The benefits and concerns of utilising alternative feed ingredients

by Dr Jonathan Broomhead, Manager, Global Poultry Research and Technical Support, Diamond V, Cedar Rapids, Iowa, USA.

Year after year poultry producers and integrators around the globe face difficulties with profitability in producing birds, eggs, chicks or meat. Whether it is disease outbreaks, increasing feed cost, or governmental regulations, the cost to produce meat or eggs are consistently increasing for growers/integrators.

Profitability in animal agriculture has been particularly difficult to achieve within the last year due to the environmental conditions affecting crop production in many regions of the world. The Corn Belt in the United States was particularly hit hard due to the most devastating drought in decades. Corn is the primary carbohydrate source used in diets in many regions of the world, so when prices skyrocketed, potential profit to produce a bird or egg diminished.

When the price of one carbohydrate grain goes up, so does the price of all (for example wheat and barley). As a result, increased corn prices will affect grain/feed costs throughout the world; even those regions that rely more on wheat and barley as a major energy source.

The same situation can be observed with protein ingredient sources such as soybean meal (SBM) and animal proteins, etc. When this occurs, nutritionists will start to consider supplementing the diets with lower cost ingredients to reduce feed costs and improve profitability.

However, if not careful, utilisation of alternative feed ingredients may come with a cost of lower body weight yield, egg production, meat and egg quality, or breeder fertility and worse feed conversion (FCR).

The reduction in performance can result from less digestible, variable, or imbalanced nutrients or even anti-nutritional factors that can affect feed intake, growth, or egg yield and negate the benefits of using the less expensive, alternative ingredients.

DDGS and energy sources

Corn distillers dried grains with solubles (DDGS) has been a hot topic as a less expensive replacement for corn and SBM because of being a by-product of the ethanol industry. The historic concerns of using DDGS in diets are finding a consistent source, potential increasedmycotoxins, variability in nutrient values, and antibiotic residues.

Other nutritional concerns about using higher doses of DDGS are amino acid imbalances, such as being limiting in lysine, tryptophan and arginine and increased dietary cysteine, with lower methionine, when formulating on total sulphur amino acid content.

Feed pellet quality and meat quality issues have also been noticed when feeding higher DDGS to meat type birds.

As corn availability has decreased and prices have increased, so has the price of DDGS, which would make it a little less attractive to nutritionists. Also, with ethanol companies finding better methodology to extract more oil from the corn, low oil DDGS is becoming more prevalent. The low oil DDGS will also typically have lower energy content and less value for adding into diets to substitute corn.

Noll and Purdum (2013) suggested that low oil DDGS might fit better with layer diets. The authors cited research in which egg production was not significantly affected and yolk colour score was improved with addition of DDGS (20%) containing low, medium, or normal oil contents (compared to corn/SBM diet). Authors reported that most laying hens have the flexibility to adjust feed intake when reductions in dietary energy may occur (from DDGS variations; Fig. 1) making DDGS an attractive option for layers.

Barekatain et al (2012) conducted a study in broilers feeding either 0, 15 or 30% sorghum DDGS with or without protease,

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Fig. 1. Egg production and feed intake of hens fed DDGS with varying oil contents (adapted from Noll and Purdum, 2013).

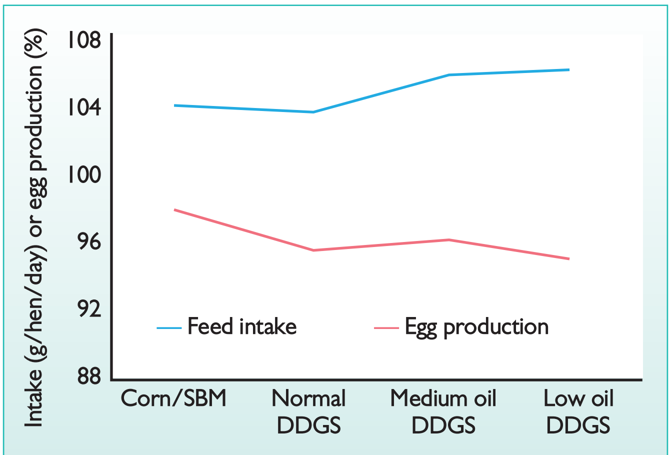
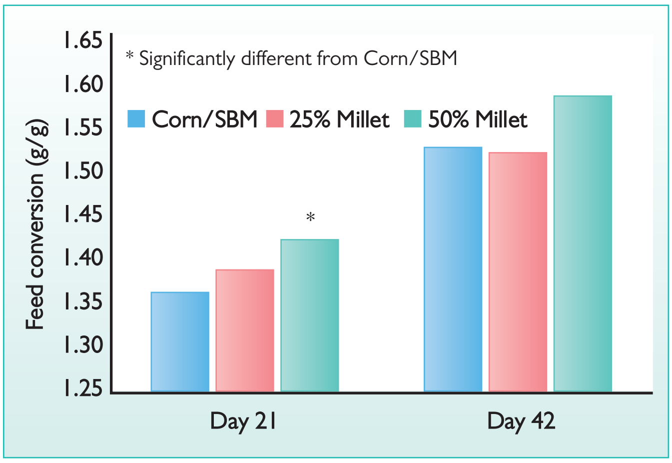


Fig. 2. Feed conversion in broilers fed pearl millet (adapted from Davis et al, 2003).



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xylanase, or the combination. Feed intake and body weight gain was improved with the sorghum DDGS addition, however at the expense of a higher FCR.

As dietary sorghum DDGS increased, ileal insoluble non-starch polysaccharides (NSPs) increased and protein digestibility decreased, which is the probable cause for the poor FCR. Addition of enzymes did improve the FCR in the birds fed the sorghum DDGS diets, with the best improvement observed in the protease/ xylanase combination treatment.

Pearl millet has shown to be more drought resistant and can grow well in acidic soils and matures quickly. Having a higher protein level than corn, pearl millet can substitute both corn and SBM. Davis et al (2003) tested a rust-resistant pearl millet hybrid, and found that 50% can be formulated into diet reducing corn and SBM by approximately 46 and 4%, respectively.

A potential limiting factor with pearl millet is more variable protein levels than found with corn. Researchers found that feeding the broilers 25 or 50% pearl millet for 42 days had similar growth and carcase weight as the corn/SBM control birds.

An increase in early FCR (Fig. 2) was observed with 50% pearl millet, however, male broilers fed 25% pearl millet had significantly higher carcase yield (Fig. 3) than the corn/SBM fed birds.

Results show that pearl millet may be a good supplement in meat-type bird diet but maximum dietary levels should be maintained and feed efficiency monitored.

Cassava root meal (CRM) is not a novel feed ingredient for poultry and has become more of a staple in tropical regions of the world where there is a high production of cassava.

Garcia and Dale (1999) wrote a review article citing research with maximum inclusion levels of CRM in broilers between 10-30% (with even 40-60% reported) and 15% for layer starter or 30-40% during lay. The anti-nutritional factor, cyanogenic glucoside, can be present in CRM and produces hydrocyanic acid (HCN), which is highly toxic. As with many feed ingredients, processing methods affect anti-nutritional factors and improve palatability and potentially allow increased dietary inclusion rates.

Protein sources

Cassava leaf meal (CLM) has also been used for a poultry feed additive, along with the roots, but there may be greater HCN concentrations in the leaves. Researchers added CLM to finishing broilers diet at 0, 5, 10, or 15% (replacing soybean meal) for five weeks (Iheukwumere et al, 2008).

The addition of 5% CLM did not significantly affect BWG and FCR, but 10 or 15% reduced performance. There appeared to be numeric reduction in nutrient digestibility as CLM increased in the diet. Even 5% CLM reduced crude protein and ether extract (fat) digestibility by 10%, with a numerical (17 point) increase in FCR.

In a separate paper, Iheukwumere et al (2007) reported that even the 5% CLM numerical reduced carcase yield by 10% and part weights were significantly lower. The authors reported that the leaves were only sun-dried and ground, which may not have removed anti-nutritional factors such as HCN and tannin.

However, Ravindran (1991) stated that sun drying, alone, would reduce HCN by 90% and is more efficient than mechanical drying. Low levels of CLM could be included but animal performance should be monitored and supplemental sulphur amino acids may be required.

Peanut meal (PM) is well known for its high protein content and can be used for substituting SBM in the diet. However, PM is also well known for potentially containing higher levels of the mycotoxin, aflatoxin and can be detrimental for performance.

When using PM it is advised to also include an aflatoxin binder/ameliorator in the diet. Laying hen research comparing the use of SBM vs. PM as the main protein source for 12 weeks resulted in similar egg production and FCR between protein sources. The eggs from the PM fed birds were slightly smaller during the first six weeks and lower specific gravity, but had better interior quality (Haugh units; Pesti et al, 2003).

Peanut meal based diets are limiting in threonine, methionine and lysine, so supplemental synthetic amino acids would be required, particularly in broiler diets.

Broiler research conducted by Costa et al (2001) showed that increasing synthetic threonine addition to 30% PM-corn diet improved performance (0-18 day), but not equivalent to the corn/SBM fed birds.

A separate study was conducted, in which corn/SBM diet was fed from 0-18 days and either PM (plus additional synthetic threonine, methionine and lysine) or SBM was fed as the main protein source from 19-42 days. Similar performance and carcase characteristics were observed when either SBM (36%) or PM (35%) was fed, resulting in 24% dietary protein. The results suggest that PM can be used to replace some SBM in poultry diets if precautions are taken for aflatoxins and amino acid limitations.

Sunflower seed meal (SSM) has been used in the diet as a protein ingredient to replace SBM. Laying hens (28 weeks old) were able to be fed up to 25% SSM for six weeks without negatively affecting egg production and egg quality or fatty acid profile. The researchers also showed a linear decrease in egg yolk cholesterol as SSM increased in the diet (0, 8.3, 16.5, and 24.8%; Fig. 4). Nassiri Moghaddam et al (2012) tested levels of 7, 14, or 21% SSM added to a corn/SBM diet in broilers from 1-49 days of age. A linear improvement in BWG and FCR and breast and thigh yield was observed, when up to 14% was fed, but dropped back down with 21% SSM. The authors suggested that 14% SSM is maximum inclusion rate in broilers. Higher fibre and lower energy and lysine may limit the use of SSM, so supplemental synthetic lysine and dietary enzymes may be needed when feeding broilers.

Cottonseed meal (CSM) has been investigated as an alternative protein source in poultry for decades. Other than having a

Fig. 3. Carcase yield in broilers fed pearl millet (adapted from Davis et al, 2003).

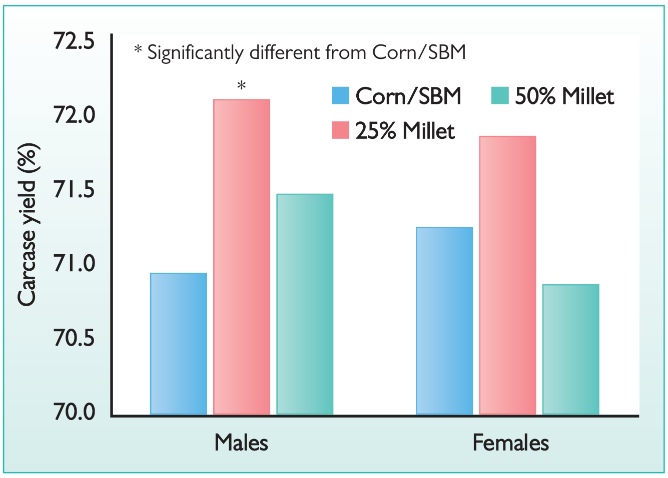
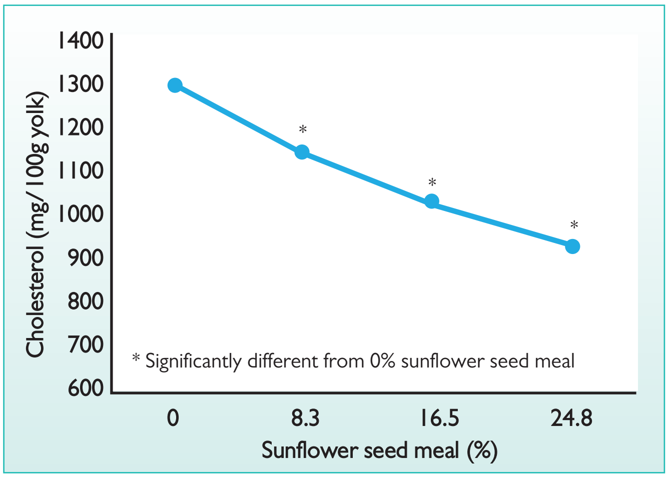


Fig. 4. Effects of sunflower seed meal on egg yolk cholesterol (adapted from Shi et al, 2012).



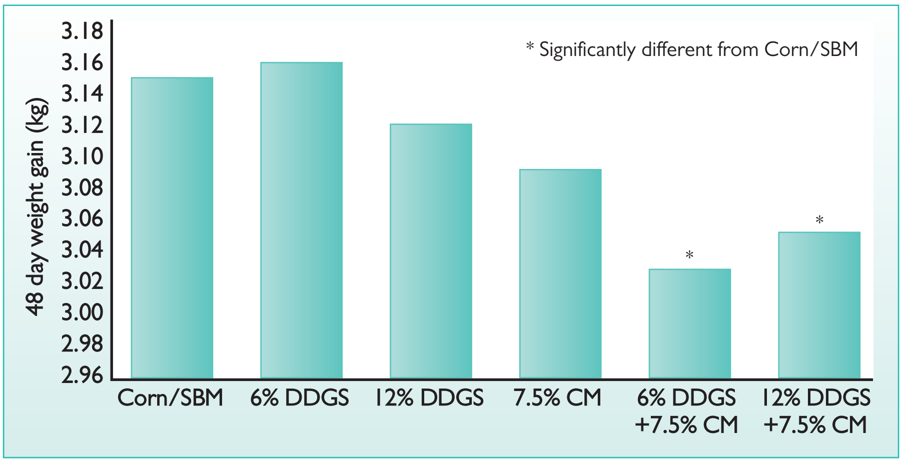


Fig. 5. Body weight gain in broilers fed corn DDGS and/or canola meal (CM) (Adapted from Jung et al, 2012).

lower nutrient quality compared to SBM, the main concern of CSM is gossypol (natural phenol).

Gossypol can cause egg yolk discolouration and reduced egg production in laying hens and reduced weight gain and FCR in broilers fed elevated levels (>10%). Certain processing methods have been shown to reduce the negative effects of CSM (glandless CSM, solvent extraction, fermentation), but add cost to the product.

Researchers have shown that CSM may have a niche for broiler breeder pullets when fed from 2-18 weeks of age, in which 20% dietary addition improved uniformity (Lordelo et al, 2004). Gossypol will accumulate in the liver and will gradually disappear on the removal of cottonseed meal from the diet. These authors report that CSM must be removed from the broiler pullet diet at least four weeks prior to onset of lay to prevent negative effects of gossypol on fertility and hatchability.

Canola meal (CM), also referred to as rapeseed meal, is a protein source that also has a high fibre content that can negatively affect energy utilisation. Khajali and Slominski (2012) reviewed the nutritive value of CM discussing anti-nutritional factors such as glucosinolates (breakdown products affect growth), tannins (binds intestinal enzymes), phytic acid (reduce mineral availability), and sinapine (odour in eggs). These authors also reviewed nutritional deficiencies such as lower metabolisable energy, variable protein digestibility, and less potassium (affects dietary electrolyte balance; DEB). Most of the issues can or have been dealt with by plant breeding (low fibre canola), processing methods (dehulling) or additional dietary enzymes and synthetic amino acids.

Combining ingredients

A broiler study was conducted feeding either 6 and 12% corn DDGS or 7.5% CM, or the combination of both through 48 days of age. Other than an increase in FCR with 12% DDGS, feeding either DDGS or CM alone did not negatively affect performance (Fig. 5).

However, feeding the combination of canola meal with either level of DDGS resulted in reduced animal performance as well as carcase yield.

A turkey study (2-14 weeks of age) was also conducted, investigating the effects of feeding either a corn/SBM diet, 20% corn DDGS, or 20% corn DDGS and 10% canola meal, with increasing levels of dietary chloride.

Litter moisture and FCR increased from feeding 20% corn DDGS with or without 10% canola meal, and this increase was more obvious with the higher chloride diets. When feeding DDGS and canola meal the DEB needs to be monitored, with particular attention to dietary chloride levels.

Conclusions

This article summarises research on only a handful of alternative feed ingredients, with many more available to poultry producers worldwide.

Utilising alternative feed ingredients may be necessary during times of high grain and oilseed meal prices, when limited supplies are available.

However, when deciding on which ingredient(s) to use, it is a good idea to do a little research on the ingredients' limitations in the type of bird you are feeding.

When either adding one or multiple alternative feed ingredients make sure they are compatible and do not amplify problems and additional feed additives may be required to aid in digestion/nutrient availability.

In summary, issues of concern when testing new ingredients include (but are not limited to): nutrient variability, unbalanced amino acids or minerals, nutrient digestibility, pellet quality, meat or egg quality and anti-nutritional/toxic factors. ■

References are available from the author on request