W182 Effects of increasing inclusion of supplemental magnesium oxide (MgO) on laying performance and eggshell quality in 72-week-old brown egg-laying hens. C. H. Kim, I. K. Paik, and D. Y. Kil,* *Department of Animal Science and Technology, Chung-Ang University, Anseong-si, Korea.*

In our previous experiment, increasing level of supplemental MgO in diets improved the eggshell quality in 46-week-old laying hens. However, such an effect has not been determined in aged laying hens that may encounter more problems in eggshell quality than young laying hens. The objective of this experiment, therefore, was to investigate the effect of increasing inclusion of supplemental MgO in diets on laying performance and eggshell quality in aged laying hens. A total of 640 Hy-Line Brown laying hens of 72 weeks of age were assigned to 1 of 4 dietary treatments with 4 replicates in a completely randomized design. Each replicate consisted of 40 hens raised in 2 hens per cage. The basal diet contained 0.16% Mg and 3 levels of 0.10, 0.15, and 0.20% MgO (60% Mg) were supplemented to the basal diet. All other nutrients and energy were included to meet or exceed NRC requirement estimates for laying hens. Laying performance was recorded daily and summarized for a 5-week feeding trial. Eggshell quality was measured in 20 eggs collected randomly from each replicate on the last day of each week during 5 weeks and the data were pooled. Results indicated that increasing inclusion of supplemental MgO increased (linear, $P < 0.05$) eggshell strength and decreased (linear and quadratic, $P < 0.01$) broken and shell-less egg production. However, there was no difference in eggshell thickness among treatments. Hunter lightness (L*) and redness (a*) values in eggshell decreased (linear, $P < 0.05$) as inclusion of supplemental MgO increased. Feed intake, feed conversion ratio, hen-day egg production, egg weight, egg yolk color, and Haugh unit were not affected by dietary treatments. The concentrations of Mg in eggshell increased (linear, $P < 0.01$) with inclusion of supplemental MgO, but those of Ca, P, and Fe in eggshell were not influenced by dietary treatments. In conclusion, inclusion of supplemental MgO improves eggshell strength and color with no effect on laying performance in aged laying hens.

Key Words: aged laying hens, eggshell quality, magnesium oxide

W183 Evaluating the impact of pre-weaning calcium and phosphorus supplementation on growth performance and carcass characteristics of low and high birth-weight pigs. P. L. Y. C. Chang*[1], C. H. Stahl[1,2], and E. van Heugten[1], *[1]Department of Animal Science, North Carolina State University, Raleigh, [2]Laboratory of Developmental Nutrition, North Carolina State University, Raleigh.*

Neonatal Ca and P deficiencies affect growth performance and the activity of the tissue-specific stem cells responsible for lifetime muscle and bone growth. This study evaluated the effect of direct oral supplementation of Ca and P to nursing pigs on growth performance and carcass characteristics. From commercial sows (n = 52), 2 light-weight pigs (LW, 1.52 ± 0.04 kg BW) and 2 heavy-weight piglets (HW, 2.14 ± 0.04 kg BW) were selected at d 3 of age. Within sow, 1 of the LW and 1 of the HW piglets were orally supplemented once daily with 2 mL of a $CaPO_4$ solution that provided 240 mg Ca and 182 mg P. The remaining LW and HW pig from each litter orally received 2 mL of a placebo. Pigs were weaned at 22.5 d of age and were randomly allotted to pens (3 to 5 pigs per pen) according to sex, supplementation, and birth weight. Pigs were fed 3 diet phases in the nursery (44 d) and 3 diet phases in the finisher (98 d). At the end of the study carcass characteristics were determined using ultrasound. Pigs in the HW group were heavier ($P < 0.001$) at weaning (6.3 vs. 4.7 kg), at the end of the nursery (29.1 vs. 23.7 kg), and at the end of the finisher (121.0 vs. 108.1 kg). Heavy birth weight pigs grew faster ($P < 0.01$; 518 vs. 430; 938 vs. 861; 808 vs. 728 g/d for nursery, finisher, and overall), consumed more feed (0.70 vs. 0.57; 2.44 vs. 2.20; 1.90 vs. 1.69 kg/d for nursery, finisher, and overall) and had greater ($P < 0.01$) loin eye area (19.5 vs. 17.7 cm^2) and daily lean gain (377 vs. 350 g/d). Pre-weaning supplementation with $CaPO_4$ did not affect ADG, ADFI, G/F or any of the carcass traits. In conclusion, increased birth weight of pigs greatly enhanced pig performance to market weight; however, pre-weaning supplementation with $CaPO_4$ did not improve performance of either LW or HW piglets. This work does not support the hypothesis that low birth weight pigs receive inadequate Ca and PO_4 nutrition during the nursing period.

Key Words: nursing pigs, pre-weaning nutrition, $CaPO_4$ supplementation

W184 Bone ash and strength traits of young pigs fed diets with no supplemental vitamin D were compromised within a four-week trial. L. A. Rortvedt,* D. K. Schneider, and T. D. Crenshaw, *University of Wisconsin-Madison, Madison.*

Last year we reported > 30% reduction in growth and whole body skeletal traits in pigs fed diets without supplemental vitamin D (D) during a 4-wk trial. Excess dietary Ca and P did not alleviate D responses. A method to detect kyphosis via DXA was reported, but individual bones were not assessed. The current objective was to evaluate the effect of diets on individual bone traits. In 2 trials (n = 72 ea) pigs were weaned (~3 wk) and fed diets with no supplemental D for 1 wk, then 1 of 8 diets (corn-SBM) for 4 wk. Treatments, arranged as a 2 × 2 × 2 factorial, included diets supplemented with D, 0 (-D) or 280 (+D) IU/kg; Ca, 75% (0.53%) or 150% (1.05%); P, 95% (0.57%) or 120% (0.72%) of requirements. On d 28 pigs (n = 24/trial) were euthanized, femurs and tenth ribs were excised. Femurs were scanned by DXA (GE Lunar Prodigy) to determine bone mineral content (BMC, g/bone) and density (BMD, g/cm^2), then subjected to a 4-point bending test to assess strength. Ribs were dried, de-fatted, and combusted (700°C) to determine ash. Femur BMC was reduced ($P < 0.01$) by > 50% in pigs fed -D vs +D, but responses depended on dietary Ca and P. Additional Ca and P increased femur BMC in pigs fed +D, but not -D ($P < 0.05$). Femur bending moments (BM) and rib ash (g and %) responded in similar patterns as femur BMC. Femurs from pigs fed +D vs -D had decreased ($P < 0.01$) strain, but responses did not depend on Ca or P. In conclusion, individual bone traits responded similarly to dietary D, Ca, and P as whole body DXA responses. Dramatic responses to dietary vitamin D within a 4 wk trial were not expected and may reflect carry-over effects of sow diets.

Table 1.

VitD, IU/kg:	0	0	0	0	280	280	280	280	
Ca, %:	75	75	150	150	75	75	150	150	
P, %:	95	120	95	120	95	120	95	120	SEM
Femur BMC, g[a, b, c, d, e]	8.80	9.51	10.59	9.90	13.51	15.83	16.02	20.60	0.77
BM, kg-cm[a, b, c, d, e]	235	306	354	360	410	567	571	809	39.9
Strain, cm/cm[a]	0.240	0.249	0.193	0.240	0.156	0.140	0.140	0.120	0.026
Rib ash, g[a, b, c, d, e]	1.010	0.958	1.088	0.999	1.445	1.710	1.842	2.251	0.091
Rib ash, %[a, e]	42.59	38.81	41.70	40.37	47.01	49.10	48.82	51.17	0.84

a. D, $P < 0.01$; b. Ca, $P < 0.05$; c. P, $P < 0.05$; d. D*Ca, $P < 0.05$; e. D*P, $P < 0.01$; f. D*Ca*P, $P < 0.05$.

Key Words: kyphosis, Ca, P

W185 Estimates of relative bioavailability of monocalcium and dicalcium phosphates based on whole body DXA scans to determine the efficiency of dietary P use by growing pigs. P. T. Merkatoris,* L. A. Rortvedt, and T. D. Crenshaw, *University of Wisconsin, Madison.*

Monocalcium phosphate (MCP) is a less expensive source of P than dicalcium phosphate (DCP). However, the relative bioavailability of P between the 2 sources may not be equal. The current experiment was designed to access the relative bioavailability of P in MCP and DCP based on a slope-ratio assay using growth, femur ash, and calculations derived from dual energy x-ray absorptiometry (DXA, GE Lunar Prodigy) scans to determine mineral retention and efficiency. Crossbred barrows (n = 35) were fed standard diets until ~10 kg then randomly allotted within weight blocks to 1 of 7 treatments. Treatments included a basal, corn-SBM diet with no supplemental inorganic P (0.39% P) and 3 diets formulated to supply 0.05, 0.10, or 0.15% added P from either MCP or DCP. Pigs were individually housed and allowed continuous access to feed and water except for an overnight fast before DXA scans on d 0 and 20. Skeletal gain (gBMC) was calculated as the difference in d 20 and d 0 whole body bone mineral content (BMC, g) derived from DXA scans. Assuming a distribution of Ca (99%) and P (80%) in the whole body, Ca and P retentions were calculated assuming 38% Ca and 18% P in bone ash. Efficiency of Ca and P retention was calculated as the ratio of nutrient retained to nutrient consumed. Relative bioavailability of MCP vs DCP were based on the ratio of linear slope coefficients calculated for various criteria shown below. Criteria based on assessment of bone traits (femur BMC, gBMC, P efficiency) predicted 9 to 29% higher relative bioavailability for MCP than DCP. However, traits based on growth and feed consumption (ADG, FG ratio) predicted 5 to >35% higher bioavailability of P from DCP vs MCP. Reasons for a discrepancy in relative bioavailability estimates among criteria were not obvious.

Table 1.

Trait	Intercept	Basal	DCP	MCP	R^2	MCP/DCP
ADG	0.0379	0.1432	0.1341	0.1273	0.872	95.0
FG ratio	1.7442	−0.0190	−0.0541	−0.0340	0.090	62.8
gBMC	−1.8927	0.6943	1.3705	1.6362	0.734	119.4
P efficiency	0.0008	−0.0328	0.0529	0.0683	0.598	129.0
Femur BMC	3.2918	0.9628	1.7320	1.8849	0.751	108.8

Key Words: Ca retention, P retention, slope-ratio assay

W186 Effects of sulfur concentration in diets containing distillers dried grains with solubles on carcass characteristics and tissue mineral concentrations in growing-finishing pigs. B. G. Kim*[1], D. Y. Kil[2], D. C. Mahan[3], G. M. Hill[4], and H. H. Stein[5], *[1]Konkuk University, Seoul, Korea, [2]Chung-Ang University, Anseong-si, Korea, [3]Ohio State University, Columbus, [4]Michigan State University, East Lansing, [5]University of Illinois, Urbana.*

The objective of this experiment was to determine if concentration of S in diets containing distillers dried grains with solubles (DDGS) affect carcass characteristics, loin quality, and tissue S, Se, and Cu concentrations in growing-finishing pigs. A total of 120 growing barrows (34.2 ± 2.3 kg BW) were allotted to 3 dietary treatments with 10 replicate pens and 4 pigs per pen in an 84-d experiment. The control diet was based on corn and soybean meal (0.14% S, 0.19 mg/kg Se, and 15.3 mg/kg Cu). The DDGS diet was formulated with corn, soybean meal, and 30% DDGS (0.16% S, 0.32 mg/kg Se, and 14.0 mg/kg Cu). The DDGS-S diet was similar to the DDGS diet, except that 1.10% CaSO4 (16.2% S) was added to this diet (0.37% S, 0.35 mg/kg Se, and 13.8 mg/kg Cu). Organ weights and loin quality, 24-h pH, drip loss, loin subjective color, marbling, and firmness did not differ among treatments, but loin redness (a*) was greater ($P < 0.05$) for pigs fed the control diet than for pigs fed the DDGS-S diet. Concentrations of S in hair, liver, heart, loin, and all other tissues did not differ among treatments, but urinary S concentration was greater ($P < 0.05$) for pigs fed the DDGS-S diet than for pigs fed the other diets. Pigs fed the DDGS diet or the DDGS-S diet had greater ($P < 0.01$) Se concentrations in hair, liver, heart, and loin than pigs fed the control diet, but liver concentrations of Cu did not differ among treatments. In conclusion, inclusion of 30% DDGS in diets fed to growing-finishing pigs does not influence carcass characteristics or tissue S concentrations regardless of S concentration in the diet, and excess dietary S is excreted in the urine. In contrast, because of the greater concentration of Se in DDGS compared with corn and soybean meal, tissue concentrations of Se are increased if DDGS is included in the diet. However, liver concentrations of Cu are not influenced by dietary DDGS.

Key Words: distillers dried grains with solubles, selenium, sulfur