151 Phytase supplementation in soybean meal-based practical diets improves apparent digestibility coefficients of nutrients for rainbow trout (*Oncorhynchus mykiss*). Zongjia Cheng*[1], R.W. Hardy[1], V. Verlhac[2], and J. Gabaudan[2], [1]*University of Idaho,Hagerman Fish Culture Experiment Station* , [2]*Research Center for Animal Nutrition and Health, STE Chimique Roche, Ltd, France*.

Fishmeal is formulated into carnivorous fish feeds at 30-50% by weight. Fishmeal production is not growing worldwide but the demand for fish is increasing. Therefore, plant protein source such as soybean meal (SBM) will be used to replace portions of fishmeal. However, the availability of phosphorus (P) and zinc (Zn) in SBM are very low. Phytase supplementation may have an effect on improving availability of P and Zn, and other nutrients. In this study, SBM (50% of the diet) was formulated into a fishmeal (15%) diet and supplemented with 5 dosages of phytase (Ronozyme P (L), Roche Vitamins France). Duplicate tanks were assigned randomly to each diet. Three hundred rainbow trout, mean BW of 100.1 7.4 g, were stocked in ten 40-L tanks. Experimental diets were fed once daily at 1300 h to apparent satiation for one week before fecal collection began. Feces were collected at 0800 h the next day by stripping all fish. Collection of feces was repeated three days until sufficient amount was obtained. Average apparent digestibility coefficients (%) of SBM-based practical diets supplemented with 0, 500, 1000, 2000, and 4000 FTU/kg diet were: dry matter, 77.4, 82.7, 81.9, 82.9, 84.2, respectively ($P < 0.05$); crude protein, 97.0, 97.9, 98.1, 98.1, 98.1, respectively ($P < 0.05$); lysine, 98.3, 98.9, 98.9, 98.9, 99.0, respectively ($P < 0.005$); total-P, 31.5, 70.1, 78.7, 78.9, 85.2, respectively ($P < 0.0001$); phytate-P, -0.13, 42.1, 60.9, 71.4, 61.3, respectively ($P < 0.005$); and Zn, 28.4, 41.1, 43.4, 51.6, 63.7, respectively ($P < 0.0001$).

Key Words: Soybean meal, Phytase, Rainbow trout

152 Effect of α-1,6-galactosidase, β-1,4-mannosiase, and β-1,4-mannanase on intestinal morphology and the removal of dietary antinutritional factors in young pigs. S. W. Kim*, *Texas Tech University*.

Ninety nursery pigs, weaned at d 21 of age, were used to determine the effect of an enzyme complex (EasyBio System, Inc) on the growth performance, intestinal morphology and the removal of dietary anitinutritional factor. Main enzymes in the complex were α-1,6-galactosidase, β-1,4-mannosiase, and β-1,4-mannanase. Pigs were allotted to one of two dietary treatments, i.e., control and enzyme supplementation (0.1%). Each treatment had nine replicates and five pigs per pen-replicate. Pigs were fed based on the three-phase feeding program (phase-1, 1 wk; phase-2, 2 wk; and phase-3, 3 wk. All pigs fed the same diet during phase-1 and -2, and fed one of two treatment diets during phase-3 period. Previously, supplementing this enzyme to nursery diet with low soybean meal did not show any beneficial to the pigs. Thus, the enzyme was supplemented only to the phase-3 diet that contains 34% soybean meal. All pigs had free access to the diet and water. Body weight and feed intake were measured weekly. Four pigs were randomly selected from each treatment totaling eight pigs. Selected pigs were killed to obtain tissue and digesta samples. Stomach, small intestine, cecum, and large intestine were separated, emptied, and weighed. Small intestine was separated to proximal, middle, and distal sections. Tissue samples were obtained from three different sections of small intestines. Digesta from stomach, cecum, and proximal and distal section of small intestines were collected. Collected tissue samples were fixed for histological evaluation to measure the length of villus. Digesta samples were measured for the content of anitinutritional factor. Pigs in the enzyme treatment had a greater ($P < 0.05$) ADG during the third week of phase-3 period. Average daily feed intake was not different between treatment groups. Gain/feed was greater ($P < 0.05$) in pigs of the enzyme treatment during the whole phase-3 period. Villus heights from proximal and middle portion of small intestines were not different between treatments. However, pigs in the enzyme treatment had a longer ($P < 0.05$) villus height than control pigs at distal portion of small intestine. This study also demonstrates that the enzyme degraded anitinutritional factors at proximal site of small intestine.

Key Words: Pigs, Enzyme, Antinutritional factor

153 Effects of increasing xylanase supplementation of medium quality wheat based diets on the growth performance of entire males between 24 and 56 kg live weight. D. J. Cadogan*[1], H. Simmins[2], G. Partridge[2], and C. Argent[1], [1]*Bunge Meat Industries,* [2]*Finnfeeds International Ltd*.

The recommended xylanase dose rate (Porzyme 9300) to maximise growth performance was 1000 g/t, however lower levels enzyme levels maybe more cost effective. To establish the cost optimum xlyanase dose rate, 144 four entire males (Bunge genotype) were blocked by weight (24.2 kg) and allocated to wheat based diets with 5 increasing levels (0, 250, 500, 750, 1000 and 1400 g/t) of enzyme. Pigs were housed in individual pens and offered ad libitum feed and water throughout the 35 d study. The basal diet was formulated to contain 65% of a medium quality wheat, pre-characterized in an earlier growth study, 14.0 MJ DE/kg (3,350 kcal DE/kg) and 1.15% total lysine (0.70 g/MJ DE available lysine). There was a linear ($P<0.05$) effect of Porzyme 9300 on average daily gain, average daily intake and ultra-sound P2 backfat. There was also a quadratic ($P<0.05$) effect on daily gain. The xylanase significantly improved daily gain and F:G when increased from 0 to 250 g/t and 0 to 500 g/t respectively. The improvement in FCR, and the linear effect on P2 backfat, suggests enzyme may increase the energy availability of the wheat. The results indicate that the most cost effective dose rate of Porzyme 9300 is between 250 and 500 g/t.

Key Words: Pigs, Wheat, Xylanase

Nonruminant Nutrition
Antimicrobial Agents and Plant Extracts on Immunity, Health, and Performance

154 Introduction of antibiotics in animal production. Virgil W. Hays, *University of Kentucky*.

The discovery of the growth promotional benefits of chlortetracycline (aureomycin) came largely as a bonus from Animal Protein Factor (APF) research. Like many significant findings, a number of researchers and teams of researchers were involved in the steps leading up to the discovery of APF (also known as Anti-Pernicious Factor), the identification and isolation of Vitamin B_{12}, the discovery of antibiotics for treatment of diseases and the observations of the growth-promotional or growth-permitting effects of chlortetracycline and subsequently other antibacterial agents. A team of researchers (Tom Jukes, Bob Stockstad and others in the Lederle Laboratories) were searching for organisms that would produce APF. Their screening procedures involved the growth of chicks fed an all plant diet with a liver extract as the APF standard. At the same time another team of researchers (Dr. Benjamin Duggar and collaborators) was searching for organisms that would produce antibacterial agents. This team found that the soil microorganism *streptomyces aureofaciens* produced chlortetracyline. After this finding, Jukes and his collaborators included this organism in their APF screen tests. They found that products from this organism resulted in growth rates greater than did the liver extract used as the standard. Because of the great medical need of these substances, some time passed before the pure antibiotic was available for addition to animal feeds to confirm the antibiotic effect. Once available, the acceptance was rapid. Soon the other antibiotics and combinations of antibiotics were tested and found to be beneficial. During the 1950's many papers (peaking about 1953) on benefits and modes of action were published. The use of antibiotics has contributed to many changes in the way pigs and poultry are housed and managed.

Key Words: Antibiotics

155 Protection of piglets against Salmonella infection with dried bacterial cells. Z. Mroz*[1] and Y. Toride[2], [1]*Institute for Animal Science and Health, Lelystad, The Netherlands,* [2]*Ajinomoto Co., Inc., Tokyo, Japan*.

Dried bacterial cells (DBC) from Brevibacterium lactofermentum (BL) and Escherichia coli K-12 (EC) were fed as immunomodulators to 40 piglets challenged with Salmonella typhimurium (ST). After weaning at 24 d of age, they were kept over 14 d in individual pens and allotted to

five cereal-soybean based diets: 1) Negative control (C); 2) C + 0.5% TMS (Trimethoprim sulfadiazine); 3) C + 0.05% BL; 4) C + 0.05% EC; 5) C + 0.5% EC. These diets (20% CP, 0.98% lysine, and 8.79 MJ NE/kg) and water were offered ad libitum. On d 2 postweaning, the animals were challenged orally with ST (5 x 10^5CFU). Based on the performance, blood indices, gut histology, and ST shedding in feces of weaned piglets challenged with ST (Table 1) it can be concluded that adding DBC from EC was more effective than DBC from BL, and the differences in ST shedding in feces of piglets fed TMS and DBC were merely numerical.

	Diet						
Response	1	2	3	4	5	SED	P value
ADFI, g	305^b	304^b	250^a	302^{ab}	322^b	20	0.076
ADG, g	194	208	143	201	227	28	0.134
WBC, x10^3/mL	25.5^c	17.0^a	23.1^{bc}	20.5^{ab}	18.7^{ab}	2.3	0.00 7
Lymphocytes, % WBC	32.3^a	52.3^b	37.0^a	36.3^a	37.6^a	4.9	0.004
T-cell subpopul., CD4:CD8 ratio	0.62^a	0.58^a	0.59^a	0.73^{ab}	0.86^b	0.10	0.035
Villus: crypt ratio, prox. jejunum	5.06^{ab}	5.46^b	3.96^a	5.17^b	5.88^b	0.48	0.038
Villus:crypt ratio, mid jejunum	4.94^{ab}	5.03^{ab}	4.32^a	5.10^{ab}	5.66^b	0.28	0.035
ST in feces, $\log_{10}$CFU/g	2.00	1.68	2.07	2.62	2.29	0.56	0.426

^{ab}Within a row, means without a common superscript letter differ at P<0.05.

Key Words: Piglets, Dried bacterial cells, Salmonella

156 Studies on the blood cholesterol lowering effect of specific lactic acid bacteria in growing pigs. Y. H. Park*[1], K. M. Lee[1], J. G. Kim[1], Y. W. Shin[1], H. S. Kim[2], S. H. Kim[1], and K. Y. Whang, [1]*Korea University, Seoul, Korea,* [2]*Culture Systems, Inc., Mishawaka, IN.*

An experiment was conducted to examine the effect of specific lactic acid bacteria (LAB, *Lactobacillus casei* and *Lactobacillus longum* mixture) on blood cholesterol level in growing pigs. Twenty-four crossbred (Yorkshire × Landrace × Duroc) growing pigs (50.0 ± 2.5 kg) were assigned to six treatments to evaluate plasma cholesterol level-lowering effects of the specific LAB. Animals were individually penned. Hypercholesterolemia in pigs was induced by feeding a diet containing 0.5% cholesterol (HCD) for 15 days (period I) after a 4-day adaptation period. Serum cholesterol levels were measured every 5 days during period I. Pigs fed the HCD diet had a higher ($P < .01$) cholesterol level in serum than pigs fed the normal diet (ND). During period II, total cholesterol, triglyceride (TG), and high-density lipoprotein (HDL) cholesterol levels in serum were measured every 5 days. The treatments and the changes of serum total cholesterol level (mg/dL) during period II were shown in Table. A significant level of serum cholesterol was reduced in hypercholesterolemia-induced pigs fed LAB for 20 days of experimental period. But there was no significant effect of LAB in ND fed groups. There was no significant difference among treatments in TG and HDL levels. This experiment demonstrates that abnormally high cholesterol level in blood can be reduced by feeding a diet containing LAB in growing pigs.

Treatment[1]	Day 0	Day 5	Day 10	Day 15	Day 20
ND-ND	112.37^c	108.19	120.34^e	105.19^b	102.21^c
HCD-HCD	159.48^{ab}	140.67	157.78^{de}	156.29^a	173.79^a
HCD-HCDL	182.36^a	150.60	158.47^{de}	135.37^a	144.52^b
HCDL-HCDL	153.79^b	144.91	168.62^d	156.18^a	157.09^{ab}
HCD-NDL	159.26^{ab}	149.80	187.73^d	101.64^b	105.52^c
HCD-ND	182.82^a	162.38	178.24^d	96.50^b	98.10^c

[1]ND, normal diet; HCD, hypercholesterolemic diet; HCDL, hypercholesterolemic diet with LAB; NDL, normal diet with LAB. ^{a,b,c} $P < .01$ ^{d,e} $P < .05$ within the same column.

Key Words: Pigs, Lactic acid bacteria, Hypercholesterolemia

157 Growth performance and immune parameters of weanling pigs fed mannan oligosaccharides. M. E. Davis*, C. V. Maxwell, D. C. Brown, and T. J. Wistuba, *University of Arkansas, Fayetteville.*

Thirty-two weanling pigs averaging 19 d of age and 5.7 kg initial BW were randomly assigned to 16 pens in an on-site nursery to determine the effects of supplementation with mannan oligosaccharides (MOS) on growth and immune function. Pigs were fed one of two dietary treatments for 21 d after weaning: 1) corn-soybean meal control diet (1.5% Lys, 14.5% lactose) with 3.8% spray-dried plasma, 2% spray-dried blood cells, 6.8% processed soy protein, and 8.5% fish meal, and 2) control diet with 0.3% MOS. Dietary treatments were randomly assigned to pens in a completely randomized design and initial BW was used as a covariate when analyzing ADG, ADFI, and gain:feed (G/F). Blood samples were obtained from each pig on d 0 and d 14 after weaning to measure α_1-acid glycoprotein concentration (AGP), and on d 14 to determine differential leukocyte counts, lymphocyte proliferation response, and macrophage phagocytisis of sheep red blood cells. Average daily gain and G/F were greater ($P \leq 0.05$) when pigs were fed diets supplemented with MOS from d 0 to 14 and d 0 to 21 after weaning. Dietary treatment did not affect ADFI or AGP. However, on d 14 after weaning, AGP was greater in pigs regardless of dietary treatment compared to the initiation of the study (557 ± 51 vs 934 ± 51 μg/mL, $P \leq 0.01$). Percentage of neutrophils was lower ($P \leq 0.08$) and percentage of lymphocytes was greater ($P \leq 0.05$) in blood from pigs fed MOS compared to pigs fed the control diet. Lymphocyte proliferation in response to mitogen stimulation *in vitro* and percentage of phagocytic macrophages were not altered by dietary treatment. Supplementation of MOS in the diets of weanling pigs improves gain and efficiency, and may impact immune function as evidenced by the alteration in the percentage of blood neutrophils and lymphocytes.

Item	Control	MOS	SE	P =
ADG, g (d 0 to 14)	154	253	31	0.05
ADG, g (d 0 to 21)	220	301	24	0.04
G/F (d 0 to 14)	0.63	0.82	0.04	0.01
G/F (d 0 to 21)	0.66	0.80	0.04	0.04
AGP, μg/mL	940	924	100	0.91
% Neutrophils	53	45	3	0.08
% Lymphocytes	43	51	2	0.03
% Macrophage phagocytosis	16	17	2	0.43

Key Words: Swine, Mannan oligosaccharides, Leukocytes

158 Dietary galactooligosaccharides (GOS) affect nutrient digestion, bacterial populations, and ileal short-chain fatty acid (SCFA) production in the pig. M. R. Smiricky*, C. M. Grieshop, E. A. Flickinger, and G. C. Fahey, Jr., *University of Illinois, Urbana-Champaign.*

Fermentable substrates in the pig diet alter the fermentative activity of gut bacteria and increase proliferation of beneficial bacteria. The objectives of this study were to evaluate the influence of GOS additions to the diet on nutrient digestion, bacterial populations, and ileal SCFA production. 12 pigs (avg. initial BW = 26 kg) were surgically fitted with a simple-T cannula and fed a diet free of GOS for 21 d. On d 22, pigs were randomly allotted to 3 dietary treatments, a GOS-free (CON) diet and CON with 3.5% added GOS from soy solubles (SS) or transgalactooligosaccharides (TOS). The diets were formulated to contain 17% CP and contained chromic oxide for digestibility determinations. Pigs were fed twice daily (0800 and 2000 h, equal portions at each meal). Initial feeding level was determined on the basis of 0.09 * $BW^{0.75}$. The experimental period lasted 7 d, with 5 d of diet adaptation, fecal collection on d 6, and ileal digesta collection on d 7. Diets, feces, and digesta samples were analyzed for DM, OM, CP, and chromic oxide concentrations. Feces and ileal digesta were analyzed for Lactobacillus and bifidobacteria populations. Digesta samples were analyzed for SCFA production. Ileal and total tract DM and OM digestion was decreased ($P < 0.05$) by addition of GOS to the diet. Ileal and total tract N digestibilities were decreased by addition of SS to the diet. Ileal bifidobacteria and Lactobacillus populations were numerically increased by addition of GOS to the diet. Fecal bifidobacteria were increased ($P < 0.05$) by addition of SS to the diet. Fecal Lactobacillus populations were increased ($P < 0.05$) by TOS addition when compared to CON diet and increased ($P < 0.05$) further with the addition of SS to the diet. However, ileal

SCFA production was numerically greater only for those pigs fed diets containing GOS. The diet containing SS resulted in greater production of SCFA than the TOS diet. In conclusion, dietary addition of GOS to pig diets resulted in greater concentrations of beneficial bacteria and only a small decrease in nutrient digestibility.

Key Words: Digestibility, Bacteria, Fermentation

159 Botanicals for nursery pigs. P.J. Holden* and J.D. McKean, *Iowa State University, Ames, IA.*

The historical use of botanicals to treat or prevent infectious diseases has been supplanted with relatively low cost, effective and available synthetic antimicrobial products. Selected herbs possess natural antimicrobial activity and other characteristics useful in value-added animal protein production and their inclusion in animal feeds as alternative growth promotion and efficiency stimulating strategies may address antibiotic resistance concerns while producing a more holistically grown pork product. Echinacea, garlic, goldenseal and peppermint were evaluated with pigs weaned at 18 d and 6.25 kg. Pigs were allotted to 1.2 x 1.2 m raised-deck pens at random by litter and initial weight. Each pen received 16 kg of prestarter treatment per pig and starter treatment diets for the remainder of the 5-wk study. The positive diet contained 45 ppm of Mecadox. Botanical treatments consisted of the same diet without Mecadox and botanicals replaced corn, with the 0% level considered a negative control. Pigs were weighed and feed disappearance measured weekly. ADG, ADF and F/G were analyzed using the GLM procedure of SAS with the pen as the experimental unit. **Echinacea** (0 to 3%) was the most efficacious botanical evaluated. In the first three weeks pigs fed additions of 2 or 3% Echinacea had ADG and F/G similar to Mecadox controls and improved over the negative control. **Garlic**(0 to 5%) was evaluated in two trials. High garlic levels reduced performance primarily by depressing feed intake. Feeding any garlic depressed performance compared to Mecadox. Garlic also flavored the meat of harvested animals. **Goldenseal** (0 to 1.0%) was not statistically efficacious in one trial and was poorer than Mecadox controls. **Peppermint** (0 to 5%) was not a statistically efficacious in nursery diets when evaluated over two trials. Additions generally were no better than the negative control and sometimes statistically depressed performance. More information at www.extension.iastate.edu/ipic/reports/00swinereports/Nutrition00.html

Key Words: Swine, Botanical, Nursery

160 Plant extracts enhance sow lactation performance. S. E. Ilsley[1], H. M. Miller[1], H. M. R. Greathead[1], and C. Kamel*[2], [1]*University of Leeds, Leeds, UK,* [2]*AXISS France SAS, Archamps, France.*

Many plant extracts promote health and growth. This study aimed to evaluate their ability to stimulate piglet and sow performance when supplemented in the diets of lactating sows. Three extracts were tested: Yucca Shidigera, Quillaja Saponaria and Combination (a blend of capsicum, cinnamaldehyde and carvacrol). Eighty sows (25% Large White, 50% Landrace, 25% Duroc) of mixed parity were housed in conventional indoor farrowing crates from d107 of gestation to weaning. Sows were allocated according to parity, liveweight, fatness and past performance, to one of 4 dietary treatments: Control (CTR), Combination (COM, 100 ppm), Yucca (Y, 200 ppm), Quillaja (Q, 250 ppm). Diets were otherwise identical, containing 3,333 kcal DE/kg and 1.0% total lysine. From d107-114 of gestation, sows received 2.5 kg feed/d. In lactation sows were fed *ad-libitum* with FI recorded daily. Piglet liveweight and sow P2 backfat were recorded on d1, 7, 14, 21 and at weaning on d23 2.5. Data, corrected for litter size and birth weight, were analysed using the GLM procedure of Minitab 12.2. Piglet growth between birth and d1 was better for COM sows. (117 g vs CTR 99 g, Q 77 g, Y 107 g; $P < 0.01$, SEM = 7.9). Similarly, between d15-21, piglets of COM sows outperformed all other treatments (COM 290 g/d, CTR 246 g/d, Q 235 g/d, Y 255 g/d; $P < 0.001$, SEM = 9.3). Piglet weights on d21 were also greater for COM sows (6878 g vs CTR 6584 g, Q 6330 g, Y 6498 g; $P < 0.05$ SEM = 132). Sow FI and P2 backfat loss were unaffected by treatment. Improved growth rates in the first 24h suggest facilitation of lactogenesis or enhanced piglet vigor at birth. The improved piglet weight gains of COM sows from d15-21 suggest enhanced milk yield at a time when it normally limits piglet growth. As sow FI and backfat loss remained unchanged, this indicates greater efficiency in feed utilisation for milk production. Alternatively, or additionally, piglets may have been utilising the milk with greater efficiency resulting in enhanced growth.

Key Words: Sows, Plant extracts, Lactation

161 Plant extracts enhance broiler performance. D. Jamroz[1] and C. Kamel*[2], [1]*The Agricultural University of Wroclaw, Poland,* [2]*AXISS France SAS, Archamps, France.*

Many plant extracts reportedly improve animal performance and well-being. This study evaluated their effects on live performance parameters and carcass characteristics at slaughter in commercial broilers. A commercial feed formulation based on ground wheat, barley, and soybean meal containing a coccidiostat and an enzyme with 0.5% chromic oxide as an indigestible marker served as the control diet. Four treatments were compared: control diet without additive (negative control), control diet with Avilamycin (10 ppm; positive control), and XT (a blend of capsicum, cinnamaldehyde and carvacrol) at 150 and 300 ppm. 1,120 broilers were housed in conventional indoor floor pens from day 1 to 48 and allocated to 1 of 4 dietary treatments: Control (CTR), XT150 (XT, 150ppm), XT300 (XT, 300ppm), and Avilamycin (AV, 10ppm). Diets were otherwise identical, containing a metabolizable energy content of 12.5MJ/kg. The trial was run over two periods: 1-21 days and 22-48 days. Broilers were fed *ad libitum* with FI recorded daily. Broiler liveweight was recorded on d1, 21, and 48. Mortality was recorded daily. Concurrently, a digestibility trial was run in 420 broilers for apparent ileal nutrient digestibility coefficients and gut flora characterization. Raw data means were analyzed by STATISTICA PL ver. 5.1 (1997). Broilers on the XT diets between d1 and 17 had significantly better daily weight gains (XT300 625g vs XT150 608g, AV 605g, CTR 578g $P<0.001$) and feed conversion ratios (XT300 1.44 vs XT150 1.49, AV 1.47, CTR 1.56, $P<0.05$). Similarly XT broilers showed greater liveweights at d48, and at slaughter higher percentages of breast muscle. Digestibility studies performed at d21 showed that XT broilers significantly digested fiber, fat, ash, and nitrogenous substances better. In addition, XT broilers showed lower caecal counts for *E. coli*and *C. perfringens*. This study illustrates that plant extracts fed to commercial broilers give similar live performance levels as the antibiotic growth promoter Avilamycin. These benefits may be due to the greater efficiency in the utilization of feed, resulting in enhanced growth. The improved digestibility leads to a more balanced gut flora, with the potential to reduce shedding of pathogenic bacteria (i.e. *E. coli* and *C. perfringens*) into the environment.

Key Words: Plant extracts, Broilers, Gut flora

Production, Management, and the Environment
Dairy Management

162 Nutritionally induced growth pattern changes of pregnant heifers and subsequent changes in body weights and dry matter intake. H. C. Freetly*, C. L. Ferrell, and T. G. Jenkins, *USDA, ARS, U.S. Meat Animal Research Center.*

The objective of this study was to determine the effect of altering the amount of feed provided at different periods of pregnancy and lactation on the efficiency of feed utilization for calf production. MARC III heifers (n=128) were individually fed a corn silage-based ration (2.39 Mcal ME/kg DM). Heifers were allocated to three treatments that varied in the timing that dry matter was offered. Dry matter intakes from 94 through 186 d of gestation were M-M-M-M 674±4 kg, L-H-M-M 521±5 kg, and L-L-L-H 523±5 kg. Dry matter intakes from 187 d of gestation to parturition were M-M-M-M 817±9 kg, L-H-M-M 938±12 kg, and L-L-L-H 679±8 kg. Dry matter intakes from parturition through 27 d postpartum were M-M-M-M 260±4 kg, L-H-M-M 264±3 kg, and L-L-L-H 220±3 kg. Dry matter intakes from 28 through 66 d postpartum were M-M-M-M 385±5 kg, L-H-M-M 377±6 kg, and L-L-L-H 528±10 kg. At 187 d of gestation, BW of L-H-M-M (n=40; 448±6 kg) and L-L-L-H heifers (n=43; 447±6 kg) did not differ (P=0.83), but was less