace corn in a poultry diet (it will replace corn, soybean meal, meat and bone meal, phosphorus, methionine, etc and thus its use will depend on the price of all these ingredients) and has other constraints which limit its use. Currently, the main issues with DDGS are the price, availability and logistics/transportation. There is also high variation in its nutrient content and quality, such as for protein (especially for lysine digestibility), fat, and phosphorus. The energy value of DDGS for poultry is approximately 17% lower than that for corn (1,280 vs. 1,540 kcal/lb, respectively) and has the most influence on the value of DDGS. The variation in DDGS can be due to corn (variation in corn from regions), the processing at the ethanol plant (mash times, temperatures, enzyme use, distillation process, etc), drying temperatures, and the amount of solubles that are added back to the product. Between plants and sometimes even within plants there can be a high variation in the moisture level (moisture should never exceed 12% and during the summer should be 10% or lower), lysine digestibility (which is likely due to drying and has been shown to be correlated with color, the lighter and more yellow the product the higher the available lysine), sodium (due to products used at the plant for cleaning) and protein and phosphorus, (which is likely due to the variation in corn used at the various plants). Reliable nutrient values are important to obtain when using DDGS in poultry diets, especially when high levels of inclusion are being used, as the risk associated with nutrient variability becomes greater.

The nutrient variation is not the only problem with the use of DDGS. DDGS has caused problems at nearly every phase of feed manufacturing. This includes railcars that simply won't unload, lack of bin space, problems with handling and flowability, and maybe of greatest concern is pellet throughput and pellet quality issues. The handling problems with DDGS may be attributed to the flat, plate-like structure of the bran, which results in an arch-formation when DDGS is stored. There are a few approaches that can help to improve the flow characteristics of DDGS, however most need to be implemented at the ethanol plant. The first is to simply hold the DDGS in the flat storage site until the moisture equilibrium has occurred, which will be longer during the summer months. It is likely that the main issue with DDGS in poultry feed mills is the effect on pellet throughput and quality. However, few studies have been conducted looking at this area, and thus the information is limited. It has been said that when the level of DDGS in the diet exceeds 5 to 7%, pellet throughput and pellet quality will suffer.

Even with these issues/challenges, DDGS is a highly acceptable feed ingredient that can be used successfully in poultry diets to reduce costs.

Distillers Dried Grains and Corn Germ:

In recent years, policies encouraging the production of ethanol have stimulated an enormous increase in the production of distiller's dried grain with solubles (DDGS).

Until recently, the majority of the dry-grind ethanol plants used unmodified corn (or other cereal grains) to produce ethanol and some type of distillers dried grains (DDG). However, many plants are implementing a modified dry milling process as the first step in the ethanol facility. The whole corn is milled into several fractions; corn germ, bran and the endosperm which is used for ethanol fermentation. Ethanol facilities are implementing this modified dry milling process because it increases ethanol yield. However, what is not so obvious is how these changes affect the nutrient quality of the resultant co-product. When considering the potential use of a feed ingredient such as HP-DDG and corn germ, primary emphasis is placed on obtaining accurate information regarding metabolizable energy, phosphorus availability and amino acid composition and digestibility. The two main resultant products are corn germ and a high protein distillers dried grains (HP-DDG), which is the product after the fermentation of the endosperm to ethanol. The corn germ fraction is high in fat and phosphorus, and has a more desirable amino acid profile. The DDG product has a very high protein level (which is why it is often called high protein DDG) and lower levels of fat and phosphorus, because it does not contain the syrup that would normally be added back to the DDG. The average protein, fiber, and fat % for DDGS was 27, 7, and 10, for HP-DDG 44, 7, and 3, for corn germ 15.5, 4.5, and 17. The average TME_N was 2,879, 2,846, and 3,204 kcal/kg (as-fed basis) for the DDGS, HP-DDG, and corn germ, respectively. The total P content and P bioavailability of the DDGS, HP-DDG, and corn germ were 0.77 and 60, 0.35 and 47, and 1.18 and 31%, respectively. Total concentration and percent availability, of lysine for the DDGS, HP-DDG, corn germ, and bran was 0.94 (75), 1.16 (74), 0.83 (86) and 0.43% (68%), respectively. The total lysine as a % of CP was 3% for the conventional DDGS and only 2% for the HP-DDG, however these products had a similar TME_N. New bio-refining techniques result in co-products that have unique nutritional qualities compared to conventional DDGS. Thus, confirmatory analyses should be conducted prior to utilizing these new co-products in poultry diets.

Most of the work conducted to date with products from new processing techniques in the ethanol plant has been done to look at the effects on the nutritional value of these products. Currently two broiler feeding studies and one laying hen study have been conducted/are under way to evaluate the feeding value of DDG. Hy-line W36 laying hens were fed a commercial layer diet with 0, 3, 6, 9, or 12% DDG. The addition of 3% DDG to the commercial layer diet significantly ($P > 0.05$) improved egg production and egg mass over the positive control (0% DDG). However, there was no difference in egg production between the diets with 6, 9 and 12% DDG as compared to the positive control or the diet with 3% DDG. There was no significant difference in specific gravity, haugh units, yolk color, body weight, or feed efficiency during the first 5 wks (21 to 26 wks of age) due to the addition of up to 12% DDG. This experiment will be carried out to 41 wks of age. Cobb 500 by product males were fed commercial starter diets with 0, 3, 6, 9, 12, and 16% DDG. The addition of 3% DDG to the diet significantly improved ($P > 0.05$) weight gain as compared to the broilers fed the diet with 0, 6, 9, 12 and 16% DDG. Increasing the level of DDG in the diets to 16% significantly ($P > 0.05$) depressed weight gain, feed intake, and feed efficiency as compared to the 0 or 3% DDG diets, likely due to a deficiency in lysine. The addition of 3% DDG to a commercial

layer or broiler diet significantly improved performance and DDG (up to 12%) is a highly acceptable feed ingredient for poultry diets.

Glycerin:

Increased government pressure for biofuels has led to a significant increase in biodiesel production resulting in increased cost for fat. Demethylated glycerin, a by-product of biodiesel production, may be used as an alternate source of fat in broiler diets. The proximate analysis, TME_N, mineral content, and fatty acids of four glycerin samples were determined. The TME_N of the glycerin samples ranged from 4,800-6,700 kcal/kg. The samples had approximately 25-35% fat, 8-12% moisture, 4% ash. The methanol content ranged from 0.01 to 1.8%. Minerals present in greater than trace amounts were calcium and potassium at 70 and 800 ppm, respectively. The principle fatty acids of the glycerin samples were oleic acid and linoleic acid. One of the glycerin samples was added to a broiler diet as a partial fat replacement and fed in a 42 d experiment. Six diets were fed to eight replications of 40 chicks consisting of: 1) a positive control with 3.6% poultry fat (3,085 Kcal/kg); 2) a negative control with 1% poultry fat (2,920 Kcal/kg); 3) 5% glycerin, 1% poultry fat (3,085 Kcal/kg); 4) 2.5% glycerin, 1% poultry fat (3,085 Kcal/kg), achieved by blending treatment 1 and 3 in a 1:1 ratio; 5) 2.5% glycerin, 1% poultry fat (2,975 Kcal/kg), achieved by blending treatment 2 and 3 in a 1:1 ratio; and 6) 7.5% glycerin, 1% poultry fat (3,085 Kcal/kg). There were no significant differences in weight gain or feed intake between the positive, negative control diets or the 2.5% glycerin (3,085 kcal/kg). Weight gain and feed intake decreased significantly for the 2.5% glycerin (2,975kcal/kg), the 5% and 7.5% glycerin for all periods except the grower period. During the grower period there were no differences in weight gain or feed intake. No differences in feed efficiencies were observed. The reduction in body weight and feed intake with increasing levels of glycerin may be due to the high methanol content of the glycerin used (1.7% methanol). Glycerin may be used at low levels (2.5%) as a partial fat replacement in broiler diets. However, studies conducted out of Park Waldroup's laboratory (University of Arkansas) revealed that from up to 10% demethylated glycerin (<0.05% methanol) could be included in broiler diets from 1 to 16 d of age without adversely affected performance. Based on a second study Dr. Waldroup's laboratory demonstrated that diets with 5% demethylated glycerin supported performance to 42 d of age equal to that of a positive control (with no added glycerin). However, diets with 10% glycerol did not flow well in the tube feeders and inhibited feed intake, resulting in slower growth and poor feed conversion. Also they found the litter from the pens of broilers fed diets with 10% glycerin was visibly wetter and contained about 0.15% higher K levels as a results of residual K in the glycerin. Demethylated glycerin may have some promise as a feed ingredient (energy source) for poultry diets however issues with product consistency, methanol, sodium or potassium, and moisture levels and feed flow, handling and manufacturing need to be better understood.

The concern over the future availability and price of energy for poultry feeds increasingly being voiced by feed producers is based on the expansion of the biofuel industry. Increasing ethanol and biodiesel production will certainly raise grain and feed fat (and ultimately food) prices. Thus, the use of alternative ingredients in poultry diets

to keep feed cost low will become essential. However, it is imperative that we learn to deal with these byproducts effectively so that we can produce the highest quality feeds possible.