Symposium: Nonruminant Nutrition: Energy Systems and Alternative Energy Ingredients for Swine

782 Recent developments in net energy research for pigs. Jean Noblet*, *INRA, Saint Gilles, France*.

Feed represents the most important cost in pig production and energy represents the greatest proportion of this cost. It is then important to express the feed energy value on an appropriate basis and both energy supply (a diet characteristic) and energy requirement (an animal characteristic) should be expressed using the same system. Feeds can be attributed energy values according to DE, ME or NE bases. Reference methods for evaluating DE or ME contents are based on in vivo digestibility measurements while NE values originate from prediction equations established from energy balance studies. Literature results indicate that energy digestibility of feeds is negatively affected by dietary fiber content but the negative effect is attenuated with body weight increase. This suggests that feeds should be attributed DE values according to pig BW; in practice, two different DE values, one for growing-finishing pigs and one for reproductive sows, are recommended. The energy digestibility of pig feeds can also be affected by feed processing (pelletting, extrusion, etc.); this effect is the most important for some fat rich ingredients (corn, rapeseed, linseed). Metabolic utilization of ME averages 75% but it is dependent on diet chemical composition with efficiencies higher for energy from fat (90%) or starch (82%) than from protein or dietary fiber (60%). The hierarchy between feeds is then dependent on the energy system with overestimation of protein rich feeds and underestimation of starch and/or fat rich feeds in the DE or ME systems. For example, in the system proposed by INRA, the energy values (% of a conventional diet) of corn, soybean meal and animal fat are 100, 104 and 235 on a DE basis, 102, 99 and 244 on a ME basis, and 107, 79 and 289 on a NE basis. The NE system provides an energy value which is the closest estimate of the "true" energy value of a feed and it predicts accurately the performance of the pigs independently of diet characteristics. Furthermore, it allows implementing new feeding strategies such as the use of low protein and/or high fat and/or high fiber diets.

Key Words: Feed, Pig, Net Energy

783 Practical application of the net energy system in swine nutrition. R.T. Zijlstra*[1] and R.L. Payne[2], [1]*University of Alberta*, *Edmonton, AB, Canada*, [2]*Evonik-Degussa Corporation*, *Kennesaw, GA, USA*.

Energy is the greatest cost-pressure in swine feed; thus, an accurate system to evaluate energy quality is critical managing feed costs. The NE system has been used for decades in swine feed formulation in Europe, and interest in this system has recently increased in North America due to an apparent competitive disadvantage of the DE and ME systems. Advantages of the NE versus the DE or ME systems are: 1) ensuring consistent growth performance and carcass quality while altering the macro-nutrient composition and thus NE content of feeds; 2) managing the risk of including alternative feedstuffs into swine diets, and 3) reductions in feed costs per kg of feed or lean gain. Other advantages such as higher growth or feed efficiency have been overstated, resulting in reluctance by nutritionists to implement the NE system following lack of positive experimental results. Following a decision to apply the NE system, an implementation plan focused on feedstuff composition and formulated diet NE content is required. For feedstuffs, the focus is to develop or update a feedstuff data base including macronutrient composition. Used NE systems are solidly based on macronutrient composition of feedstuffs indicating that laboratory analyses and variation in composition should be part of the evaluation. For diets, these can be reformulated or directly recalculated to a NE content. The NE system might be implemented without an evaluation of feedstuff data base; however, ingredients vary regionally in macronutrient profile and thus NE content. Thus, feedstuff evaluation is recommended for risk management. Following the switch to the NE system, feed costs, growth performance, and carcass characteristics should be monitored to ensure that the switch was implemented successfully, and diet DE or ME content can be monitored initially for comfort. Application of the NE system combined with standardized ileal digestible AA and ideal AA profile will allow practical feed formulation providing the pig with the energy and AA required for efficient and predictable growth performance and carcass quality.

Key Words: Feed Formulation, Net Energy, Pig

784 Impact of the biofuels industry on alternative ingredients available to swine. B.J. Kerr* and T.E. Weber, *USDA-ARS-NSTL*, *Ames, IA, USA*.

The biofuels industry has exhibited astonishing production advances in the past decade, and in its wake, has lead to a wide diversity of co-products available to the livestock industry. During times of historically high prices for grains, proteins, minerals, and fats, this has lead to a rapid increase in research activities evaluating the nutritional potential of these products. For example, from the biodiesel industry, research has recently been conducted on the availability of energy from crude glycerin for swine and poultry of various ages, and on the variability of energy from crude glycerin produced from biodiesel plants utilizing different initial feedstock. Likewise, from both the wet and dry corn milling industry there are numerous products produced that vary in CP, AA, P, S, GE, and 'fiber' concentration. Data will be presented showing variations in the nutrient profiles of these co-products, how they might fit into feed formulations, limitations or concerns with product use, and variability of co-product quality.

Key Words: Biofuels Co-Products, Crude Glycerin, Dried Distillers Grains

785 Effects of feeding increasing levels of glycerol with or without distillers dried grains with solubles in the diet on grow-finish pig growth performance and carcass quality. J. Stevens*, A. Schinckel, M. Latour, D. Kelly, D. Sholly, B. Legan, and B. Richert, *Purdue University*, *West Lafayette, IN*.

Crossbred pigs (N=150; initial BW = 28.2 kg) were assigned to one of 6 dietary treatments to assess the impact of increasing levels of glycerol in grow-finish pig diets on growth and carcass traits. The 6 dietary treatments were: 1) Control, 0% Glycerol (Gly); 2) 5% Gly; 3) 10% Gly; 4) 15% Gly; 5) 20% dried distillers grains w/ solubles (DDGS); and 6)

20% DDGS +10% Gly. Diets were formulated to be equal in ME and dig. Lys. Growth performance was evaluated on a four phase feeding program. Pigs were fed two grower diets (G1 d0-d28; G2 d28-d56) and two finisher diets (F1 d56-d84; F2 d84-d105). A crude glycerol (84% Gly, <100 ppm methanol) was fed for Phases G1-F1 and a food grade glycerol (99.7% Gly) was fed during F2. As glycerol increased in the diet from 0 to 15%, overall ADG (851, 876, 880, 851 g/d, respectively; $P < 0.05$) responded quadratically while linearly increasing ADFI (2.47, 2.54, 2.57, 2.67 kg/d, respectively; $P < .01$) and linearly decreasing G:F ($P < 0.001$). Adding DDGS (0 or 10% Gly) decreased ADG (836 and 831g/d, respectively; $P < 0.02$) and G:F ($P < 0.04$). Increasing Gly to 10% increased final BW 3.0 kg ($P < 0.07$) while DDGS decreased final BW 1.9 kg ($P < 0.03$). Increasing Gly linearly increased tenth rib backfat (21.9, 23.5, 26.8, 25.3 mm, respectively, $P < 0.02$) and linearly decreased percent fat free lean (FFL) (52.1, 51.8, 49.8, 50.4%, respectively, $P < 0.02$). Feeding 20% DDGS increased FFL (53.1%) while feeding DDGS+10% Gly decreased FFL (50.8%; $P < 0.05$). Adding Gly to diets tended to linearly increase liver weights ($P < 0.06$). Adding DDGS tended to increase kidney weights ($P < 0.10$). Visual loin marbling decreased linearly with increasing Gly ($P < 0.01$). Loin Minolta color L* linearly increased with increasing Gly ($P < 0.09$). Feeding Gly up to 10% of grow finish diets can improve ADG and ADFI; however, carcass quality may be impacted by increasing backfat and reducing percent FFL and loin quality characteristics.

Key Words: Swine, Glycerol, Pork Quality

786 Effects of increasing dietary glycerol and dried distillers grains with solubles on growth performance of finishing pigs. A. W. Duttlinger*[1], M. D. Tokach[1], S. S. Dritz[1], J. M. DeRouchey[1], J. L. Nelssen[1], R. D. Goodband[1], and K .J. Prusa[2], [1]*Kansas State University*, *Manhattan*, [2]*Iowa State University*, *Ames*.

A study was conducted to determine the effects of dietary glycerol and dried distillers grains with solubles (DDGS) on grow-finish pig performance and carcass characteristics. The experiment was conducted at a commercial swine research facility in southwest Minnesota. A total of 1,160 barrows (initially 31.0 kg, PIC) were used in a 97-d study. Pigs were blocked by initial weight and randomly allotted to one of six dietary treatments with seven replications per treatment. Pigs were fed corn-soybean meal-based diets with 3% added fat arranged in a 2 × 3 factorial with main effects of glycerol (0, 2.5, or 5%) and DDGS (0 or 20%). There were no glycerol × DDGS interactions ($P > 0.13$). Increasing glycerol did not affect ($P > 0.33$) ADG or G:F. Adding 20% DDGS to the diet did not affect ADG. Pigs fed diets with added DDGS had greater ($P < 0.02$) ADFI than pigs fed diets with no DDGS (2.47 vs. 2.41 kg/d) resulting in decreased ($P < 0.01$) G:F (0.40 vs. 0.39) for pigs fed DDGS. Increasing glycerol tended to increase (linear, $P < 0.11$) yield (74.8, 75.7, and 75.7%). In conclusion, adding up to 5% glycerol to finishing diets did not affect growth performance, but tended to improve carcass yield. Adding 20% DDGS decreased G:F, but did not influence growth rate. Funded by National Pork Board in cooperation with the Minnesota Pork Board.

Item	DDGS, % / Glycerol, %	0 / 0	0 / 2.5	0 / 5	20 / 0	20 / 2.5	20 / 5	SE
ADG, kg		0.97	0.96	0.96	0.97	0.96	0.96	0.01
ADFI, kg		2.43	2.39	2.40	2.45	2.46	2.51	0.03
G:F		0.40	0.40	0.40	0.40	0.39	0.38	0.01
Carcass wt, kg		93.1	92.9	92.1	91.4	91.9	92.7	1.08
Carcass wt CV, %		9.0	9.4	9.2	8.8	8.1	8.9	0.67
Yield, %		75.1	75.5	75.7	74.5	75.9	75.7	0.47
Backfat, mm		19.9	19.7	19.8	19.3	19.0	19.6	0.48
Loin depth, mm		62.9	62.8	60.7	60.9	61.2	62.0	0.79
FFLI, %		49.2	49.1	49.1	49.3	49.4	49.3	0.24
Lean, %		54.3	54.3	54.2	54.4	54.6	54.4	0.33

Key Words: Dried Distiller Grains with Solubles, Glycerol, Finishing Pig

787 Effect of feeding an alternative carbohydrate source on nursery pig growth performance. B. E. Bass*, C. L. Bradley, C. V. Maxwell, Z. B. Johnson, and J. W. Frank, *University of Arkansas*, *Fayetteville*.

Lactose is a key ingredient in nursery pig diets due to its digestibility and improvement on performance. The purpose of this study was to examine the impact of replacing whey permeate (WP; 80% lactose) with a carbohydrate blend (CB; 40% lactose, 30% sucrose, 10% dextrose) on growth performance of nursery pigs. In the study, 240 pigs were weaned at 21.1±0.1 d of age (BW = 7.36±0.1 kg) and penned in groups of 6-7 pigs/pen in an offsite nursery facility. Pigs were randomly assigned to one of five experimental diets during phase 1 (10 d) and phase 2 (10 d). The phase 1 and 2 diets were corn-soy based and contained spray-dried plasma, fish meal, and soy protein concentrate. Phase 1 and 2 treatments were: control (CON, 0 and 0%), Low WP (7.5 and 5% WP), High WP (15 and 10% WP), Low CB (7.5 and 5% CB), and High CB (15 and 10% CB), respectively. All pigs were fed a common corn-soy phase 3 (14 d) diet. During phase 1, ADG (110^{b}, 133^{ab}, 178^{a}, 153^{ab}, 178^{a} g/d; $P = 0.06$) and ADFI (232^{b}, 238^{b}, 318^{a}, 254^{b}, 303^{a} g/d; $P < 0.01$) were different in CON, Low WP, High WP, Low CB, and High CB fed pigs, respectively. Phase 2 G/F for CON, Low WP, High WP, Low CB, and High CB were different (0.770^{ab}, 0.802^{a}, 0.797^{a}, 0.819^{a}, 0.717^{b}, respectively; $P < 0.01$). For phase 1 and 2 combined, ADG (323, 347, 385, 378, 355 g/d; $P = 0.12$) and ADFI (466, 470, 531, 495, 526 g/d; $P = 0.07$) were not different for CON, Low WP, High WP, Low CB, and High CP, respectively. Overall (phase 1 through 3), there was no effect of dietary treatment on growth performance. Final BW for CON, Low WP, High WP, Low CB, and High CB (23.90, 23.67, 24.87, 24.28, and 24.66 kg, respectively) were not different ($P = 0.48$). This experiment demonstrates that incorporating lactose into nursery diets improves growth performance. In addition, lactose can be at least partially replaced with simple sugars such as sucrose and dextrose without reducing growth performance.

Key Words: Pigs, Lactose, Sucrose