

773 The effect of consuming endophyte-infected tall fescue on lameness in the horse. K. C. Gradert*¹, J. M. Bormann¹, S. F. DeWitt², L. W. Lomas³, J. M. Kouba¹, and T. L. Slough¹, ¹Kansas State University, Manhattan, ²Woodside Equine Clinic, Ashland, VA, ³Southeast Agricultural Research Center, Parsons, KS.

The objective of this study was to assess the effect of endophyte-infected tall fescue consumption on equine soundness. Researchers have shown a vasoconstrictive effect of ergovaline on equine tissue *in vitro*. If circulation to the hoof is reduced *in vivo* then soundness may be compromised. Animals consisted of 12 clinically sound, three-year-old American Quarter horses with a mean BW of 459 ± 31 kg. They were blocked by weight, sex, and HYPP status and divided into two cohorts: control horses (n = 6) received an endophyte-free diet (E-) and treatment horses (n = 6) received an endophyte-infected (E+) diet. Fescue seed was integrated into the concentrate at a rate sufficient to bring daily ergovaline consumption in the E+ diet to a minimum of 0.20 ppm. The E- concentrate contained an equal amount of endophyte-free fescue seed. Horses had *ad libitum* access to native prairie hay. From d 30 to d 60 the native hay was replaced by a low- (E-) or high-endophyte (E+) variety of fescue hay. Based on assumed daily DM consumption of 2% BW, inclusion of fescue hay brought total dietary ergovaline consumption to 0.19 ppm (E-) and 1.04 ppm (E+). Lameness exams were conducted by a DVM blinded to treatment and occurred on d 0, d 30, d 60 and d 90. Animals were trotted in a straight path, tested for hoof sole and frog sensitivity, and lunged in both directions on a concrete surface. Horses on the E+ diet tended (P = 0.06) to have increased hoof sensitivity to hoof testers on d 60 compared to E- horses. While numerically there appeared to be a treatment effect, limited numbers of observations resulted in no significant difference between groups. Further research with increased numbers of horses or increased treatment duration may better elucidate whether the consumption of endophyte-infected fescue has a negative impact on equine soundness.

Key Words: lameness, fescue, horse

774 The use of thermal imaging to monitor temperature in the hoof of horses consuming endophyte-infected tall fescue. K. C. Gradert*¹, J. M. Bormann¹, S. F. DeWitt², L. W. Lomas³, J. M. Kouba¹, and T. L. Slough¹, ¹Kansas State University, Manhattan, ²Woodside Equine Clinic, Ashland, VA, ³Southeast Agricultural Research Center, Parsons, KS.

The objective was to evaluate blood flow in the hoof of horses consuming endophyte-infected tall fescue. A digital thermography camera was used to measure temperature in the hoof as an indicator of blood perfusion. Twelve clinically sound three-year-old Quarter horses with a mean BW of 459 ± 31 kg were blocked by weight, sex, and HYPP status and divided into two groups: those receiving an endophyte-free diet (E-; n = 6) and those receiving an endophyte-infected diet (E+; n = 6). Fescue seed was fed twice daily to bring daily ergovaline consumption in the E+ diet to a minimum of 0.20 ppm. The E- diet contained an equal amount of endophyte-free fescue seed. Horses had *ad libitum* access to native prairie hay, which was replaced with a high-endophyte (E+) or low-endophyte (E-) fescue hay from d 30 to d 60. Based on assumed daily DM consumption of 2.0% BW, total daily ergovaline consumption was calculated to be 0.19 ppm (E-) and 1.04 ppm (E+). Temperature was recorded at the center of both front hooves just below the coronary band on d 0, d 30, d 60 and d 90. Following the morning meal, ten serial temperature readings were taken on each hoof. On d 60, lower temperatures were noted in horses consuming the E+ diet compared to E- horses (P = 0.04). On d 90, E+ horses had higher hoof temperatures than E- horses (P = 0.03), and the regression coefficient for weight was positive (P = 0.05) indicating heavier horses exhibited higher temperatures compared to lighter horses. Regardless of diet, horses with HYPP status of NH had higher temperature readings on d 60 and d 90 than NN horses (P < 0.04). Adding the fescue hay to the diet prior to the d 60 measurements, and thus increasing total ergovaline content, appeared to alter the hoof temperature response in E+ horses. Consequently, if there is a vasoactive effect of ergovaline, it may be a dose dependent response.

Key Words: thermography, fescue, hoof

Nonruminant Nutrition: Fats and Oils

775 Effect of rice oil supplementation in diets for weaning pigs. G. J. M. M. Lima*¹, L. Wortmann², and A. Mior², ¹Embrapa, Concordia, SC, Brazil, ²Helmut Tessmann Vegetable Oils, Camaquã, RS, Brazil.

Natural vitamin E (E) has been shown to be a superior source for young pigs to synthetic forms. This study was conducted to determine the effects of feeding high nutrient rice oil (RO) for weaned pigs. RO was extracted from bran to preserve E (166.79 mg total E/100 g and 37.47 mg α -tocopherol/100 g). Other natural constituents such as γ -oryzanol (1.1%) and n-3 fatty acids (16.3%) were present, too. Four hundred and thirty two weaned pigs, 21 days old and 6.49 ± 0.30 kg average weight (wt), were allotted to 2 treatments according to a randomized complete block design with 7 blocks, defined by wt and sex. Treatments were: T1- control diet, based on ensiled corn grain, soybean meal, porcine plasma, lactose sources, soybean oil, supplemented with minerals, vitamins and growth promoters, formulated to meet or exceed 1998 NRC levels; T2- same diets of T1, except for the inclusion of 2% RO in partial replacement of soybean oil. Pigs were raised on a three phase feeding program with free access to feed and water until the end of trial (42 days). Diarrhea frequencies were not different between treatments (X² test, P>0.05). Pigs fed T2 diets showed heavier final wt (P=0.02) compared to T1, even when data were adjusted to initial weight (P=0.05) by analysis of covariance. RO dietary supplementation

improved (P=0.02) average daily gain (ADG) and feed consumption (ADFC), but had no significant effect on feed:gain ratio (FCR, P=0.29). It is difficult to delineate the importance of each RO component (E, n-3 fatty acids, γ -oryzanol) for the obtained performance improvement, but these results confirm previous positive effects of supplementing natural E and n-3 fatty acids for young pigs.

Table 1. Effects of partial replacement of soybean oil by rice oil in diets for weaning pigs.

Variable	T1 - 2% SBO	T2 - 2% RO	SEM	CV%	P
Initial wt, kg	6.376	6.601	0.143	5.86	0.31
Final wt, kg	28.610	31.078	0.556	4.93	0.02
Adj. final wt, kg ¹	28.821	30.866	0.559	4.72	0.05
ADG, kg/d	0.442	0.487	0.010	5.60	0.02
ADFC, kg/d	0.893	0.956	0.015	4.19	0.02
Adj. ADFC, kg/d ¹	0.896	0.952	0.016	4.42	0.07
FCR	2.029	1.972	0.035	4.60	0.29

¹ Data adjusted to initial body wt. SEM=Standard error of the mean. CV=Coefficient of variation.

Key Words: swine, γ -oryzanol, n-3 fatty acids

776 Apparent and true ileal digestibility of acid hydrolyzed ether extract in various feed ingredients fed to growing pigs. B. G. Kim*, D. Y. Kil, and H. H. Stein, *University of Illinois, Urbana.*

An experiment was conducted to measure the apparent (AID) and true ileal digestibility (TID) of acid hydrolyzed-ether extract (AEE) in extracted corn oil (CO), high-oil corn (HOC, 7.1% AEE), full-fat soybeans (FFSB, 21.4% AEE), distillers dried grains with solubles (DDGS, 11.8% AEE), corn germ (CG, 18.1% AEE), and high protein-distillers dried grains (HP-DDG, 6.8% AEE). The ileal digestibility of AEE in these ingredients was determined using 19 barrows (initial BW: 52.2 ± 3.81 kg) that were fitted with a T-cannula in the distal ileum. Pigs were allotted to a 19 × 12 incomplete Latin square design with 19 diets and 12 periods. A basal diet (0.67% AEE) based on cornstarch, casein, sucrose, and corn bran was formulated. Fifteen additional diets were formulated by adding 2.0, 4.0, or 6.0% AEE from CO (2 to 6%), HOC (24 to 72%), FFSB (9 to 28%), DDGS (17 to 51%), and CG (11 to 33%) to the basal diet at the expense of corn starch, casein, and corn bran. In the remaining 3 diets, 1.1, 2.2, and 3.2% of AEE was added to the basal diet by including 16, 32, and 48% HP-DDG, respectively. The AID of AEE increased with increased concentrations of AEE from CO and FFSB ($P < 0.05$; linear and quadratic), and from DDGS and HP-DDG ($P < 0.05$; linear). However, the inclusion level of AEE from HOC and CG did not affect the AID of AEE. The average AID of AEE was 85.8, 48.1, 76.6, 59.8, 49.4, and 66.5% (SEM = 1.68) in CO, HOC, FFSB, DDGS, CG, and HP-DDG, respectively. The ileal endogenous excretion of AEE was 0.695, 0.112, 0.525, 0.137, -0.021, and 0.427 g/100 g DMI, and the TID of AEE was 96.8, 50.8, 86.1, 62.6, 48.9, and 76.3% (SEM = 1.63) for CO, HOC, FFSB, DDGS, CG, and HP-DDG, respectively. In conclusion, the digestibility of AEE in DDGS and HP-DDG is greater than in HOC or CG, implying the distillation process may improve the digestibility of AEE in corn. However, all the sources of intact corn oil that were used in this experiment had lower AID and TID values for AEE than extracted corn oil.

Key Words: acid hydrolyzed ether extract, ileal digestibility, pigs

777 The impact of dried distillers grains with solubles withdrawal programs on swine carcass fatty acid profiles and bacon quality. J. Stevens, A. Schinckel, B. Richert, and M. Latour*, *Purdue University, West Lafayette, IN.*

Crossbred pigs (N=112; initial BW = 29.0 kg) were blocked by initial BW and sex and assigned to 1 of 7 dietary treatments to assess the impact of removing dried distillers grains w/ solubles (DDGS) the last 26 d and adding fat to the late finishing diet on carcass fatty acid (FA) profiles, belly processing, and bacon cooking traits. Dietary treatments were: 1) Corn-soybean meal (CS) control d 0-103; 2) 20% DDGS d 0-103; 3, 4, and 5) 20% DDGS d 0-77 and CS, CS+5% beef tallow (BT), or CS+5% choice white grease (CWG) from d 77-103, respectively; 6 and 7) 20% DDGS+5% CWG d 0-77 and CS+5% BT or CS+5% CWG d 77-103, respectively. All diets were formulated on an equal dig. Lys to calorie ratio and were phase fed (2 grower and 2 finisher diets). Belly firmness was tested by placing bellies over a 7.6 cm pipe. Bellies were pumped, smoked and the center slices were baked at 204°C for 12 min to evaluate cooking properties of the bacon. The FA profiles of the belly, loin, outer backfat, and inner 2 layers of backfat were determined. Pigs fed treatment 1 had firmer bellies than pigs fed treatment 2 (Avg. 8.4 vs 5.8 cm vertical flex scores; $P = 0.001$). Feeding treatment 4 during the 26 d withdrawal tended to improve belly firmness over all other withdrawal programs ($P < 0.10$). The high levels of linoleic acid in the DDGS resulted in the greatest difference between treatments 1 and 2

in linoleic acid (Belly; 9.3 vs 16.2%) in all adipose tissues measured ($P = 0.001$), resulting in a higher carcass calculated iodine value (belly; 57.1 vs 66.4), increased omega 6 to omega 3 ratios, and decreasing ($P = 0.037$) saturated to unsaturated ratios (belly; 0.70 vs 0.59) in all adipose tissues. Dietary treatments had minimal effects on belly yields or bacon cook scores. Feeding a CS or CS + 5% fat diet during a 26 d DDGS withdrawal program partially recovered some of the adverse fat quality effects caused by the increase in linoleic acid in the diet from the DDGS, however longer withdrawals are required for complete recovery of pork fat quality.

Key Words: swine, distillers dried grains, fatty acid profile

778 Analysis of iodine value in pork fat by Fourier transform near infrared spectroscopy for pork fat quality assessment. R. A. Coccia*, J. M. Benz², H. Li¹, S. S. Dritz², J. M. DeRouchey², M. D. Tokach², J. L. Nelssen², R. D. Goodband², and A. W. Duttlinger², ¹*Bruker Optics Inc., Billerica, MA*, ²*Kansas State University, Manhattan.*

The inclusion of dried distillers' grains with solubles (DDGS) in swine diets has rapidly increased in recent years because of increased availability. Because DDGS is high in linoleic acid, dietary intake by pigs has resulted in pork fat with higher levels of unsaturated fatty acids, adversely affecting pork fat firmness and quality. In this study, Fourier transform near infrared (FT-NIR) spectroscopy was used to measure iodine value (IV), a measure of the degree of unsaturation of fat. A total of 168 pork belly and jowl fat samples from pigs fed DDGS or ractopamine HCl were cut into pieces, placed on a glass petri dish and analyzed by FT-NIR spectroscopy in diffuse reflectance. Partial-least-squares (PLS) calibration models were developed for measuring IV in fat derived from pigs fed DDGS and ractopamine HCl by correlating their FT-NIR spectra to their respective gas chromatography-mass spectrometry reference values. Leave-one-out cross validation of the PLS models yielded R² values of 89.0 and 90.6 and a root mean square error of cross validation of 1.04 IV and 1.26 IV for pork fat samples from pigs fed ractopamine HCl and DDGS, respectively. When the ractopamine HCl pork fat model was used to predict the DDGS pork fat model, a bias of 1.41 IV was obtained due to the compositional differences between the two types of samples. To obtain a more robust PLS calibration model, both data sets were merged and a test set validation of this model using half the samples as a validation set yielded an R² value of 90.9, a root mean square error of prediction of 1.10 IV and a bias of 0.02 IV. This study demonstrates that FT-NIR spectroscopy combined with a robust PLS calibration model can measure IV in pork fat samples directly with an accuracy of approximately 1.1 IV. Conventional methods for measuring IV in pork fat are time consuming and costly, while this method allows processors to obtain IV results for quality assessment of pork fat on-site in under a minute.

Key Words: near infrared spectroscopy, iodine value, pork fat

779 The role of linoleic and α -linolenic acid for synthesis of long chain polyunsaturated fatty acids in liver and brain: A model study with growing pigs. W. Smink, J. Van Baal, R. Hovenier, and W. J. J. Gerrits*, *Wageningen University, Wageningen, the Netherlands.*

The effects of linoleic acid (LA) and α -linolenic acid (ALA) as precursor and inhibitor in the chain of n-3 and n-6 polyunsaturated fatty acids (LC PUFA) were studied in liver and brain of growing pigs (15-30 kg BW). In a 2x2 factorial arrangement, 32 gilts from 4 litters were

assigned to one of four dietary treatments, varying in LA and ALA intake. Differences between low and high intake were designed to be identical for LA and ALA: Low ALA and LA intakes were 0.15 and 1.30, and high ALA and LA intakes were 1.45 and 2.60 g/(kg BW^{0.75}/d), respectively. Intakes of saturated and monounsaturated FA, and other nutrients were kept constant. Consequently, energy intake increased with LA and ALA additions. After 28d on the dietary treatments, pigs were sacrificed. Liver and brain tissues were sampled and analyzed for FA composition and mRNA levels of $\Delta 5$ and $\Delta 6$ desaturase and elongase 2 and 5. In the liver, LA intake substantially increased C20:4n-6 (ARA) and ALA intake increased C20:5n-3 (EPA) concentrations, but decreased C22:6n-3 (DHA) (all $P < 0.01$). Competition between n-3 and n-6 pathways was evidenced by substantial reductions of ARA at high ALA intakes (>40%) and EPA (>35%) and DHA (>20%) by increased LA intake (all $P < 0.001$). Liver mRNA levels of $\Delta 5$ and $\Delta 6$ desaturase were increased by LA intake, and elongase 2 by both ALA and LA ($P < 0.01$). Brain DHA was virtually unaffected by the dietary treatments, but C22:5n-3 was increased by ALA and decreased by LA (all $P < 0.001$). mRNA levels of Elongase 2 were increased by ALA intake. In conclusion, ALA is a strong regulator in both the n-3 and n-6 LC PUFA chains. In addition to desaturation ($\Delta 6$), elongation from EPA and ARA may be rate limiting in brain and liver. Finally, brain DHA is virtually unaffected by ALA and LA.

Key Words: fatty acids, pig, brain

780 Comparing oxidation of fatty acids in pigs fed starch, animal fat or soy oil using ¹³C labeled fatty acids. J. J. G. C. van den Borne¹, E. M. A. M. Bruininx¹, E. van Heugten², J. van Milgen³, and W. J. J. Gerrits^{*1}, ¹Wageningen University, Wageningen, the Netherlands, ²North Carolina State University, Raleigh, ³INRA, UMR1079, Systèmes d'Élevage, Nutrition Animale et Humaine, St Gilles, France.

A study was conducted to compare oxidative loss of dietary starch, unsaturated and saturated fats in growing pigs. Eighteen barrows (28 kg BW) were assigned to one of 3 dietary treatments, in which starch (20%), animal fat (9.7%) or soy oil (9.1%) were exchanged isocalorically. Diets were fed twice daily at a rate of 1200 kJ DE/(kg BW^{0.75}.d) for an adaptation and experimental period of 7d each. A bolus dose of [U-¹³C] labeled glucose was administered 1 h after feeding on d 1, and [U-¹³C] bolus doses of linoleic (C18:2), stearic (C18:0) and oleic acid (C18:1) with the feed on d 2, 4 and 6, respectively. Pigs were housed individually in climate-respiration chambers. Based on ¹³CO₂ measurements by non-dispersive infrared absorption, ¹³C recoveries of tracers were calculated (Table 1). Complete energy balances were measured using indirect calorimetry. Exchanging starch for fat, regardless of its source, reduced heat production by 4%. Cumulative recovery of ¹³C from labeled glucose was unaffected. Replacing starch by fat increased the ¹³C recovery of all fatty acid tracers used ($P < 0.01$). Exchanging animal fat for soy oil did not affect the recovery of any of the tracers used. Recovery of ¹³C from C18:0 was markedly lower compared with that of C18:1 and C18:2, which may result from a reduced tracer digestibility, but more likely reflects a reduced β oxidation of C18:0. In addition, these results

indicate that exchanging starch for fat, regardless its source, increases fatty acid oxidation but reduces heat production.

Table 1. Treatment effects on heat production (HP, kJ/(kg BW^{0.75}.d)) and on recovery¹ of an oral bolus of ¹³C tracers as ¹³CO₂ in pigs (% of dose)

Item	Diet			P-value
	starch	animal fat	soy oil	
C18:0	3.6 ^a	9.5 ^b	6.6 ^{ab}	<0.01
C18:1	7.6 ^a	14.4 ^b	20.4 ^b	<0.01
C18:2	8.5 ^a	15.0 ^b	15.7 ^b	<0.01
glucose	49.1	48.4	46.9	0.69
HP	692 ^a	664 ^b	665 ^b	<0.05

^{a,b} means within a row without common superscript differ ($P < 0.05$); ¹ 24h (glucose) or 48h (fatty acids)

Key Words: pig, fatty acid, stable isotopes

781 Essential oil micro encapsulation increases stability during pelleting and premix and feed storage. D. Bravo, C. Ionescu*, A. Vienne, and S. Oguey, *Pancosma, Geneva, Switzerland.*

This experiment evaluated the influence of micro encapsulation technologies and encapsulate formulation on recovery of essential oils during the feed production process. Encapsulate formulations incorporated carvacrol (CA) into silica (SI), fat with a large particle size (HYB), modified starch (MS), maltodextrin (MA), arabic gum combined with maltodextrin (MAG) or as maltodextrin coated with either salts (MAS) or with fat (MAF). Encapsulates were produced using adsorption (SI), spray granulation (MA, MS, MAG), spray cooling (HYB), or their combination (MAS, MAF). Encapsulates were then blended into mineral premixes and meal feeds. Unblended encapsulates were stored at room temperature for 20 wks, premixes were stored at 20C or 40C for 3 and 5 wks. Meals were expanded at 120C and then pelleted (75C). Pelleting stability was checked and samples of meals and pellets stored at 25C or 40C for 3, 6 and 20 wks. CA level was measured in feed samples. Under the most stringent condition for mineral premixes (40C for 5 wks), CA recovery was greater ($P < 0.01$) for MAG, MAS and MA (100, 97 and 97%, respectively) than for MAF (91%), with lower recovery from HYB, SI and MS ($P < 0.01$, 74, 72 and 70%, respectively). Pelleting stability was higher ($P < 0.001$) for MS, MAG and HYB (97, 96 and 96%, respectively) than for MA, MAF, MAS and SI (89, 87, 86 and 81%, respectively). After 6 weeks at 25C, CA recoveries in meal feed were higher ($P < 0.001$) for MA, MAG, MAS, MS and MAF (100, 100, 100, 97, 97%, respectively) than for HYB and SI (91 and 84%, respectively). Under the same conditions, recoveries in pellets were higher ($P < 0.001$) for MA and MAG (100 and 98%, respectively) compared with MAF, MAS, MS, HYB and SI (94, 93, 92, 92 and 90%, respectively). These results show that micro encapsulation method and formulations of the encapsulated additive itself are important determinants of essential oil recovery during feed production.

Key Words: Carvacrol, microencapsulation, stability