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Short-term effects of lower oil dried distillers grains with solubles in laying hen rations

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Research Note

Short-term effects of lower oil dried distillers grains with solubles in laying hen rations

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ABSTRACT Extraction of oil from dried distillers grains has become a common practice among US ethanol producers. The valuable oil has been diverted to markets other than poultry feed, leaving new dried distillers grains with solubles (DDGS) products higher in fiber and purportedly lower in ME. This study compared 3 DDGS products with 10.3, 7.3, or 5.2% ether extract, respectively, with a corn-soy control ration in young Bovan laying hens for a feeding period from 20 to 33 wk of age. The DDGS was fed at the rate of 20% of the ration. Lower oil content of DDGS had no effect on short-term egg production parameters: feed intake, egg production, egg weight or mass, and hen weight gain. The diets containing lower fat DDGS (5.2%) did have reduced AME and kilocalories per day intake for laying hens. For each percent reduction in oil from a normal DDGS sample (10.3%) to medium oil (7.3%) DDGS, AME decreased 42.3 kcal/kg of diet. However, total kilocalories per day intake did sustain good egg production during this short trial.

Key words: low oil distillers dried grains with solubles, laying hen, dried distillers grains with solubles metabolizable energy

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INTRODUCTION

Dried distillers grains with solubles (**DDGS**) have become a common ingredient in poultry rations over the past 5 to 10 yr. Researchers have shown the ability of both pullets (Masa'deh et al., 2011) and laying hens (Lumpkins et al., 2005; Masa'deh et al., 2012) to be able to use as high as 30% inclusion rates of DDGS in a balanced ration. Distillers dried grains with solubles have been an economical source of nutrients in poultry rations. However, because ethanol plants are extracting oil from DDGS for other purposes (Wenger Feeds, 2012), the value of DDGS as an energy and nutrient source in poultry rations needs to be reassessed. By the end of 2012, 80% of the ethanol plants still in operation will be extracting oil to some degree (Wenger Feeds, 2012).

Batal and Dale (2006) noted a weak correlation of DDGS determined TME (roosters) with crude fat ($r^2 = 0.29$) in distillers grains. Rochell et al., (2011) reported a low nonsignificant correlation of DDGS AME_n determined in chicks with crude fat content of $r^2 = 0.39$. More recently, Dale (2013) tested TME on a series of oil-extracted DDGS samples and reported a stronger ($r^2 = 0.98$) regression equation compared with the earlier reports (Batal and Dale, 2006) indicating a decrease of 17.5 kcal/kg for each 1% decrease in DDGS oil content. Dale (2013) recommended an estimate of 2,215 to 2,240 kcal/kg for low oil DDGS with 5% remaining fat. Because of the decrease in fat content and increased fiber content, acceptability of low oil DDGS in laying hen diets needs to be tested in these new generation DDGS products.

MATERIALS AND METHODS

Experimental Diets

Four diets were fed to 160 White Leghorn hens from 20 to 33 wk of age. Diets were formulated to meet or exceed breeder recommendations allowing for 110 g/hen per day of predicted feed intake (Centurian Poultry Inc., 2012). Experimental diets were formulated with an inclusion of 20% DDGS in a standard corn and soybean meal laying hen ration with the control diet being devoid of DDGS. Diets 2 to 4 contained 20% DDGS from 3 sources varying in fat content. Nutrient content of the experimental DDGS samples with varying fat levels is shown in Table 1. All diets were formulated to be isonitrogenous, containing 18% CP and 2,860 kcal/kg ME (calculated; Table 2). The same ME value of 2,800 kcal/kg was used for all DDGS tests ingredients despite anticipated lower ME values of the medium and

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Table 1. Nutrient profiles of diets containing dried distillers grains with solubles (DDGS)[1,2]

Nutrient	Normal DDGS (10.3%)	Medium oil DDGS (7.3%)	Low oil DDGS (5.2%)
CP, %	28.9	28.3	27.5
CP, % analyzed	24.9	27.8	27.4
Fat, %	11.2	7.3	5.6
Fat, % analyzed	10.3	7.31	5.19
DM, %	90.9	91.4	89.9
Lysine, %	1.00	0.86	0.83
Methionine, %	0.55	0.58	0.55
Cysteine, %	0.74	0.70	0.57
TSAA, %	1.19	1.28	1.12
Phosphorus, %	0.98	0.84	0.91
Phosphorus, % analyzed	0.90	0.86	0.91

[1]DDGS products and nutrient profile provided by Dakota Gold (Dakota Gold, Sioux Falls, SD).

[2]Further analysis of % protein, fat, and total phosphorus by Midwest Labs (Midwest Laboratories Inc., Omaha, NE).

low oil DDGS sources; to allow the testing of our hypothesis that lower oil DDGS sources would have less ME available to the laying hen. Dietary samples were taken once during the study and analyzed for % CP (AOAC 990.03), Ca, and P (AOAC 985.01) by standard Association of Official Analytical Chemists (1990) methods (Midwest Laboratories Inc., Omaha, NE).

Birds and Housing

Experimental diets were each fed to 10 replicate cages with four 20-wk-old Bovan White laying hens/cage. Food and water were provided to the hens ad libitum throughout the study. Pullets were purchased from a commercial pullet grower at 14 wk of age and fed a standard prelay ration before initiation of the study at 20 wk. Hens were housed in a stacked deck manure belt style caging system with cages measuring 50.8 cm × 47.65 cm equaling 2,420.62 cm^2 total floor space per cage, allowing 605 cm/hen. Cages were equipped with 1 nipple drinker/pen and adequate (10 cm/hen) feeder space. The study was conducted with the approval of the University of Nebraska–Lincoln's Institutional Animal Care and Use Committee.

Parameters Measured

Throughout the study, hen day egg production and feed intake were recorded daily. Weekly, one day's egg production was used to determine average egg weight. Egg yolk color score was measured biweekly, on the same eggs weighed, using a Kemin Natural Egg Yolk Fan (Kemin Industries Inc., Des Moines, IA). The same individual performed the yolk color scores each time. Hen weight and weight gain were recorded monthly, averaging the weight of 4 hens per cage. Feed intake and egg production were adjusted for mortalities. Feed efficiency was calculated as feed intake/hen per day divided by egg mass/hen per day. Average kilocalories/hen per day was calculated based on hen feed intake/day and analyzed AME for the diets.

At the end of the trial, AME was determined. The digestive marker Celite (Celite 545 Filter Aid Powder, Fisher Chemical, Thermo Fisher Scientific Inc.,

Table 2. Experimental diet formulations and calculated and analyzed nutrient values

Ingredient	Control (no DDGS)	Diets 2 to 4 (DDGS with 10.3, 7.3, 5.2% oil)
Corn	55.7	45.9
Soybean meal (47% CP)	29.5	19.1
DDGS	0.0	20.0
Corn oil	2.83	3.02
Limestone	9.62	9.92
Dicalcium phosphate	1.58	1.21
NaCl	0.42	0.32
L-Lysine HCl	0.03	0.21
DL-Methionine	0.17	0.16
Vitamin and mineral premix[1]	0.20	0.20
ME, kcal/kg, calculated	2,860	2,860
CP, %, calculated	18.0	18.0
CP, %, analyzed	18.9	18.8 (2), 19.00 (3), 19.00 (4)

[1]Vitamin and trace minerals provided the following per kilogram: vitamin A (retinyl acetate, 6,600 IU); vitamin D_3, 2,805 IU vitamin E (DL-α-tocopheryl acetate, 10 IU); vitamin K_3 (menadione dimethpyrimidinol, 2.0 mg); riboflavin (4.4 mg); pantothenic acid (6.6 mg); niacin (24.2 mg); choline (110 mg); vitamin B_7 (biotin, 8.8 mg); and ethoxyquin (1.1 mg). Mn (MnO, 88 mg); Cu ($CuSO_4H_2O$, 6.6 mg); Fe ($FeSO_4H_2O$, 8.5 mg); Zn (ZnO, 88 mg); and Se (Na_2SeO_3, 0.30 mg).

Table 3. Treatment effects of diets with dried distillers grains with solubles (DDGS) on laying hen performance[1]

Treatment	Feed intake, g/hen per d	Hen day egg production, %	Egg weight, g	Feed conversion, g of feed/g of egg	Egg mass, g	Final hen weight, g/hen	Weight gain, g/hen
Control (no DDGS)	103.4	97.8	58.8	1.74	55.6	1,515.5	179.0
Normal DDGS (10.3%)	103.4	95.5	59.0	1.67	54.6	1,541.2	178.0
Medium oil DDGS (7.3%)	105.5	95.8	59.9	1.67	55.4	1,506.4	193.6
Low oil DDGS (5.2%)	105.7	94.9	59.7	1.69	55.9	1,530.4	158.4
SEM	0.997	2.30	0.552	0.033	1.01	16.40	10.43
P-value	0.203	0.830	0.443	0.465	0.836	0.458	0.145

[1]Experimental diets were each fed to 10 replicate cages with four 20-wk-old Bovan White laying hens/cage.

Waltham, MA) was added to the experimental diets (1% of diet) and fed to the hens for 1 wk. Excreta samples were collected from the manure belt under each replicate cage after the 1-wk feeding period. Excreta samples were placed in aluminum trays and stored in a −20°C freezer before freeze drying. Freeze-dried excreta samples as well as dietary samples were ground to pass through a 1-mm screen and placed in labeled bags until further use. Gross energy of dietary and fecal samples was determined by a bomb calorimeter (Parr 1241 Adiabatic Bomb Calorimeter, model 1241, Parr Instrument Company Inc., Moline, IL) in duplicate for each excreta and diet sample. Dried fecal and diet samples were then ashed in a muffle furnace to determine percent acid insoluble ash (Van Keulen and Young, 1977). Dietary AME was then calculated based on the outlined formula noted by Scott and Boldaji (1997).

Statistical Analysis

Data were analyzed as a randomized complete block design using the GLIMMIX procedure of SAS Institute Inc. (2011). Cage was designated as the experimental unit. Each treatment was replicated 10 times and cages were blocked by cage unit tier consisting of 2 tiers: top and middle. Repeated measures ANOVA with the factors treatment (the error term being cage within treatment) and time (the residual error being the error term) as well as the treatment by time interaction were carried out on all production data. For each response with repeated measures over time, an appropriate residual variance-covariance structure was chosen based on the Akaike information criterion.

RESULTS AND DISCUSSION

Table 1 shows the nutrient profile of the different DDGS products tested. These DDGS products were provided by Dakota Gold (Sioux Falls, SD) and the nutrient profiles were provided by POET Nutrition (Sioux Falls, SD). Further analysis for CP, fat, and total phosphorus was conducted by Midwest Labs (Midwest Laboratories Inc.) before formulating the experimental diets. There was a large difference for CP in the analysis for the normal DDGS sample protein (24.9 vs. 28.9%) and oil (10.3 vs. 11.2%). Otherwise the values provided by POET very closely matched the analyzed values. Table 2 shows the experimental diet formulations, analyzed nutrient values, and calculated ME. Diets were formulated to provide a relatively high level of ME (2,860 kcal/kg) and to meet breeder standards for daily kilocalorie intake per hen with an anticipated feed intake of 110 g/hen per d. Analysis of the mixed rations for % CP indicate a uniformly mixed ration with little variation across the diets (18.9, 18.8, 19.0, and 19.0% protein for diets 1, 2, 3, and 4, respectively).

There were no significant treatment by time or treatment effects with regard to daily egg production, feed intake, egg weight, egg mass, and hen weight (Table 3) despite the reduction in dietary fat and gross energy due to the lower fat DDGS. Lower dietary ME and intake did not significantly alter hen feed intake or weight gain during this trial, which was contrary to what was expected. Although there was some indication of an increased need for energy with slightly increased feed intake by 2 to 2.5 g in hens fed diets 3 and 4, this was not significant due to limited cage replication. There was no change in egg production or egg weight or egg

Table 4. Gross and determined AME and calorie intake of diets with dried distillers grains with solubles (DDGS)[1]

Diet	Diet gross energy, kcal/kg	Calculated intake, kcal/hen per d	Determined AME, kcal/kg	Actual intake, kcal/hen per d
Control (no DDGS)	3,780	312.9	3,026.4	308.3[a]
Normal DDGS (10.3%)	3,958	309.7	2,995.1	313.1[a]
Medium oil DDGS (7.3%)	3,917	302.6	2,868.0	297.7[a]
Low oil DDGS (5.2%)	3,806	281.8	2,666.4	277.2[b]
SEM			45.82	26.2
P-value			0.0001	0.002

[a,b]Significantly different means.

[1]Experimental diets were each fed to 10 replicate cages with four 20-wk-old Bovan White laying hens/cage.

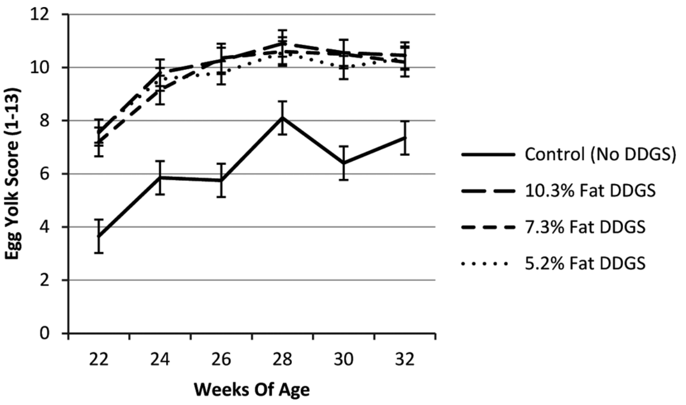

Figure 1. Treatment effects of diets with dried distillers grains with solubles (DDGS) on yolk pigment score over time. Experimental diets were each fed to 10 replicate cages with four 20-wk-old Bovan White laying hens/cage. Error bars represent SD for each mean.

mass due to the low oil DDGS treatments, indicating adequate ME intake despite the lower energy available from low oil DDGS. If the trial had gone past 33 wk of age, it may have shown different results. Hen weight gain was trending toward a lower value for hens fed diet 4, low oil DDGS.

Table 4 shows dietary gross energy, determined AME, and actual kilocalories/hen per day intake as affected by low oil DDGS treatments. It is interesting to compare the dietary gross energy versus determined AME. The loss of fat from DDGS caused a more significant drop in AME in diets 2 to 4 than in gross energy. Going from normal to medium oil DDGS (diet 2 to 3) caused a drop of 127 kcal/kg equivalent to 42.3 kcal/% decrease in DDGS oil, whereas going from normal oil to low oil DDGS (diet 2 to 4) caused a decrease of 329 kcal/kg or 65.8 kcal/% decrease in oil. The first value (42.3 kcal/% oil) going from normal (11.2%) to medium (7.3%) oil closely matches the Batal and Dale (2006) estimate of 38.6 kcal/1% decrease in oil. As more fat is taken out of DDGS, the fiber content likely increases and the proportion of protein would increase, thereby more significantly affecting AME of the low oil sample. Actual kilocalies/hen per day consumption was not far from the calculated intake values (Table 4) and showed a significant ($P < 0.002$) reduction for birds fed the low oil DDGS diet compared with diets 1 to 3. The highest kilocalories per hen per day consumption was for hens fed the high oil DDGS (diet 2).

There was no time by treatment effect in regard to yolk color. However, there was a significant effect between the control diet and other treatment diets containing DDGS in regard to yolk color with all DDGS treatment diets producing higher yolk scores (Figure 1). Differences between the DDGS diets versus the control diets were significant with a P-value < 0.0008, but DDGS diets compared with each other were not significantly different ($P > 0.0869$).

In summary, low oil DDGS products can be used in poultry rations, but they will have less value as more oil is taken out. Low oil DDGS products are more likely to fit in laying hen rations, which are lower in ME compared with meat bird rations such as those for broilers or turkeys. Producers of low oil DDGS should not expect as high an economic value associated with low oil products compared with higher oil products in the poultry feed industry.

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