

## Nonruminant Nutrition: DDGS

**T187 Effect of the inclusion levels of DDGS to the feeds of broilers and glucanase, xylanase and phytase addition to low-energy DDGS-added diets.** M. L. Angeles\*<sup>1</sup> and S. Gómez<sup>1,2</sup>, <sup>1</sup>INIFAP, Ajuchitlán, Colón, Qro, México, <sup>2</sup>FESC-UNAM, Ajuchitlán, Colón, Qro. México.

Three experiments were carried out to evaluate the growth performance and breast yield of broiler chickens fed diets with increasing levels of DDGS and the additions of different enzymes to compensate the energy reduction in DDGS-added diets. In all the experiments Ross B308 male broilers were individually fed. In Exp. 1, 96 broilers from 21 to 35 d of age were used and assigned to 8 treatments in a factorial combination of 2 diets based either on sorghum (S) or corn (C) and 4 increasing dietary levels of DDGS (0, 5, 10 and 15%). Diets were formulated to meet the nutrient requirements of grower broilers. In Exp. 2, 80 broilers from 35 to 49 d of age were used and assigned to the same treatments used in Experiment 1, but diets were formulated to meet the nutrient requirements of finisher broilers. In Exp. 3, 84 broilers from 32 to 49 d of age were used and assigned to 6 dietary treatments in a factorial combination of 2 cereals: S or C and 3 diets: 1) S or C plus soybean meal (SBM) and 3200 kcal of ME/kg, 2) S or C, SBM, 10% DDGS and 3200 kcal of ME/kg, and 3) S or C, SBM, 10% DDGS but reductions of 100 kcal of ME/kg, 0.12% Ca and 0.12% available P, and added with 200 ppm of phytase (Ronozyme-P [CT]), 175 ppm of glucanase (Ronozyme VP) and 175 ppm of xylanase (Ronozyme WX). In Exp. 1, the feed intake and weight gain were better when 10% DDGS was included in the diet. In Exp. 2, the weight gain, feed conversion and energetic efficiency were improved ( $P < 0.01$ ) at each increment of DDGS in the diet; the best responses were observed for dietary levels of 10 and 15% DDGS. In Exp. 3, there was not any negative effect on the growth performance of broilers fed a low-energy, low-Ca and low-available P diet supplemented with phytase, glucanase and xylanase. In summary, 10% and between 10 and 15% of DDGS can be included in the diet of grower and finisher broilers, respectively, without any negative effect on the growth performance even in low-energy, Ca and P diets added with phytase, glucanase and xylanase enzymes

**Key Words:** broiler chickens, DDGS, enzymes

**T188 High dietary inclusion of dried distillers grains with solubles in broiler rations—Production effects and yields.** M. K. Masa' deh\* and S. E. Scheideler, *University of Nebraska-Lincoln, Lincoln.*

A study was conducted to test the effects of feeding high levels of dried distillers grains with solubles (DDGS) in broiler chicks on body wt, feed intake, feed to gain ratio and parts yield. Ross x Ross broiler chicks were divided into 6 dietary treatments with different inclusion rates of DDGS (0, 10.0, 15.0, 20.0, 25.0 or 30.0%) from day-old to 50 d of age. All diets were formulated to be isocaloric and isonitrogenous and 3 phase-feeding diets were used, starter (0–14 d), grower (14–35 d), and finisher (35–50 d). Birds were assigned to 24 floor pens with total of 15 birds per pen with 4 replicate pens per treatment. Feed intake and body wt were recorded at 14, 35, and 50 d of age. At 53 d of age, 2 birds per pen were selected for whole carcass processing and parts yield. Birds were cut into 8 pieces to determine parts yield (breast, wing, drumstick, and thigh yields). Weight gain and feed intake were significantly different ( $P < 0.05$ ) during the starter period between dietary treatments with the highest wt gain and feed intake for chicks fed 30% DDGS. However, no differences were observed ( $P > 0.05$ ) during grower, finisher or the whole period between dietary treatments for weight gain and feed intake. Feed conversion ratio was not affected ( $P > 0.05$ ) by

level of DDGS during all periods. Dressing percentage was similar ( $P > 0.05$ ) between levels of DDGS. Breast yield, wing yield and drumstick yield as percentage of live or carcass weight were not significantly ( $P > 0.05$ ) different between levels of DDGS. Thigh yield as percent of live or carcass weight was different ( $P < 0.05$ ) between levels of DDGS with the highest yield for broilers fed 25% DDGS. In summary, feeding DDGS at higher levels did not negatively affect chick wt, feed intake, feed conversion ratio, wt gain, mortality or dressing percentage compared with a basal diet. Percentage thigh yield was affected by levels of DDGS, while breast yield, wing yield, and drumstick yield were not influenced by DDGS. Feeding DDGS at 30% had an economical benefit with an average of \$60/ton compare with basal diet (0% DDGS) when DDGS priced at \$146/ton.

**Key Words:** DDGS, broiler, dressing percentage

**T189 Effect of pellet quality on utilization of distillers dried grains with solubles (DDGS) in broiler diets.** C. A. Coto\*<sup>1</sup>, C. Lu<sup>1</sup>, Y. Min<sup>1</sup>, A. J. Kariimi<sup>2</sup>, F. Yan<sup>1</sup>, and P. W. Waldroup<sup>1</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>University of Kurdistan, Kurdistan, Iran.

DDGS can be used in broiler diets but at high levels a loss in performance is observed with much attributed to reduction in pellet quality. A study was conducted to evaluate different types of pellet binders in diets with addition of 25% DDGS, a level which provides a marginal but detectable reduction in performance. Dietary treatments consisted of a 2 × 4 factorial arrangement with 2 levels of DDGS and 4 levels of binder for a total of 8 treatments. Two basal diets were formulated to contain either 0% or 25% DDGS. The binder applications were as follows: No binder (fed as mash), No binder (fed as pellets), Pel-Stik (fed as pellets) and PellTech (fed as pellets). One-day old birds of a commercial strain were placed in floor pens with 35 birds per pen and 6 replicates per treatment. Pellet quality was determined by quantifying the amount of fines. Birds were weighed and feed consumption determined at d 14, 28 and 41 d. At d 41, 5 birds per pen were processed to determine dressing percentage and parts yield. The inclusion of 25% DDGS in the diet significantly increased the amount of fines in the diet. No significant effect of the binder applied in the diet was found for the amount of fines. The amount of fines in the finisher diet was significantly increased in the following order: No binder (mash) > PellTech > Pel-Stik > No binder (pellets). Birds fed pellets had BW and FCR than those fed mash diets. Birds fed 25% DDGS showed higher BW at d 28 with no difference during the remaining feeding stages. No difference among pellet binders was observed for BW at 41 d. An improved FCR at 28 and 41 d was observed when DDGS was included in the diet. The addition of Pelltech increased FCR at 41 d. A significantly higher mortality rate was observed when birds received diets containing 25% DDGS. The addition of 25% DDGS in the diet significantly reduced the dressing percentage, no other effect from the addition of DDGS was observed for yield. Birds receiving pellet diets regardless of the binder showed a significantly higher yield for breast, leg quarters and wings than birds receiving diets in the mash form.

**Key Words:** DDGS, broilers, pellets

**T190 Effect of distillers dried grains with solubles and an enzyme supplement on performance and egg quality of brown egg layers.** A. J. Pescatore\*, P. Rossi, A. H. Cantor, J. L. Pierce, T. Ao,

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Effects of diets containing 15 or 23% distillers dried grains with solubles (DDGS) with and without a naturally occurring enzyme complex (Allzyme SSF, Alltech Inc., Nicholasville, KY) was evaluated in brown egg laying hens. Egg production and egg quality was evaluated during 36 wk of production. At 17 wk of age, 420 Hy-Line Brown hens were randomly assigned to 5 treatments with 7 replicate groups of 12 hens each. Treatments consisted of feeding: 1) positive control (corn-soybean meal) formulated to be adequate in all nutrients 2) 15% DDGS, 3) 15% DDGS + enzymes, 4) 23% DDGS, and 5) 23% DDGS + enzymes. Diets containing DDGS had reduced levels of ME (2800 vs. 2877 Kcal/kg), Ca (4.1 vs. 4.2%) and available P (0.17% for 15% DDGS or 0.2% for 23% DDGS vs. 0.29%), compared with the control diet. Six eggs were collected from each replicate every 4 wk to determine egg quality. Feed intake was significantly ( $P < 0.05$ ) decreased by DDGS during wks 5–8 and 17–20. Dietary treatment did not affect feed conversion. Allzyme SSF increased HDP during wks 21–24. Egg weight at wk 20 and yolk weight at wk 20 were decreased by DDGS. Percent yolk was not significantly affected by the addition of DDGS. The diet with 15% DDGS + enzyme increased albumen wt at Week 20. The diet with 23% DDGS + enzyme increased percent shell at wk 36 and shell breaking strength at wks 4, 32 and 36. Haugh unit values were significantly increased by DDGS at wks 16 and 28. Shell weight, percent shell, specific gravity and shell breaking strength were initially lower for DDGS diets at 4 wks of production. By 36 wks the addition of Allzyme SSF to the DDGS diets improved shell weight, percent shell, specific gravity and shell breaking strength. Hens fed 15 or 23% DDGS, +/- enzymes, had lower yolk lightness ( $L^*$ ). Hens fed 23% DDGS had higher yolk redness ( $a^*$ ) and yolk yellowness ( $b^*$ ) values vs. hens fed 15% DDGS or control diet. This study suggests that DDGS could be included to the diet up to 23% without negative effects on feed efficiency and can be used to improve yolk color. Using Allzyme SSF in DDGS diets increase shell quality and albumen weight.

**Key Words:** DDGS, shell strength, yolk color

**T191 Feeding value of DDGS for pigs: Correlating in vitro dry matter digestibility and crude protein digestibility to its nutrient content and color.** M. Rudar\*, C. F. M. de Lange, I. B. Mandell, C. L. Zhu, and P. McEwen, *University of Guelph, Guelph, Ontario, Canada.*

Distillers dried grains with solubles (DDGS), a co-product of ethanol production, may be cost effective for supplying energy and protein in pig diets. However, concerns about the variation in digestible nutrient content of DDGS prevent more widespread use. Techniques to rapidly evaluate the feeding value of DDGS are necessary to properly formulate diets. The study was conducted to determine how the feeding value of DDGS can be estimated via product color, nutrient analysis, and in vitro digestibility assays. Seventy-two DDGS samples were collected from 6 corn-based ethanol plants (12 samples per plant collected over 3 mo) that supply DDGS to Ontario. Each sample was analyzed for dry matter (DM), crude protein (CP), fat, starch, NDF, ADF, acid detergent insoluble nitrogen (ADIN), ash, P, Na, K, Mg, S, and color (before and after grinding to < 1mm particle size) using the CIE,  $L^* a^* b^*$  scale. Samples contained (mean  $\pm$  SD, %): 26.6  $\pm$  1.62 CP, 10.0  $\pm$  0.75 fat, 2.9  $\pm$  1.60 starch, 31.6  $\pm$  2.47 NDF, 2.5  $\pm$  1.13 ADIN, 0.8  $\pm$  0.05 P, and 1.1  $\pm$  0.08 K. Fecal DM and ileal CP digestibility values were determined using in vitro incubations with a series of porcine gastric, enteric, and hindgut enzymes. Step-wise regression analysis was carried out to correlate nutrient content and product color to in vitro DM and CP digest-

ibility values, and to predict DM and CP digestibility. DM digestibility was predicted as  $y = -0.43(L^*_{\text{ground}}) + 88.03$  ( $R^2 = 0.54$ ,  $P < 0.0001$ ) while inclusion of P, K, starch, and CP improved  $R^2$  to 0.78. CP digestibility was predicted as  $y = -0.55(b^*) + 106.22$  ( $R^2 = 0.49$ ,  $P < 0.0001$ ) while inclusion of ADIN, CP, starch, and  $L^*$  improved  $R^2$  to 0.69. From the analyzed samples,  $b^*$  was a better predictor of CP digestibility than  $L^*$ . These models provide a rapid way to estimate the feeding value of DDGS from simple nutrient and color analyses, but relationships with in vivo measurements still need to be determined.

**Key Words:** DDGS feeding value, pigs, in vitro digestibility

**T192 Substitution of sorghum and soybean meal by distillers dried grains with solubles in diets for fattening rabbits.** H. Bernal-Barragán<sup>1,4</sup>, Y. Vázquez-Pedroso<sup>2</sup>, M. Valdivie-Navarro<sup>2</sup>, C. A. Hernández-Martínez<sup>1</sup>, M. A. Cerrillo-Soto<sup>3,4</sup>, A. S. Juárez-Reyes<sup>3,4</sup>, and E. Gutiérrez-Ornelas<sup>1,4</sup>, <sup>1</sup>Universidad Autónoma de Nuevo León, Monterrey, Nuevo León, México, <sup>2</sup>Instituto de Ciencia Animal, La Habana, Cuba, <sup>3</sup>Universidad Juárez del Estado de Durango, Durango, Durango, México, <sup>4</sup>Red Internacional de Nutrición y Alimentación en Rumiantes, Monterrey, Nuevo León, México.

A trial was conducted to evaluate the partial substitution of sorghum grain and soybean meal by distillers dried grains with solubles (DDGS) in diets for fattening rabbits. Fifty-six 35-d old rabbits (Negro Azteca  $\times$  Chinchilla) of both genders were allocated in cages, according to a complete randomized design, with 4 treatments (0, 10, 20 and 30% of DDGS in diet) and 7 replicates by treatment. Diets were isonitrogenous (17.4% CP) and isoenergetic (2.80 Mcal DE/kg) and were formulated to meet NRC rabbit requirements. Basal ingredients were alfalfa hay, ground sorghum grain, soybean meal and a commercial vitamin and mineral mix. Feed and water were offered ad libitum. At an age of 96 d viability was 100% and morbidity 0%. There were no differences ( $P > 0.05$ ) among treatments at final weight (1914, 1961, 1853 and 1810 g), average daily gain (21, 22, 20 and 19 g/day), feed intake (93, 93, 92, and 98 g/day) and feed/gain ratios (4.51, 4.32, 4.64, and 5.24) for the 4 treatments, respectively. Carcass yield varied from 46.6 to 49.7% and was not different among treatments ( $P > 0.05$ ). Meat content of carcass was lower ( $P < 0.07$ ) and bone proportion was higher ( $P < 0.07$ ) in rabbits fed 20% DDGS in the diet. Results indicate the possibility to include up to 30% DDGS in diets for fattening rabbits without affecting performance indicators. Effect of DDGS in carcass composition warrants further investigation.

**Key Words:** rabbits, DDGS, carcass traits

**T193 Evaluation of in vitro procedures to measure digestibility of fiber in distillers dried grains with solubles.** P. E. Urriola\* and H. H. Stein, *University of Illinois, Urbana.*

Four experiments were conducted to develop and evaluate an assay for measuring in vitro digestibility of dietary fiber in distillers dried grains with solubles (DDGS). Exp. 1 was conducted to validate the 3-step in vitro digestibility assay (pepsin, pancreatin, viscozyme) in our laboratory. In vitro apparent ileal digestibility (AID) and in vitro apparent total tract (ATTD) digestibility of OM in 4 diets and corn (83.7 and 93.1%) were not different from values analyzed at a reference laboratory (82.4 and 92.4%) indicating that we were able to repeat the assay. Exp. 2 was conducted with the objective of increasing the amount of sample that was used for the in vitro digestibility assay from 0.5 g to 2.0 or 4.0 g. Results of this experiment showed that ATTD of DM was not different among the 3 sample sizes (85.1, 83.7, 83.3% for 0.5, 2.0, and 4.0 g, respectively). Exp. 3 was conducted to measure AID and ATTD of NDF

in DDGS. In vitro AID of NDF was different ( $P < 0.01$ ) among sources of DDGS (21.9 to 40.4%). Values for AID of NDF were greater than expected considering that at this point there were no fiber degrading enzymes added to the samples. The ATTD of NDF (32.5 to 52.2%) was different ( $P < 0.01$ ) among sources of DDGS. These observations suggested that the average concentration of NDF in DDGS (40.2%) in the current experiment may be overestimated. The objective of Exp. 4 was to measure in vitro hindgut fermentation of NDF using purified enzymes or fecal inoculums in 10 sources of DDGS that had in vivo data available. Values for hindgut disappearance of DM and NDF obtained after fecal inoculation (23.0 and 54.3%) were greater ( $P < 0.05$ ) than values obtained using purified enzymes (6.3 and 5.6%), values obtained using fecal inoculums were also closer to values observed in vivo (23.3%). In conclusion, modifications to the 3 step in vitro digestibility assay allowed measuring the in vitro AID and ATTD of DM and NDF in DDGS. Results obtained with the fecal inoculum are closer to in vivo values than values obtained using purified enzymes. Concentration of NDF in DDGS may be overestimated if CP contaminates the NDF residue.

**Key Words:** in vitro digestibility, DDGS, inoculum

**T194 Effects of distillers dried grains with solubles and lactose on fecal *Lactobacillus* biota of nursery pigs.** H. Tran\*, R. Moreno, J. W. Bundy, E. Hinkle, J. Walter, T. E. Burkey, and P. S. Miller, *University of Nebraska, Lincoln*.

An experiment was conducted to evaluate the effects of distillers dried grains with solubles (DDGS), lactose, and their interaction on fecal *Lactobacillus* biota of nursery pigs. Ninety-six pigs (age, 23 d; initial BW, 6.43 kg) were randomly allotted into each of 16 pens by gender, ancestry, and weight (6 pigs/pen; 4 pens/treatment). In phase 1 (wk 1 and 2), pigs were fed 1 of the 4 treatments: 1) control (no DDGS or lactose), 2) 15% DDGS, 3) 20% lactose, or 4) 15% DDGS + 20% lactose. In phase 2 (wk 3 and 4), all pigs were fed a common diet containing 15% DDGS and 10% lactose. Fecal samples were randomly collected from 2 pigs/pen on d 0, 7, 14, and 21. A subsample was taken from 1 pig/pen (4 pigs/treatment) for DNA extraction. *Lactobacillus* specific primers were used for PCR and subsequent denaturing gradient gel electrophoresis (DGGE). Staining intensities of DGGE bands were determined as a proportion of peak surface area of the entire molecular fingerprint of the sample. No interactions of DDGS and lactose on *Lactobacillus* biota were observed; however, tendencies for a main effect of both DDGS and lactose were observed with respect to putative *L. sobrius/amylovorus* on d 7. Pigs fed diet containing DDGS had greater (41.95 vs. 25.36%;  $P =$

0.06) staining intensities of *L. sobrius/amylovorus* than pigs not receive DDGS. Similarly, decreased (26.36 vs. 40.95%;  $P = 0.09$ ) staining intensities of *L. sobrius/amylovorus* were observed in pigs fed lactose compared with non-lactose fed pigs. On d 14, a main effect of lactose was observed with respect to putative *L. reuteri* where lactose-fed pigs had greater (54.67 vs. 20.07%;  $P = 0.02$ ) staining intensities of this species compared with pigs not receiving lactose during phase 1. On d 21, DDGS-fed pigs had greater (72.26 vs. 42.02%;  $P = 0.05$ ) staining intensities of *L. reuteri* compared with pigs not receiving DDGS in phase 1. These research findings suggest that feeding lactose and DDGS may affect fecal *Lactobacillus* spp. in nursery pigs.

**Key Words:** distiller dried grains with solubles, *Lactobacillus*, lactose

**T195 Bone breaking strength of laying chickens fed increasing levels of omega-3 PUFA DHA (22:6) using algae as vehicle of diet enrichment.** N. P. Johnston\*, C. B. Evans, and R. T. Davidson, *Brigham Young University, Provo, UT*.

In recent years a host of health benefits have been associated with the intake of omega-3 fatty acids in general and DHA (22:6 n-3) in particular for both humans and animals. During a 12-wk feeding trial 60 SCWL pullets were fed omega-3 PUFA-rich diets with increasing levels of docosahexaenoic acid (DHA) 22:6 (n-3) to determine the dietary effects on bone breaking strength (BRS) measured by Young's Modulus (YM). Two of the diets were DHA-free including a corn oil-enriched control and a flaxseed-enriched diet and in the remaining 4 diets a portion of the diet was replaced with increasing levels of algae ranging from 10% to 50%. As a result dietary DHA ranged from 0 to 0.94% of the diet. The birds were evenly divided by treatment and housed in individual cages in environmentally controlled rooms where they received feed/water ad libitum and a light-dark cycle of 14L:10D. It was hypothesized that with increasing levels of DHA there would be a corresponding increase in bone strength. At the conclusion of the feeding trial the femur, tibia and humerus bones were broken on an Instron 3345 to determine bone strength (YM). Diet improved ( $P < 0.05$ ) the strength of the tibia, femur and humerus (3.08, 2.04, 3.13 N/mm<sup>2</sup>) at the 50% level and the femur at all added algae levels. In conclusion the 10, 20, and 50% algae-fed birds ( $P < 0.05$ ) had stronger femurs and the 50% ( $P < 0.05$ ) stronger humerus and tibias than the controls; hence, the replacement of flaxseed with DHA-rich algae had a beneficial effect on the bone strength of laying chickens.

**Key Words:** bone breaking strength, omega-3, algae