Nonruminant Nutrition: Sow Nutrition and Management

82 Composition of porcine colostrum and milk as affected by various production environments. G. Voilqué*, Y. Zhao, and S. W. Kim, *North Carolina State University, Raleigh.*

Colostrum and milk composition can be influenced by production environments to sows. Nutritional effects are well investigated whereas other production environments are not. This study examined the effects of ambient temperature (AT) and gestation housing (GH) on composition of porcine colostrum and milk. Eighty-one sows were randomly assigned to 4 treatments based on a 2 × 2 factorial arrangement with AT (21.5°C or 27.3°C) and GH (individual crate or small pen) as main factors. All sows received the same diet meeting the requirements. Colostrum (within 24 h after farrowing) and milk (on d 18 of lactation) were obtained from all sows to measure composition of fat, protein, and lactose. Sows in high AT tended to produce colostrum with a lower ($P = 0.08$) protein content (52.9% of DM) than sows in moderate AT (46.5% of DM). However the composition of fat and lactose in colostrum was not affected ($P > 0.10$) by AT. Also AT did not affect ($P > 0.10$) the composition of fat, protein, and lactose in milk. The GH did not affect ($P > 0.10$) the composition of fat, protein, and lactose in colostrum. However sows from individual crates have smaller ($P = 0.02$) protein content (31.6% of DM) in milk compared with sows from small pen (35.6% of DM). An increase of parity from 2 to 6 linearly increased (fat%DM = 3.03 × parity + 17.14, $P = 0.03$ for the slope, $P = 0.01$ for the intercept, $R^2 = 0.09$) fat content in colostrum, whereas other components in colostrum and milk were not affected ($P > 0.10$). Sows body weight at d 109 of gestation, and at d 1 and 18 of lactation did not affect ($P > 0.10$) the composition of colostrum and milk. Lactose content linearly increased ($P = 0.01$, from 20.0 to 30.6% of DM), whereas protein content tended to linearly increase ($P = 0.07$, from 23.0 to 28.8% of DM) as a litter size increased from 8 to 14 piglets at birth. However, litter size at weaning was not related to colostrum and milk composition. The average daily gain of piglets was not related to colostrum and milk composition. In conclusion, colostrum and milk compositions were influenced by AT, GH, parity of sows, and litter size at birth.

Key Words: colostrum, milk, production environment, sows

83 Transitional changes in gestation and lactation serum α-tocopherol, and postpartum colostrum and milk α-tocopherol and fat concentrations in multiparous sows. J. S. Jolliff* and D. C. Mahan, *The Ohio State University, Columbus.*

Because the neonatal pig has low body α-tocopherol and contents, an α-tocopherol source is necessary to prevent deficiency in these young animals. Two observational studies evaluated changes in serum α-tocopherol during late gestation and serum, colostrum, and milk α-tocopherol, along with milk fat, during lactation in multiparous sows. Gestating sows were fed 2.2 kg /d of a fortified corn soybean meal gestation diet with 22 IU of DL-α-tocopheryl acetate added per kg and no added fat. Lactating sows were adjusted to an ad libitum feed intake within 5 d postpartum and fed a fortified corn soybean meal diet containing 1.0% total lysine, 22 IU added dl-α-tocopheryl acetate per kg, and 5% added fat. Study 1 involved a total of 96 bleedings from 54 sows from 85d postcoitum through weaning (17 d). Serum α-tocopherol concentrations were relatively constant from 85 to 100 d postcoitum but then quadradically declined ($P < 0.01$) until parturition whereupon serum α-tocopherol concentrations linearly increased ($P < 0.01$) through weaning. In study 2, colostrum and milk were collected from 22 sows at 0, 2, 4, 6, 10, 14, 18, 24, 36, 48, 72, 96, 120, 144, and 168 h (7 d) postpartum and analyzed for d-α-tocopherol and fat. Colostrum and milk were collected from all functional glands after an i.m. injection of oxytocin. The α-tocopherol content of colostrum was relatively constant from parturition to 24 h postpartum and then declined until d 5 where it remained relatively constant. This resulted in an overall cubic ($P < 0.01$) response over the 7 d time frame. In contrast, colostrum and milk fat increased quadratically ($P < 0.01$) over time. Together, the results of these 2 studies imply that, during late gestation, serum α-tocopherol was transferred to the mammary tissue for inclusion into colostrum. After parturition, there was an inverse relationship between the α-tocopherol concentrations of colostrum and milk with α-tocopherol declining as lactation progresses.

Key Words: colostrum, milk, sow, vitamin E

84 Effects of dietary vitamin E level and source on sow, milk, and piglet levels of α-tocopherol. N. W. Shelton*[1], J. L. Nelssen[1], M. D. Tokach[1], S. S. Dritz[1], J. M. DeRouchey[1], R. D. Goodband[1], H. Yang[2], and D. C. Mahan[3], *[1]Kansas State University, Manhattan, [2]ADM Alliance Nutrition, Quincy, IL, [3]The Ohio State University, Columbus.*

A total of 126 gilts and sows (PIC 1050) and their litters were used to determine the effect of dietary vitamin E level and source on sow plasma, milk, and piglet concentrations of α-tocopherol. The 6 dietary treatments were 2 levels of dl-α-tocopherol acetate (Syn E) at 44 and 66 mg/kg, and 4 levels of d-α-tocopherol acetate (Natural E) at 11, 22, 33, and 44 mg/kg. From breeding to d 69 of gestation, sows were fed 2.0 kg/d of a diet containing 40% DDGS, 0.30 ppm added Se, and no supplemental vitamin E. Vitamin E treatments were fed from d 70 of gestation to weaning. Plasma was collected from sows on d 69 and 100 of gestation, at farrowing, and at weaning. Colostrum and milk samples (weaning) were also collected. Plasma from 3 pigs per litter and heart and liver samples from 1 pig per litter were collected at weaning (19.7 d). All samples from 6 litters per treatment were analyzed for α-tocopherol. Treatment effects were not observed ($P > 0.10$) for lactation feed intake, piglet BW or BW gain, or sow BW measures. As Natural E increased in the diet, sow plasma, colostrum, milk, piglet plasma, and piglet heart concentrations of α-tocopherol increased (linear; $P < 0.03$). Sows fed diets with 44 mg/kg Natural E had increased plasma, colostrum, and piglet plasma α-tocopherol concentrations ($P < 0.03$) compared with sows fed the 44 mg/kg of Syn E. Regression analysis indicated that the relative bioavailability coefficients for Natural E:Syn E ranged from 2.1 to 4.2 for sow and piglet plasma α-tocopherol, 2.9 to 3.0 for colostrum α-tocopherol, 1.6 to 7.3 for milk α-tocopherol, and 1.8 to 7.5 for heart and liver α-tocopherol. Overall, this study shows that the relative bioavailability for Natural E:Syn E varies depending on the response criteria but is greater than the standard value of 1.36 in sows.

Table 1. Tissue and plasma α-tocopherol, μg/mL, with 2 levels of synthetic vitamin E and 4 levels of natural vitamin E.

	Syn		Natural					Relative Bioavailability	
Vitamin E, mg/kg	44	66	11	22	33	44	SEM	44	66
Sow Plasma									
D 69	1.00	0.85	0.89	0.89	0.95	0.98	0.082		
D 100	1.32	1.51	1.09	1.28	1.64	1.99	0.187	2.1	2.4
Farrowing	0.72	0.87	0.75	0.86	1.01	1.19	0.120	4.2	3.0
Weaning	1.41	1.88	1.15	1.75	2.02	2.53	0.139	2.7	2.4
Colostrum	8.19	10.31	7.62	11.39	9.40	17.76	2.165	3.0	2.9
Milk	3.25	2.51	2.36	3.22	3.75	3.63	0.458	1.6	7.3
Weaned piglet									
Plasma	2.47	2.38	2.11	3.03	3.51	3.78	0.376	3.0	5.1
Heart	4.84	3.93	3.60	4.75	5.93	6.00	0.619	1.8	5.3
Liver	4.18	3.39	2.99	4.88	4.96	5.12	1.063	2.0	7.5

Key Words: α-tocopherol, bioavailability, natural vitamin E, sow

85 Quantifying time-varying efficiency of utilizing sow's milk for piglet growth. A. B. Strathe*[1], A. V. Hansen[1,2], E. Kebreab[1], and P. K. Theil[2], [1]*Department of Animal Science, University of California, Davis,* [2]*Department of Animal Science, Faculty of Science and Technology, Aarhus University, Tjele, Denmark.*

The traditional expression of piglet growth efficiency is the milk conversion ratio (MCR) and it may be affected by milk yield (MY) and composition, resulting from inclusion of dietary fat into lactation diets. The objective of the study was to quantify the effects of different sources of fat on MY as well as time-varying effects on MCR. Forty-six sows were allotted to 1 of 6 diets based on barley, wheat, and soybean meal supplemented with 3% animal fat, 8% coconut oil, sunflower oil, fish oil or 4% fish oil + 4% octanoic acid. The sixth diet was added 2.5 g/d β-hydroxy-β-methyl butyrate as topdressing. Litter weight (LW) was recorded on d 7, 10, 14, 17 and 28 while MY was measured by the deuterium dilution technique on d 9, 16 and 23, respectively. The classical Wood function (i.e., $a \times t^b \times e^{-c \times t}$) was adopted for the analysis of the MY data while LW was modeled as a function of total milk intake (TMI) ($LW(t) = W_0 + k \cdot TMI(t)$) where TMI was derived as the integrated form of the Wood function. The parameter k (MCR = 1/k) describes the LW gain per kg milk ingested. The MY and LW data was modeled sequentially; first, a nonlinear mixed model was fitted to the MY data; second, sow specific parameters were plugged into the integrated Wood function, to compute the independent variable TMI(t) and then LW(t) was fitted to LW data. Both models incorporated fixed effect of diet and random effect of sow through the functional parameters while k also included time as a fixed effect, allowing k to change continuously during the suckling period. The dietary treatments did not affect the parameters of the Wood function, W_0 and k ($P > 0.10$). Significant changes in k were estimated during the suckling period ($P < 0.001$). The following relationship was derived k(t) = 0.283(SE = 0.0097) - 0.0016(SE = 0.00033)t. It was estimated that MCR were increasing from 3.69(SE = 0.10) at d 7 to 4.21(SE = 0.07) at d 28 of suckling. Population mean peak MY and time to peak MY were 12.9(SE = 0.23) kg/d and 19.3(SE = 1.03) days. The total MY was estimated to 299(SE = 22) kg during the 28 d lactation. In conclusion, the modeling framework quantified key aspects of piglet growth efficiency and sow lactational performance.

Key Words: lactation, sow, piglet, modeling

86 Dietary protein and amino acid requirements in lactating sows is estimated using population-based factorial approach. A. V. Hansen*[1,2], A. B. Strathe[1], E. Kebreab[1], and P. K. Theil[2], [1]*Department of Animal Science, University of California, Davis,* [2]*Department of Animal Science, Faculty of Science and Technology, Aarhus University, Tjele, Denmark.*

Estimation of protein and amino acid requirements for lactating sows is a central part of nutritional management of sow herds. The factorial approach is often used to determine the requirements for sows using an average sow to represent the herd. The objective of the study was to develop a population-based model for determination of amino acid and protein requirements for a population of lactating sows. The model inputs are the body weight of the sow and production targets, which are specified as litter size (LS) and gain (LG). The model was developed from existing literature data and individual sow data with longitudinal records of milk yield, composition and ME intake. The model used the Wood curve for representation of milk yield and ad libitum energy intake was represented by the monomolecular function. The functional parameters were drawn from multivariate normal distributions where their means were adjusted to production targets. The sow's energy intake is computed as her ad libitum ME intake and ME requirement. If the ad libitum ME intake is less than the ME requirement, the intake is set to ad libitum ME intake, otherwise the intake is the ME requirement. This way the sow is in either negative or zero energy balance. A population of 1,000 sows was simulated. An example is presented here where the inputs are set as follows: mean BW (200 kg) at parturition, LS (11 piglets) and LG (2.4 kg/d). The simulation resulted in mean daily apparent digestible lysine and protein requirement of 50.9 (5 and 95% percentiles: 41.8; 60.3) and 807 g/d (5 and 95% percentiles: 681; 937), respectively. The dietary requirement of apparent digestible lysine and protein relative to ME density was 0.64 (5 and 95% percentiles: 0.59; 0.68) and 10.1 g/MJ ME (5 and 95% percentiles: 9.61; 10.8), respectively. The results suggest that it is important to consider between sow variability when nutritional management is applied to a whole herd. Furthermore, incorporation of variability between sows eases the use of safety margins because a given percentile of the population's requirement is estimated.

Key Words: sow, requirement, amino acids, protein

87 The evaluation of supplemental L-arginine during gestation on sow reproductive performance. L. Greiner*[1], J. L. Usry[2], C. Neill[3], N. Williams[3], J. Connor[1], and G. Allee[4], [1]*Innovative Swine Solutions, LLC, Carthage, IL,* [2]*Ajinomoto Heartland, Inc, Chicago, IL,* [3]*PIC North America, Hendersonville, TN,* [4]*PorkTech, LLC, Columbia, MO.*

Two experiments were conducted to evaluate the feeding of supplemental L-arginine (Arg) in gestation on sow reproductive performance. Gestation diets consisted of corn and 40% corn dried distiller's grains with solubles and were formulated to have 3.25 Mcal ME/kg, 0.53% SID lysine and all other nutrients to exceed recommendations (NRC, 1998). In both studies, sows were allocated as a randomized complete block and either fed diets with no supplemental L-Arginine or 28 g SID L-Arginine/d. In the first study, 376 gilts and multiparous sows (PIC, Camborough 29 and 1050) were fed the randomly assigned diets from d 18–34 of gestation and were blocked by parity, day of breeding and body condition. Sows were allocated an amount of feed based on body condition score with an average of 2.27 kg of feed/d. Conception rate (96.03 vs. 94.30%, respectively, $P > 0.46$), farrowing rate (91.52 vs. 89.16%, $P > 0.46$), and total born (12.94 vs. 13.00, $P > 0.87$) were