775 Supplemental fumaric acid restored growth performance of weanling pigs fed 10% full-fat diatom microalgae. B. Y. Jung, K. K. Lum*, K. R. Roneker, and X. G. Lei, *Cornell University, Ithaca, NY.*

Previous research in our laboratory demonstrated a growth depression of weanling pigs by adding 7.5 to 15% of defatted microalgae diatom biomass in the diet to replace soybean meal and(or) corn. Subsequent chemical and fecal analyses suggested high ash contents of the diatom products as a potential negative effector on acid-base balance and utilization of trace elements Cu, Se, and Zn in diets of weanling pigs. The present study was conducted to determine if supplementing organic acid and the selected trace elements overcome or alleviated such effects of a full-fat diatom (Cellana, Kailua-Kona, HI). A total of 40 individually housed weanling pigs (BW = 9.6 ± 0.8 kg) were allotted to 4 groups (n = 10/treatment) and fed a corn-soybean meal basal diet (BD), BD + 10% diatom, BD + 10% diatom + 2% fumaric acid (Univar, Morrisville, PA), and BD + 10% diatom + 50% more Cu, Se, and Zn in the vitamin/mineral premix for 6 wk. Growth performance and blood biochemical responses were measured biweekly. Overall average daily gain and feed efficiency were 7% and 2% lower in pigs fed 10% diatom than those control pigs fed the BD. While supplementing 2% fumaric acid in the diatom-containing diet restored the growth performance of pigs, the additional Cu, Zn, or Se produced an opposite effect ($P < 0.05$). The diatom-fed pigs had marginal increases ($P = 0.06$) in packed cell volume and blood hemoglobin concentration compared with the BD-fed pigs. However, there were no differences in daily feed intake or plasma inorganic phosphorus concentration, alkaline phosphatase activity, and tartrate-resistant acid phosphatase activity among treatment groups at any time point. In conclusion, feeding weanling pigs with 10% full-fat diatom depressed their growth and feed use efficiency, but those losses could be obviated by supplementing 2% fumaric acid. (Supported in part by a USDA/DOE Biomass R&D Initiative grant).

Key Words: algae, trace mineral, organic acid

776 Weanling pigs fed 10% defatted green microalgae maintained normal growth performance and plasma biochemistry. R. D. Ekmay*, K. R. Roneker, K. K. Lum, and X. G. Lei, *Cornell University, Ithaca, NY.*

A green marine microalgal strain (*Desmodesmus* sp.) was tested for biofuel production and the defatted biomass contained 31% crude protein. The objective of the present study was to determine if this defatted microalgal biomass could replace a portion of soybean meal in diets for weanling pigs and if adding exogenous protease improved its protein digestibility. A total of 32 weanling pigs (5-wk old) were divided into 4 groups (n = 8) and fed a corn-soybean meal diet containing 0 or 10% of the defatted green microalgae (Cellana, Kailua-Kona, HI) and (or) an exogenous protease (Ronozyme ProAct, 0.06% of the diet, DSM Nutritional Products Inc., Parsippany, NJ) for 4 wk. Body weights and feed intakes were recorded biweekly and blood samples of individual pigs were collected at the same periods to measure plasma biochemistry. Data were analyzed as 2 × 2 factorial arrangements with time-repeated measurements. Neither the defatted microalgae nor the exogenous protease affected growth performance of pigs at any time point. Likewise, there was no dietary treatment effect on plasma alanine aminotransferase, alkaline phosphatase, and tartrate-resistant acid phosphatase activities or plasma concentrations of uric acid and total amino acids. However, supplemental protease decreased plasma urea nitrogen concentration by 45% ($P < 0.01$) when pigs were fed the defatted microalgae at wk 2. The same trend also remained at wk 4, but the protease effect was not statistically significant. In conclusion, including the defatted green microalgae in the corn-soybean meal diet of weanling pigs at 10% did not exert any adverse effect on their growth performance or plasma biochemical status. (Supported in part by a USDA/DOE Biomass R&D Initiative grant).

Key Words: green microalgae, protease, swine nutrition

777 Defatted microalgae diatom biomass may replace a portion of soybean meal and corn in broiler diets. R. E. Austic, A. Mustafa, B. Y. Jung, and X. G. Lei*, *Cornell University, Ithaca, NY.*

Previous research in our laboratory has shown effectiveness of defatted microalgae diatom biomass from biofuel production in replacing a portion of soybean meal in diets for layer hens and weanling pigs. Two experiments were performed to evaluate responses of broiler chickens to the same defatted diatom (DD) biomass (Cellana, Kailua-Kona, HI). In Exp.1, duplicate cages per sex of 5 broiler chicks were fed starter (0–3 wk) and grower (4–6 wk) diets containing synthetic amino acids and DD at 0% (control), 7.5% to replace soybean meal or 7.5% or 10% to replace soybean meal and corn. Chicks fed 7.5% DD replace only soybean meal had 11–18% lower ($P < 0.05$) body weight gain than the controls. Chicks fed 7.5% DD and 10% DD to replace soybean meal and corn had 5–13% and 16–21% lower ($P < 0.05$) body weight gain, respectively, than controls. The differences were statistically significant only in the starter period. Male chicks fed 10% DD also had lower ($P < 0.05$) plasma uric acid and liver triglyceride concentrations than the controls at wk 6. A follow-up experiment was conducted to determine if adding exogenous protease (Ronozyme ProAct, 0.06% of the diet, DSM Nutritional Products Inc., Parsippany, NJ) or more amino acids to the 7.5% DD (to replace only soybean meal) diet restored the growth performance of chicks. Five diets were fed to 6 replicates of 7 male chicks each for 6 wk. Compared with the control, the 7.5% DD diet resulted in a 5% decrease ($P < 0.05$) in overall gain/feed efficiency. The loss was prevented by the addition of more amino acids, but not by the protease. Responses of plasma and liver biomarkers and gross examination of digestive tract indicated no evidence of toxicity of DD in both experiments. In conclusion, the defatted diatom biomass could substitute for 7.5% of soybean alone, or in combination with corn, in diets for broiler chicks when appropriate amino acids are supplemented. (Supported in part by a USDA/DOE Biomass R&D Initiative grant).

Key Words: soybean meal, amino acid, protease

778 Effect of dietary fat sources on tissue α-tocopherol concentration in pig. D. P. Preveraud*[1], E. Devillard[1], and P. Borel[2], *[1]Adisseo France SAS-CERN (Center of Expertise and Research in Nutrition), Commentry, France, [2]UMR NORT (Nutrition Obésité et Risque Thrombotique) 1062 INSERM/1260 INRA/Aix-Marseille Université, Marseille Cedex 5, France.*

Vitamin E (VE) is essential for growth, health and reproduction in pig but its bioavailability is affected by many dietary factors. Our study evaluates the effect of dietary fat sources on tissue α-tocopherol (TOL) content in pig. After weaning at 28 d, 96 piglets were fed for 2 wk a semi-purified diet not supplemented with VE. Piglets were then randomly assigned to 5 isoenergetic diets with 100 ppm VE as dl-tocopheryl-acetate: a control diet (CTRL; with no added fat) and 4 other diets containing either

3% linseed oil (LIN), 3% hydrogenated coconut oil (COC), 3% olive oil (OLI) or 3% safflower oil (SAF). After 42 d, pigs were sacrificed; blood, muscle (Longissimus Dorsi), backfat, and whole liver (without gallbladder) were collected and analyzed for their TOL concentrations by HPLC. For all tissues, LIN and SAF diets led to lower TOL concentrations as compared with the CTRL group: −63% ($P < 0.02$) and −67% ($P < 0.03$), respectively. TOL concentrations in plasma, liver and backfat were higher in the COC group as compared with the CTRL group ($P < 0.001$). OLI diet led to higher TOL concentration in plasma (+21%; $P < 0.01$) and liver (+92%; $P < 0.01$) as compared with CTRL diet, but has no significant effect in muscle and backfat. Plasma and liver TOL showed the same differences among treatments, suggesting that TOL status in these 2 tissues is closely related. In conclusion, our study shows that polyunsaturated fatty acids (FA) found in LIN (48% n-3) and SAF (52% n-6) diets tend to decrease TOL concentration, whereas saturated FA (99% in COC) increase it. We hypothesized that polyunsaturated FA confer changes in mixed micelles size or charge, resulting in decreasing VE bioaccessibility, a necessary step before absorption.

Table 1. Mean TOL concentrations in plasma and tissues

	Fat source[1]				
	CTRL	LIN	COC	OLI	SAF
Plasma (μg/mL)	1.59[b]	0.51[c]	2.15[a]	1.93[a]	0.33[d]
Muscle (μg/g)	4.99[a]	1.75[b]	5.39[a]	4.88[a]	1.43[b]
Liver (μg/g)	6.97[c]	3.21[d]	9.17[b]	13.42[a]	2.71[d]
Backfat (i μg/g)	7.12[b]	2.41[c]	11.00[a]	4.50[bc]	2.91[c]

[a–d]Within a row, means without a common letter significantly differ ($P < 0.05$).
[2]CTRL = control diet with no added fat; LIN = 3% linseed oil; COC = 3% coconut oil; OLI = 3% olive oil; SAF = 3% safflower oil.

Key Words: vitamin E bioavailability, dietary fatty acid, swine

779 Ingredients of plant and animal origin in diets for nursery pigs. K. M. Jones*, J. D. Hancock, and K. M. Sotak, *Kansas State University, Manhattan.*

A total of 224 weanling pigs (avg. initial BW of 6.4 kg and avg age of 21 d) were used in a 34-d growth assay to determine the effects of diet ingredients on growth performance. The pigs were weaned, sorted by sex and ancestry, blocked by BW, and assigned to pens (7 pigs/pen and 8 pens/treatment) in a randomized complete block design. For d 0 to 10, treatments were arranged as a 2 × 2 factorial with main effects of primary protein sources (plant vs. animal) and inclusion of soybean meal (none vs. 30%). The plant protein sources were wheat gluten and corn gluten and the animal protein sources were spray-dried plasma protein and fishmeal. Soybean meal was used to replace corn on a kg/kg basis with no attempt made to reduce protein excess. All diets were formulated to be at least 120, 120, and 110% of requirements for essential amino acids, vitamins, and minerals, respectively, as suggested in the 1998 National Research Council guidelines for swine feeding. For the remainder of the experiment (d 10 to 34) pigs were fed a common diet to allow determination of any carryover effects from the diets fed immediately after weaning. As for results, there were no interactions for d 0 to 10, 10 to 34, or 0 to 34 ($P > 0.13$) among the protein sources and inclusion of soybean meal for ADG, ADFI, or G/F. However, use of animal products increased ($P < 0.02$) ADG by 61% and G/F by 16% for d 0 to 10 and ADG by 7% for d 0 to 34. Also, soybean meal increased ADG by 31% for d 0 to 10 ($P < 0.001$) and by 5% for d 0 to 34 ($P < 0.07$). In conclusion, the use of animal products (plasma protein and fishmeal) and soybean meal (30% of the diet) enhanced rate of gain in weanling pigs.

Table 1.

	Plant		Animal		
Item	0%	30%	0%	30%	SE
d 0 to 10					
ADG, g	111	173	212	249	13
ADFI, g	149	164	219	222	10
G/F, g/kg	745	1055	968	1122	51
d 0 to 34					
ADG, g	474	489	498	530	15
ADFI, g	590	622	628	640	15
G/F, g/kg	803	786	793	828	19

Key Words: animal protein, soybean meal, pig

780 Growth performance of weanling pigs fed diets containing copra meal, palm kernel expellers, or palm kernel meal. N. W. Jaworski*, J. C. Gonzalez-Vega, and H. H. Stein, *University of Illinois at Urbana-Champaign, Urbana.*

Three experiments were conducted to separately evaluate copra meal (CM), palm kernel expellers (PKE), and palm kernel meal (PKM) in phase 2 diets for weanling pigs. In Exp. 1, 128 pigs (initial BW = 9.2 ± 1.2 kg) were randomly allotted to 4 diets that were fed for 20 d. There were 4 pigs per pen and 8 replicate pens per treatment. The control diet was based on corn, soybean meal, and 4% fish meal. Three additional diets were formulated by including 5, 10, or 15% CM at the expense of corn and soybean meal. Diets were formulated to contain equal quantities of digestible AA and P, and ME. Individual pig BW was recorded at the start of the experiment, on d 10, and at the conclusion of the experiment. Daily feed allotments were recorded and feed left in the feeders were recorded on the same day as pigs were weighed. In Exp. 2, 128 pigs (initial BW = 9.8 ± 1.0 kg) were randomly allotted to 4 diets. This experiment was similar to Exp. 1 with the exception that 0, 5, 10, or 15% PKE rather than CM was included in the diets. Exp. 3 was also similar to Exp. 1 with the exception that 0, 5, 10, or 15% PKM were used and a total of 160 pigs (initial BW = 8.4 ± 1.3 kg) were allotted to the 4 treatment diets with 5 pigs per pen and 8 replicate pens per diet. Linear and quadratic effects of including increasing levels of CM, PKE, and PKM were determined using orthogonal CONTRAST statements in SAS. Results indicated that weanling pigs fed increasing levels of CM had a linear reduction ($P < 0.05$) in final BW (19.5, 19.1, 18.9, and 18.5 kg), overall ADG, and overall ADFI, but overall G:F was not influenced by CM in the diet. Pigs fed increasing levels of PKE also had a linear reduction ($P < 0.05$) in final BW (20.3, 19.6, 19.9, and 19.2 kg) and overall ADG, but overall ADFI and G:F were not influenced by PKE in the diet. However, if PKM was used, no differences in final BW and overall ADG, ADFI, or G:F were observed. In conclusion, if diets are formulated based on digestible nutrients and ME, phase 2 diets for weanling pigs may include up to 15% PKM without affecting overall performance, but this is not the case for CM and PKE.

Key Words: copra meal, palm kernel products, pig

781 Nutritive value of low phytate peas and barley based diets fed to growing pigs. R. K. Kahindi*[1], P. A. Thacker[2], and C. M. Nyachoti[1], *[1]University of Manitoba, Winnipeg, MB, Canada, [2]University of Saskatchewen, Saskatoon, SK, Canada.*

Five ileal cannulated barrows (BW of 42.8 ± 1.3 kg) were used in a 5 × 5 Latin square design to determine apparent (AID), standardized (SID) ileal digestibility of N and AA in low phytate barley (LPB), peas (LPP), and

normal peas (NP) and total tract (ATTD) digestibility of Ca and P of diets containing these ingredients, and the effect of phytase supplementation. Five experimental diets were formulated to contain 86.93% LPB, 86.81% LPP or 86.95% NP; phytase was supplemented at 500 FTU/kg to the LPP and NP diets to produce 2 additional diets. The ingredients contained Ca (0.13, 0.23, 0.21%), P (0.41, 0.47 and 0.43%), and phytate P (0.04, 0.07 and 0.20%) for LPB, LPP, and NP, respectively. Inorganic Ca was added in all diets to meet recommended values, while inorganic P was added only in peas containing diets to obtain 65% available P recommended by NRC (1998) for 20 to 50 kg pigs. The ingredients were the sole source of protein and SID of N and AA were calculated using published values for ileal basal endogenous AA losses from our laboratory. Titanium dioxide (0.3%) was used as indigestible marker. Daily feed allowance was set at 4% of BW at the beginning of each period and offered in 2 equal portions at 0800 and 1600 h. Each experimental period lasted for 8 d; d 1 to 4 for adaptation, 5 to 6 for ileal digesta collection, and 7 to 8 for urine and fecal collection. The ATTD of Ca and P were significantly higher ($P < 0.0001$) in LPB than in LPP and NP diets. Supplementing LPP and NP diets with phytase increased ($P < 0.05$) ATTD of Ca and P. The AID of N and AA except Met were higher ($P < 0.05$) in LPP and NP than LPB, and similar ($P > 0.05$) for LPP and NP. Phytase supplementation increased ($P < 0.05$) AID of Arg, Ile, Leu, Phe, Pro, Ser, Tyr, and Val. The average SID values for Lys (73.4, 89.5, 89.5%), Met (73.2, 75.7, 74.4%) and Thr (68.8, 81.6, 81.5%) in LPB, LPP and NP, respectively. The results show that the pea varieties had higher AID of AA than LPB. Additionally, LPP diet had higher ATTD of Ca and P compared with NP diet and enzyme supplementation improved nutrient digestibility.

Key Words: low phytate peas, nutritive value, pig

782 Effects of acidified protein feed on growth performance, digestive characteristics, and gut bacterial communities in growing and finishing pigs. J. Chen*, Y. Xiao, X. Li, Q. Hong, and A. Chen, *College of Animal Sciences, Zhejiang University, Hangzhou, Zhejiang, China.*

A new protein feed resource was developed in this study. Corn protein powder and citric acid mycelium which was the residue of production of citric acid were combined in proportion of 3 to one to make the acidified protein feed (APF). The contents (g/kg, 90.60% DM) of CP, Lys, Met, and Thr of ADF were 294.52, 8.71, 6.35, and 7.69, respectively. Potential effects of APF as a substitute for a portion of soybean meal and corn of diet on growth performance, intestinal digestive characteristics and bacterial communities in growing and finishing pigs were investigated. A total of 240 pigs of 30 ± 1.2 kg were randomly assigned into 2 groups: (1) APF group (20% APF added to basal diet instead of 10% corn and 10% soybean meal), (2) control group. There were 6 replications per group and 20 pigs per replication. Fat powder and Lys were added to meet requirements on a true ileal digestible basis. The pH value of APF-treated diet was 6.01, and the control was 6.28. Growth performance were evaluated based on each replication by *t*-test, while 6 pigs per group were euthanized to assay intestinal pH value, digestive enzyme activity, apparent ileal digestibility (AID), and ileal and cecal bacterial communities by PCR-DGGE on d 50 and d 105. Results showed that ADG increased by 6.8% ($P > 0.05$) on d 50, whereas F:G decreased by 10.2% ($P < 0.05$). Addition with APF decreased ($P < 0.05$) the pH value in duodenum of pigs. The trypsin activity increased ($P < 0.05$) in duodenum and jejunum of the APF-treated pigs. The AID of Thr, Lys, Leu, Val, Ala and Ser increased ($P < 0.05$) by 8.02%, 6.01%, 10.86%, 7.57%, 7.50%, and 7.13% in APF group on d 50, respectively, as Lys increased by 5.89% on d 105. It was observed that the total number of DGGE bands and Shannon index of diversity for ileal and cecal content samples were greater in APF group. In conclusion, the APF as a substitute for the proportion of basal diet in the form of corn and soybean meal can modify the intestinal digestive characteristics and bacterial communities to improve the growth performance in growing and finishing pigs.

Key Words: acidified protein feed, digestive characteristics, pig