indigestible marker. Ileal samples were collected for 3 d following 4 d of diet acclimation until 6 replicates were obtained for each pea sample. A protein-free synthetic diet (69% pea starch, 13% cellulose and 10% sugar) was then fed to determine isolated pea starch digestibility. Starch RH determined using in vitro or in vivo techniques was similar (r = 0.89; $P < 0.01$) but differed between varieties ($P < 0.001$). RH was highest for Noble, Cooper and Thunder pea varieties (75, 76, and 70%, respectively) and lowest for Centinal, Circus and Sage varieties (54, 56 and 57%, respectively). Prediction equations for the DE content of 5 pea samples were developed using the in vitro technique and validated in vivo using 30 growing pigs (28±2 kg) fed a basal diet or 5 pea-based diets (70% basal diet and 30% peas) supplemented with AIA, as an indigestible marker. Faecal samples were collected for 3 d following a 10 d diet adaptation and the DE content determined. Significant correlations were observed between DE and RH (r = 0.57) and DE and pea ADF content (r = –0.67). The best prediction equation used ash and ADF content (DE = 5.04–0.02Ash–0.016ADF; $r^2 = 0.55$, $P = 0.06$). In conclusion, in vitro starch hydrolysis can be used to estimate DE content of field peas.

Key Words: field peas, starch digestion, pigs

223 Standardized ileal amino acid digestibility of field peas (*Pisum sativum*) in adult pigs. C. A. Montoya, A. D. Beaulieu*, and P. Leterme, *Prairie Swine Centre, Inc., Saskatoon, SK, Canada*.

Nutrient digestibility coefficients are typically higher in adult pigs or sows relative to growing pigs. Amino acid digestibility however, is usually determined in growing pigs. This experiment determined the standardised ileal digestible (SID) AA content of eight commercial field pea varieties using 132 kg barrows. Eight barrows fitted with T-cannulas at the terminal ileum were fed a semi–synthetic diet containing 60% peas as the only source of protein and supplemented with 0.3% Cr_2O_3 as an indigestible marker. Ileal digesta samples were collected for 3 d following 4 d of diet acclimation, until 6 replicates were obtained for each pea variety. The pigs were then fed a protein-free synthetic diet to measure endogenous N losses. Diet and digesta samples were analysed for N, AA and Cr_2O_3 content. The SID AA (%) was 89.4±1.3, 80.7±1.7, 73.2±3.5, 77.7±2.1, 83.7±1.5, 69.4±4.6, 77.0±2.9, 70.5±2.6, and 72±3.5; and the SID AA content (g/kg dry peas) was 78.6±7.6, 20.5±0.5, 27.7±3.1, 57.2±2.2, 63.5±4.4, 7.2±1.2, 37.3±1.2, 29.1±0.9, and 30.5±3.4 for Arg, His, Ile, Leu, Lys, Met, Phe, Thr and Val, respectively. The SID content of Ile, Met and Val differed between varieties ($P < 0.05$). Ileal N digestibility averaged 82.2±2.0 and differed between varieties ($P < 0.05$). Average SID values were higher than those reported by NRC (1998) in growing pigs. In conclusion, the SID AA values for field peas must be determined in both adult and growing pigs.

Key Words: field peas, SID AA, adult pigs

224 Effects of added copper sulfate and zinc oxide on weanling pig growth and plasma mineral levels. N. W. Shelton*[1], M. D. Tokach[1], J. L. Nelssen[1], R. D. Goodband[1], S. S. Dritz[1], J. M. DeRouchey[1], G. M. Hill[2], R. G. Amachawadi[1], and T. G. Nagaraja[1], [1]*Kansas State University, Manhattan*, [2]*Michigan State University, East Lansing*.

A total of 216 weanling pigs (PIC TR4, initially 6.2 kg and 21 d) were used in a 42-d trial to compare the effects of supplemental zinc and copper on growth performance and plasma mineral levels. Six dietary treatments were allotted in a RCBD and included a 2 × 2 factorial with main effects of added copper from $CuSO_4$ (0 or 125 ppm) and added zinc from ZnO (0 or 3,000 ppm from d 0 to 14 and 0 or 2,000 ppm from d 14 to 42). The final 2 treatments were ZnO alone or in combination with $CuSO_4$ from d 0 to 14 with $CuSO_4$ fed d 14 to 42. There were 6 pens per treatment with 6 pigs per pen. All diets contained an additional 165 ppm zinc and 16.5 ppm copper provided by the premix. Plasma was collected from 2 pigs per pen on d 14 and 42. From d 0 to 14, ADG, ADFI, and G:F were improved ($P < 0.04$) with the addition of dietary zinc. From d 14 to 42, added copper increased ($P < 0.003$) ADG and ADFI. From d 0 to 42, continuous supplemental zinc increased ($P < 0.03$) ADG and tended to increase ($P < 0.09$) ADFI. Dietary copper also increased ($P < 0.004$) ADG and ADFI from d 0 to 42. The most advantageous values for ADG and G:F were in pigs fed 3000 ppm of zinc from d 0 to 14 and 125 ppm copper from d 14 to 42. Plasma zinc levels were also increased ($P < 0.001$) with zinc supplementation on d 14. These results indicate that each mineral regimen improved ($P < 0.05$) weanling pig growth performance compared to the control and the greatest numerical performance was observed when adding ZnO from d 0 to 14 and CuSO4 from d 14 to 42.

Table 1.

d 0 to 14 diet	Control	Cu	Zn	Cu & Zn	Zn	Cu & Zn	
d 14 to 42 diet	Control	Cu	Zn	Cu & Zn	Cu	Cu	SEM
d 0 to 14							
ADG, g	146[a]	182[b]	212[bc]	222[c]	217[bc]	222[c]	13.3
ADFI, g	220[a]	261[b]	256[ab]	274[b]	267[b]	274[b]	14.7
d 14 to 42							
ADG, g	586[a]	634[c]	605[ab]	632[bc]	643[c]	618[bc]	17.9
ADFI, g	910[a]	986[b]	956[ab]	1005[b]	998[b]	975[b]	34.3
d 0 to 42							
ADG, g	440[a]	483[bc]	473[b]	495[bc]	501[c]	486[bc]	14.9
ADFI, g	680[a]	745[b]	720[ab]	761[b]	754[b]	741[b]	27.0

[abc]Means in the same row with different superscripts differ ($P < 0.05$).

Key Words: copper, growth promotion, zinc

225 Effect of feeding organic and inorganic zinc on growth performance, zinc absorption and immune response of weaning pigs. T. S Jeong*, S. W Lee, Y. D Jang, L. G Piao, and Y. Y Kim, *Seoul National University*, *Seoul, Korea*.

This experiment was conducted to evaluate the effect of dietary zinc sources and level on growth performance, plasma Zn concentration, and immune response (IgA and IgG) in weaning pigs. A total of 144 crossbred pigs, weaned at 24 ± 3 days of age with average initial body weight of 8.04 ± 0.03, were allotted to 6 treatments in 6 replicates with 4 pigs per pen in a randomized completely block (RCB) design. Pigs were fed in three dietary phase during 5 weeks (Phase 1, d 0 to 7; Phase 2, d 8 to 21; Phase 3, d 22 to 35). Treatments were: 1) In1 (140 ppm of zinc from $ZnSO_4$), 2) In2 (280 ppm of zinc from $ZnSO_4$), 3) In3 (560 ppm of zinc from $ZnSO_4$), 4) Or1 (70 ppm of zinc from Zn-Met), 5) Or2 (140 ppm of zinc from Zn-Met), 6) Or3 (280 ppm of zinc from Zn-Met). During the 5 weeks, there were no significant differences in the body weight, average daily gain (ADG) and feed efficiency among the treatments. For phase 2 treatment In3 supplemented Zn as $ZnSO_4$ showed the lowest ($P < 0.10$) ADG (In1:456, In2:444, In3:392, Or1:444, Or2:464 and Or3:470g, respectively). For the comparison of different sources at different levels (In1 vs. Or1, In2 vs. Or2, In3 vs.