NUTRITIONAL VALUE OF DISTILLERS DRIED GRAINS AND SOLUBLES FOR POULTRY

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It is now well recognized by the feed industry that dramatically increasing quantities of distillers dried grains with solubles (DDGS) are entering the ingredient market. For those interested in the history of this ingredient, a substantial scientific literature exists in both refereed journals and proceedings of conferences, particularly the Distillers Feed Conference. In 1970, Dr. M. L. Scott presented a paper entitled "Twenty-Five Years of Research on Distillers Feeds for Broilers" (1). Aside from Dr. Scott, many prominent poultry nutritionists of the day were active in studying the use of this ingredient, these including G. F. Combs, Sr. (2), T.D. Runnels (3), R. H. Harms (4), and L. S. Jensen (5, 6). Papers of the period reported on tests with laying hens in which the effects of DDGS were studied on egg production, egg size, interior egg quality and liver fat accumulation. Cromwell *et al.* (7) reported on the feeding characteristics of DDGS. Nevertheless, in recent decades DDGS has only rarely been a component of broiler and layer feeds, despite the dramatic growth of the poultry industry. The lack of interest in DDGS seems to stem partly from a relatively limited supply, competing use in ruminant feeds without having to dry the product, and concerns over an occasionally inconsistent composition. The DDGS available many decades ago was derived primarily from the beverage industry based on the fermentation of a variety of grains, in addition to commercial production of alcohol.

In recent years, policies encouraging the production of ethanol have stimulated an enormous increase in the production of DDGS. The ingredient which is currently becoming increasingly available differs from that of previous decades in that it is derived almost entirely from corn and is dried under less severe conditions. Initial research to determine the feeding value of this "new generation" DDGS was centered at the University of Minnesota, where Noll *et al.* investigated the use in turkey diets (8), while Shurson, whose special area of interest is swine nutrition, has headed the development of an excellent website (www.ddgs.omn.edu) to provide information on current research with DDGS for both monogastrics and ruminants. Roberson (9) has recently studied the use of DDGS in growing and finishing turkey hens.

Studies with DDGS at the University of Georgia have been focused in two areas: an appraisal of the nutrient composition of currently-produced DDGS, and testing the use of this ingredient in both broiler and layer feeds.

EVALUATIONS OF NUTRIENT CONTENT OF DDGS

Except where indicated, this set of studies was conducted on samples of light colored DDGS from a variety of plants in the mid-west. Using the TME_n assay, the caloric value of DDGS was found to average 2820 kcal/kg (1310 kcal/lb). This value is based on samples having a crude protein content of roughly 27%, with a fat of 10%, crude fiber of 6%, ash of 4%, and a dry matter of 89%. It will be noted that many components of proximate composition of DDGS are approximately triple those of corn. This is to be expected as from the initial grain fraction 1/3 is lost as carbon dioxide and 1/3 is converted to ethanol, with the remaining 1/3 concentrated in the form of DDGS. Thus a lipid content of 10% is approximately three times that which would be expected in corn grain. Protein is somewhat more than three times higher than that of corn, presumably reflecting the presence of microbial protein from fermentation to be expected in this product.

As mentioned above, the average TME_n of DDGS was found to be 2880 kcal/kg. However, considering that these assays were conducted using adult experimental animals, when formulating diets for the tests to be described below, we arbitrarily reduced energy by 100 kcal/kg to include a margin of safety.

The amino acid composition and percent digestibility of critical amino acids are presented in Table 1. Digestibility was determined using cecectomized roosters. Chick growth studies were also conducted to estimate the bioavailable lysine content of DDGS using slope-ratio methodology. The percent availability between 75 and 80% appears reasonable. This is slightly lower than the lysine availability in corn grain, presumably reflecting a slight loss in digestibility due to the drying of DDGS. Recent research suggests that dark colored DDGS has a lower lysine availability than seen in Table 1, perhaps resulting from additional heating during the drying process (10).

The available phosphorus content of most plant ingredients is estimated to be about 33%. However, due to the fermentation process in which microbes synthesize phytase so as to access phosphorus for their own metabolic needs, it can be postulated that the fermentation vessel acts much like a rumen in improving phosphorus availability. On the basis of evaluating the total and phytate phosphorus composition of several samples of DDGS it was observed that phytate phosphorus comprised only 37% of the total phosphorus in these samples, suggesting a phosphorus availability in excess of 60% for this ingredient. This was in fact confirmed in later broiler chick studies, again using slope-ratio methodology.

An unexpected source of variation in DDGS composition is sodium (11). According to DDGS manufacturers, no appreciable source of sodium is added to either the fermentation or drying phases of DDGS manufacture. Assuming the three-fold concentration of nutrients mentioned above, and that corn contains approximately 0.03% sodium, one would expect 0.10% sodium in DDGS. Many samples, in fact, contain this amount. However, other samples, especially those which seem to be darker in color, were found to contain between 0.25 and 0.58% sodium. The origin of the sodium in these samples is unclear but may be related to the solubles fraction. Because of the wide possible fluctuation in sodium values, it is strongly recommended that assays for this mineral be conducted whenever product from a new supplier is to be used in formulation.

BROILER STUDIES

Once a reasonable determination has been made of the nutritional composition of a feed ingredient, studies can be undertaken to determine whether the ingredient performs well under practical feeding conditions. In such studies, unless there is an indication of a known antinutritional factor or some other issue which may be of concern, there is little to be gained by testing low levels of inclusion. Under experimental conditions, it is very unlikely that any effect, either positive or negative, would be observed with from 1-4% inclusion. Rather, it was our objective in both broiler and layer studies to attempt to determine the *maximum* level of inclusion which might be recommended. From this reference point, those interested in using the ingredient in commercial practice could estimate where to begin usage, and up to what point they might be able to increase inclusion with minimal risk.

In an initial battery study, chicks were reared to 18 days of age, receiving either 0 or 15% DDGS in either a high density (3200 kcal/kg, 22.5% protein) or low density (3000 kcal/kg, 20% protein) series of diets. Results of this 2 x 2 factorial test are shown in Table 2. While both body weight gain and feed conversion were significantly improved in the high density series, in neither case was an effect of DDGS observed on any productive parameter. Based on these results, a 42-day grow-out test was conducted using 0, 6, 12, and 18% DDGS. The nutrient composition of these diets was very similar to that currently used by the industry. General performance of chicks is shown in Table 3. It will be noted that both body weight and feed conversion were negatively effected by an 18% level of DDGS, while 12% during the starting period showed a slight decrease in performance. The 6% level of inclusion had no effect on performance. During the grower period, no significant differences were observed at any level of inclusion, suggesting that once past the starter period, chicks can efficiently use even high levels of DDGS. Twelve percent DDGS clearly gave excellent performance, while the growth rate in chicks receiving 18% was numerically, but not significantly decreased.

In attempting a conservative recommendation based on these data, 6% DDGS can safely be used in starter feeds, while this level can be doubled to 12% in subsequent feeds.

STUDIES WITH LAYING HENS

As stated above, our objective in these studies was to identify a maximum level of inclusion of DDGS. In designing an experiment with laying hens, we elected to test 0 and 15% levels of inclusion, in either a commercial or low density nutrient program. The higher density feeds were similar to those used by the layer industry, with 2870 kcal/kg and 18.5% protein during the initial period of lay, while the lower density diets were formulated at 2800 kcal/kg and 17% protein. One hundred twenty-four Leghorn hens

(Hy-Line W36, 22 wk of age) were assigned two per cage to each of the four experimental treatments. This study was conducted from June to October 2002, a year with normally high summer temperatures in a house without evaporative cooling.

Results are best interpreted by reviewing Figures 1-2. In Figure 1, which portrays egg production of birds receiving the commercial, or higher density set of diets, the flock entered production somewhat late due to lighter than expected pullet weights. However, hens in both treatments rapidly reached peak production. Hens consuming 15% DDGS laid numerically fewer eggs until 34 wk of age. From this point onward no differences in production were noted. Similar, but more noticeable, effects were noted for birds receiving the lower density set of diets (Figure 2). In this case, production of hens fed 15% DDGS remained below that of controls until 36 wk of age, from which point no differences were noted.

In retrospect, a 15% level of inclusion was a fortuitous level to choose for these studies. Clearly, the level was excessive for an underweight pullet flock entering production during the hottest months of the year. However, once temperatures moderated (after 34 wk of age) and body weights and feed consumption normalized, there was no apparent detrimental effect of using 15% DDGS in layer feeds. At no point were significant differences observed in egg weight (Figure 3), nor in shell or albumen quality (data not shown). As a practical recommendation, we feel that 6-8% DDGS can be included in layer diets from the onset of production, and this can easily increase to levels above 10%, once body weight and feed intake have stabilized.

SUMMARY

We have found DDGS to be a highly acceptable feed ingredient for both broilers and layers, in agreement with previous work conducted at the University of Minnesota with turkeys. Due to variation in processes which may be utilized at different plants, some variation in quality can be expected. As with any ingredient, the products of new suppliers should be reviewed by the quality control program prior to large scale use. Issues remaining to be further investigated are the relationship between color and lysine availability, effects of DDGS on pellet quality, pigmentation potential, and logistical issues involved in occasional difficulties in unloading DDGS from transport vehicles.

REFERENCES

1. Scott, M. L., 1970. Twenty-five years of research on distillers feeds for broilers. Proc. 25th Distillers Feed Research Council, pp. 19-24.

2. Combs, G. F. and E. H. Bossard, 1969. Further studies on available amino acid content of corn distillers dried grains with solubles. Proc. 24th Distillers Feed Research Council, pp. 53-58.

3. Runnels, T. D., 1966. The biological nutrient availability of corn distillers dried grains with solubles in broiler feeds. Proc. 21st Distillers Feed Research Council, pp. 11-15.

4. Harms, R. H., R. S. Moreno, and B. L. Damron, 1969. Evaluations of distillers dried grains with solubles in diets of laying hens. Poultry Sci. 48:1652-1655.

5. Jensen, L. S., L. Falen, and C. H. Chang, 1974. Effect of distillers dried grains with solubles on reproduction and liver fat accumulation in laying hens. Poultry Sci. 53:586-592.

6. Jensen, L. S., C. H. Chang, and S. P. Wilson, 1978. Interior egg quality: Improvement by distillers feeds and trace elements. Poultry Sci. 57:648-654.

7. Cromwell, G. L., K. L. Herkelman, and T. S. Starkly, 1993. Physical, chemical and nutritional characteristics of distillers dried grains with solubles for chicks and pigs. J. Anim. Sci. 71:679-686.

8. Noll, S., V. Stangeland, G. Speers, and J. Bramon, 2001. Distillers grains in poultry diets. Proc. Minnesota Nutr. Conf.

9. Roberson, K. D., 2003. Use of distillers grains with solubles in growing-finishing diets for turkey hens. Poultry Sci. 82(Suppl):51 (Abs. #214).

10. Ergul, T., C. Martinez-Amezcua, C. M. Parsons, B. Walters, J. Brannon, and S. L. Noll, 2003. Amino acid digestibility in corn distillers grains with solubles. Poultry Sci. 82(Suppl):70 (Abs. #295).

11. Batal, A. and N. Dale. Mineral composition of distillers dried grains with solubles. (In press).

TABLE 1. Total and available amino acid composition of DDGS		
Amino Acid	Total (%)	Availability (%)
Arginine	1.25	84
Cysteine	0.62	75
Histidine	0.74	84
Isoleucine	1.03	83
Leucine	3.10	89
Lysine	0.85	75
Methionine	0.56	89
Threonine	1.05	76
Tryptophan	0.28	84

TABLE 2. Performance of chicks receiving DDGS, 0-18 days					
	Low Density		High Density		Pooled SEM
DDGS (%)	0	15	0	15	
Body weight (g)	523^{b}	518^{b}	556^{a}	555^{a}	8.2
Feed conversion	1.40^{a}	1.42^{a}	1.28^{b}	1.30^{b}	0.2
(P<.05)					

TABLE 3. Performance of chicks receiving various levels of DDGS, 0-42 days

DDGS (%)	Weight (g/chick)		Feed Conversion	
	16 Days	42 Days	16 Days	42 Days
0	414^{a}	2314^{a}	1.34^{b}	1.77
6	416^{a}	2289^{a}	1.35^{b}	1.81
12	399^{ab}	2291^{a}	1.40^{ab}	1.77
18	387^{b}	2243^{b}	1.42^{a}	1.81
Pooled SEM	7.2	14.4	0.02	0.02

(P<.05)