Growth and Development II

680 Total body fat and subcutaneous fat distribution in beef steers. M. J. McPhee*[1], B. J. Walmsley[1], J. P. Siddel[2], J. F. Wilkins[3], V. H. Oddy[1], and P. L. Greenwood[1], [1]*Beef Industry Centre of Excellence, Armidale, NSW, Australia,* [2]*Glen Innes Research Station, Glen Innes, NSW, Australia,* [3]*Wagga Wagga Institue, Wagga Wagga, NSW, Australia.*

A serial slaughter study (5 time points) was undertaken to elucidate some factors influencing fat development in beef cattle. Relationships between the following factors were evaluated from weaning to slaughter: (1) total body fat (TBF; kg) and EBW; and (2) the contribution (proportion) of subcutaneous fat (SUB; kg) to TBF (SUB/TBF; SUBPROP) across BREED (Angus, A; Hereford, H; and Wagyu × Angus, W×A) (n = 135). Breeds were chosen to represent high intramuscular fat (IMF) plus high SUB (A), low IMF plus high SUB (H) and high IMF plus lower SUB (W×A). From weaning, steers were backgrounded and fed pasture (P) or pasture plus high energy pellets (12.3 MJME/kgDM, 110g CP/kgDM) at 1% BW (Supplementation; S) with 2 replicates per treatment for 168d. Base-line steers (n = 15, 6 mo) were slaughtered at weaning, and groups were slaughtered at the end of nutritional treatments (n = 30, 12 mo), before feedlot entry (n = 30, 18 mo), and after short (n = 30, 21 mo) and long (n = 30, 26 mo) grain finishing. Ommental, mesenteric, and channel (visceral) fat were collected and weighed at the abattoir. All primal cuts from the left carcass side were scanned using a Picker Ultra Z Spiral Computer-aided Tomography (CT) scanner (Philips Medical Imaging Australia, Sydney NSW). Total fat and lean in each primal cut was calculated using image analysis software. Boundaries for fat and lean were set at 10 to 128 and 129 to 210 gray scale units, respectively, with an image diameter of 487mm. TBF was calculated as the sum of fat in the primal cuts plus visceral fat. To estimate SUB fat, intermuscular and IMF were removed from the image of each slice using an elliptical tool in ImageJ (http://rsb.info.nih.gov/ij/). The following curves were fitted: (1) TBF = A + B*(CEBW); and (2) SUBPROP = A + (B + C*TBF)*(DTBF) where A, B, C, and D are parameter values. For the relationship between TBF vs. EBW (1) (Variance = 94.8%; SE = 13.7) EBW, BREED and BREED × EBW were significant ($P < 0.01$) for both P and S. For the relationship between SUBPROP vs. TBF (2) (Variance = 69.29%; SE = 0.026) TBF and BREED were significant ($P < 0.01$) and ($P < 0.05$) for P and S, respectively. Replicates within treatments were not significant.

Key Words: depot, deposition, development

681 Development of target growth charts for Ayrshire, Brown Swiss, Holstein and Jersey heifers. D. E. Santschi, R. Lacroix, and D. M. Lefebvre*, *Valacta, Ste-Anne-de-Bellevue, QC, Canada.*

The objective was to establish heifer growth charts for body weight (BW), wither (WH) and hip height (HH) for 4 breeds of Canadian dairy cattle, Ayrshire (AY), Brown Swiss (BS), Holstein (HO) and Jersey (JE), to monitor growth and establish targets to reach calving at 24 mo of age at a desired BW and height. Body measurements were obtained for approximately 1000 heifers for each breed and the resulting data set was used to develop target growth curves. For BW, the procedure consisted of determining: 1) BW at birth; 2) target BW at 24-mo; and 3) variation of standard deviation (SD) of weight as a function of age. BW at birth was analyzed using regression analysis and final values were established based on literature and the results of data analyses. The target BW at 24-mo was made equal to the average, 75th and 90th percentile for BW of primiparous cows within 30 d in milk plus 11.1%, assuming a BW loss of 10% at calving. A linear equation was derived from BW at birth and at 24-mo assuming constant growth rate. This equation was used to generate target weights at the 50th percentile. Target BW curves for 75th and 90th percentiles were generated from the SD at each age, assuming normal distribution at each age and that the 75th and 90th percentile values were respectively at 0.662 and 1.297 SD from the 50th percentile. Cubic polynomial produced the best fit for both HH and WH. Differences between WH and HH were constant for all ages ($P \geq 0.22$) within a breed except for HO with significant slope of −0.01 cm/month ($P = 0.001$).

Table 1.

	AY	BS	HO	JE
BW parameters (kg)	`			
Intercept	51	49.5	54	38
Slope	21.38	23.60	25.25	16.75
ADG (50th percentile) (kg/d)	0.703	0.776	0.830	0.551
ADG (90th percentile) (kg/d)	0.799	0.848	0.897	0.682
WH parameters (cm)				
Intercept	76.52	78.62	78.08	69.55
A1	5.44	5.52	6.72	6.12
A2	−0.18	−0.19	−0.26	−0.26
A3	0.002	0.002	0.004	0.004
HH parameters (cm)				
Intercept	80.55	83.69	81.58	72.00
A1	5.69	5.59	7.02	6.33
A2	−0.20	−0.19	−0.28	−0.27
A3	0.003	0.002	0.004	0.004
WH-HH (cm)	−4.7	−5.4	−4.4	−3.4

Key Words: dairy heifer, growth chart, equation

682 Mammary gland development in heifers under different metabolizable protein and metabolizable energy ratios. R. L. Albino[1], M. I. Marcondes*[1], A. C. F. Rocha[1], A. S. Trece[1], A. S. Castro[1], and B. C. Gomes[2], [1]*Universidade Federal de Vicosa, Vicosa, Minas Gerais, Brazil,* [2]*Empresa Brasileira de Pesquisa Agropecuaria, Juiz de Fora, Minas Gerais, Brazil.*

This experiment was designed to evaluate dry matter intake, performance and mammary gland development in Holstein heifers under different metabolizable protein and metabolizable energy ratios (MPMER) in diets. The experiment was conducted at the Universidade Federal de Viçosa, Brazil, throughout from 4 mo. Twenty-five heifers with age between 3 and 12 mo were divided into 5 treatments. The treatments were composed to 5 MPMER in diets, being 33, 38, 43, 48, or 53 g of metabolizable protein per Mcal of metabolizable energy (ME) for each treatment. All diets were formulated to permit an average gain daily (ADG) around 1 kg/d, being all diets isoenergetics (2,3 Mcal of ME/kg of dry matter). The dry matter intake (DMI) was adjusted daily, and it was permitted at maximum 5% of orts. Ultrasounds were performed in all quarters of each heifer at the end of each month to evaluate the mammary gland development. Images were taken, positioning the probe sloped 45° toward cranial caudal while the animals were standing. The software ImageJ® (NIH, United States) was used to analyze the average pixels taken in 6 points within each image. Then, it was used

the average pixels to analyze the variation on the density of the image. The DMI and ADG were analyzed in randomized block design. The mammary gland data were analyzed in a split plot design with repeated measures. Analysis were done using the software SAS. The MPMER did not affect DMI ($P = 0.736$) and ADG ($P = 0.090$). These results were expected, once all diets showed the same energy. The mammary gland was affected significantly for treatment ($P = 0.0001$), period ($P = 0.06$) and period-treatment interaction ($P = 0.01$). Throughout the experiment, the heifers fed diets with high protein (48 and 53) showed a reduction in pixel value. However the heifers fed with low protein (33 and 38) showed an increase of pixel value. The MPMER show has influence on the density of mammary gland image. It is inferred that the images generated with high pixel value can be associated with a higher fat accumulation in the mammary gland due to higher reflection of fat over the ultrasound waves. Supported by CNPq/INCT-CA.

Key Words: mammary gland

683 Relationships between pre- and postweaning growth on estrus behavior and reproductive parameters of Holstein heifers. B. F. Silper*[1], A. M. L. Madureira[1], T. A. Burnett[1], A. M. de Passillé[2], J. Rushen[2], and R. L. A. Cerri[1], [1]*University of British Columbia, Vancouver, BC, Canada,* [2]*Agriculture and Agri-Food Canada, Agassiz, BC, Canada.*

The relationships between weight gain in the first year of life and age at puberty, ovarian activity, and estrus expression were evaluated. Holstein heifers (n = 43) were group housed as calves and then in a free stall barn in groups of 7 to 12 animals from 6 to 12 mo old. Milk allowance was 12 kg/d until weaning when the milk allowance was reduced according to the heifer's starter intake. From 6 to 12 mo of age the heifers were weighed weekly and body size was measured monthly. Ovarian ultrasonography was performed twice a week from 7 mo old on. Physical activity and lying bouts were monitored by data loggers. Continuous data was analyzed by ANOVA using the proc MIXED of SAS. Heifers with high preweaning weight gain (PrWG) (0.92 ± 0.03 kg/d) were heavier than those with low PrWG (0.63 ± 0.03 kg/d) from 7 to 12 mo old ($P < 0.05$). However, PrWG did not influence withers height at 9 and 10 mo old ($P > 0.05$). Puberty onset was at 9.5 ± 1.1 mo of age. Age and weight at puberty were influenced by rate of weight gain from 8 to 10 mo of age (WG810) ($P < 0.01$). Heifers with high rate of weight gain from 8 to 10 mo of age (1.15 ± 0.03 kg/d) were heavier and older at puberty onset (331.3 ± 8.3 kg and 298.1 ± 7.8 d old). Heifers with low WG810 (0.85 ± 0.03 kg/d) weighed 304.8 ± 7.6 kg and were 266.9 ± 7.1 d old and at puberty onset. Weight gain from birth to puberty influenced preovulatory follicle size ($P = 0.006$). Heifers that gained less than 0.9 kg/d had preovulatory follicle of 11.1 ± 0.8 mm, whereas those with weight gain of 0.9 kg/d or more had preovulatory follicle of 14.6 ± 0.6 mm. Preovulatory follicle diameter, and estrus duration and intensity were not influenced by WG810 ($P > 0.05$). Estrus episodes lasted 14.9 ± 3.5 h and had 374 ± 133% increase in number of steps when compared with baseline days. Estrus cycle length was 19.9 ± 2.2 d. Preweaning weight gain is correlated with postweaning weight gain, but not with skeletal growth. Heifers with the highest post-weaning growth rates appear to reach puberty at a later age.

Key Words: body weight, estrus, puberty

684 Partial substitution of conventional milk replacer with whey cream drives starter intake, gastrointestinal development, and growth of dairy calves. R. J. LaBerge*[1], J. Schefers[1], R. S. Younkers[2], and N. B. Litherland[1], [1]*University of Minnesota, St. Paul,* [2]*Milk Specialties Global, Eden Prairie, MN.*

Whey cream (WC) contains nutrients and potentially functional food compounds such milk fatty acids and milk fat membrane. Our objective was to determine if replacing 0, 10, and 20% of all milk protein milk replacer (MR) with WC affects calf gastrointestinal development. Holstein and Holstein-cross dairy calves (n = 70) raised in hutches were randomly assigned to 1 of 3 isonitrogenous and isocaloric MRs which provided 22% protein and 22% fat; (1) 0% WC (0WC); (2) 10% WC (10WC); (3) 20% WC (20WC). MR was fed at 13% solids and 1.5% of birth body weight (BBW). BBW and total protein (TP) averaged 40.4 ± 0.7 kg and 6.3 ± 0.07 mg/dL. Calves were fed MR twice daily (0630, 1700) d 1 to 41, daily d 42 to 48, weaned d 49, and removed from trial d 56. Starter (19.9% CP) and water were provided ad libitum. Six male calves from each treatment (n = 18) representing average BBW, TP, and breed were harvested for gastrointestinal measurement on d 56. Data were analyzed using PROC MIXED and Pearson's coefficient of SAS. The 20WC harvested calves tended ($P < 0.07$) to have greater total d 49 and d 56 starter intake (SI). 20WC tended ($P < 0.09$) to consume 500 g/d of starter earlier, and had earlier ($P < 0.04$) SI consumption of 1000 g/d, than 0WC calves. Day 56 gain did not differ ($P < 0.14$). Reticulorumen weight (RR), abomasum weight, small intestine (SMI) length, and cecum length were similar between treatments. Omasum weight tended to be greater ($P < 0.07$) for 20WC over 10WC. SMI weight alone and as percent of BW of 10WC and 20WC was greater ($P < 0.05$) than 0WC. 20WC had a greater cecum weight alone or as a percent of BW ($P < 0.02$) than 0WC. Days to reach 250 g/d of SI was inversely correlated to SMI length ($r = –0.71$, $P < 0.001$) and days to 500, 1000, and 2000 g/d of SI ($r = 0.69$, $P < 0.002$). Days to SI of 500, 1000, and 2000 g/d was inversely correlated ($r = 0.68$, $P < 0.001$) to d 49 and 56 gain and RR weight as a percent of d 56 BW ($r = –0.46$, $P < 0.05$). Earlier SI of WC calves drove development of the gastrointestinal tract to provide greater tissue mass and surface area for potential nutrient absorption, allowing greater growth.

Key Words: nursery calf, gastrointestinal development, whey cream

685 Dietary reduction from early gestation in obese/overnourished ewes reduced adiposity and serum lipids and increased liver glycogen in late gestation fetuses. J. F. Odhiambo*[1], T. Nurmamat[1], P. W. Nathanielsz[2], and S. P. Ford[1], [1]*Center for the Study of Fetal Programming, Department of Animal Science, University of Wyoming, Laramie,* [2]*Center for Pregnancy and Newborn Research, Department of Obstetrics and Gynecology, University of Texas Health Sciences Center, San Antonio.*

As previously reported, pre-pregnancy maternal obesity and overnutrition in the ewe increases fetal plasma glucose, insulin and adiposity, predisposing offspring to metabolic syndrome (Ford et al., 2009; Am J Physiol Reg Integ Comp Physiol 297:835). In this study we evaluated the effects of reducing maternal nutrient intake of obese ewes to requirements from early gestation on fetal growth, adiposity and lipid profiles in late gestation. Sixty days before conception ewes were assigned to control [CON, 100% of National Research Council (NRC) recommendations; n = 5], obese [OB, 150% NRC; n = 5] or obese intervention [OBI, 150% NRC to d 28 of gestation then 100% NRC thereafter, n = 5] diets until necropsy on d 135 of gestation. Maternal body fat % was quantitated by DEXA, and fetal kidney-pelvic fat depots by weighing. Serum triglycerides (TG) and cholesterol (CHOL) were determined by commercial assay kits. Liver TG and glycogen were extracted by chemical methods and then quantified by colorimetric kits. PEPCK and Glucose-6-phosphatase (G6Pase) protein expression were determined by Western blotting. Data were analyzed by mixed procedures of SAS. Maternal BW and % body fat were greatest in OB, intermediate in OBI and lowest in CON ewes ($P < 0.05$), while fetal BW were similar. Kidney-pelvic fat weight was greater ($P < 0.05$) in OB than OBI and CON fetuses, averaging 31.4 ± 1.4 vs. 21.8 ± 1.0, and 24.2 ± 1.3g, respectively. Further, serum TG and CHOL were elevated ($P < 0.01$) in fetuses of OB ewes compared with those of CON and OBI ewes (23.1 ± 1.9 vs. 16.0 ± 2.0, and 16.2 ± 2.0 mg/dL and 36.3 ± 2.2 vs. 22.9 ± 2.3, and 22.6 ± 2.3 mg/dL, respectively). PEPCK expression was elevated ($P < 0.01$) and glycogen was reduced ($P < 0.01$) in fetal livers from OB versus OBI and CON ewes, while liver G6Pase and TG content were similar. The increased serum lipids, and liver PEPCK expression as well as decreased liver glycogen in late gestation fetuses might contribute to the observed elevation in plasma glucose and adiposity, predisposing OB fetuses to metabolic syndrome in postnatal life.

Key Words: obesity, fetal lipid, glycogen

686 Effect of feeding 25-hydroxycholecalciferol on vitamin D status and skeletal muscle growth and development in broiler chickens. K. C. Hutton[1], J. D. Starkey*[1], M. A. Vaughn[1], B. J. Turner[2], and G. Litta[2], [1]*Texas Tech University, Lubbock,* [2]*DSM Nutritional Products, Basel, Switzerland.*

Increases in breast meat yield have been observed in broiler chickens fed 25-hydroxycholecalciferol (25OHD$_3$; Rovimix Hy-D, DSM Nutritional Products), but it is unclear whether this effect is satellite cell-mediated. Our objective was to determine the effect of feeding 25OHD$_3$ on skeletal muscle satellite cell function in both fast-twitch (pectoralis major; PM) and slow-twitch (biceps femoris; BF) muscles. Day-old male Ross 708 broiler chickens (n = 150) were obtained from a commercial hatchery and fed one of 2 corn/ soybean meal-based diets for 49 d. The control diet (CTL) was formulated to contain 5,000 IU D$_3$/kg of diet, while the experimental diet (25OHD$_3$) contained 2,240 IU vitamin D$_3$/kg diet + 69 µg 25OHD$_3$/kg diet. Ten birds per treatment were harvested every 7 d. Two hours before harvest, birds were injected intraperitoneally with 5′-bromo-2’deoxyuridine (BrdU) to facilitate labeling of mitotically active cells. Blood was collected from each bird at harvest to determine vitamin D status. The PM and BF muscles were weighed and processed for cryohistological determination of skeletal muscle fiber cross-sectional area, enumeration of Myf-5+ and Pax7+ satellite cells, and mitotically active satellite cells using immunofluorescence microscopy. Circulating 25OHD$_3$ concentrations were greater in 25OHD$_3$-fed birds on d 7, 14, 21, 28, 35, 42, and 49 when compared with CTL ($P < 0.001$). PM and BF muscle mass were not different among treatments. Feeding 25OHD$_3$ increased the number of mitotically active (Pax7+; BrdU+) satellite cells ($P = 0.01$) and the density of Pax7+ cells ($P = 0.07$) in the PM muscle on d 21 and 35, respectively. In addition, broiler chickens fed 25OHD$_3$ tended to have greater PM Myf-5+ satellite cell density ($P = 0.09$) on d 14, greater total PM nuclear density ($P = 0.05$) on d 28, and greater PM muscle fiber cross-sectional area ($P = 0.09$) on d 49 compared with their CTL counterparts. Combined, these results suggest that feeding 25OHD$_3$ affects broiler chicken vitamin D status and stimulates a classic satellite cell-mediated muscle hypertrophy response in fast-twitch skeletal muscle.

Key Words: vitamin D, skeletal muscle, broiler chicken

687 Effect of fluted pumpkin (*Telfaria occidentalis*) leaf extract on growth performance, serum chemistry, and carcass yield of cockerel chickens. A. O. Ladokun*, N. O. Adewale, M. K. Adeoye, and J. A. Abiona, *Federal University of Agriculture, Abeokuta, Ogun, Nigeria.*

A total of 120 2-week-old cockerel chicks of the Yaffa strain were used for the experiment to determine the effect of fluted pumpkin (*Telfaria occidentalis*) leaf extract (FPLE) administered orally on growth performance characteristics-weight gain, feed intake and feed efficiency; blood chemistry-hematology and serum chemistry; carcass yield-relative organ weights and cut-out parts for a 16 week period. The birds were randomly assigned to 4 treatment groups: control group with no FPLE; 30 mL FPLE/liter of drinking water; 60 mL FPLE; and 90 mL FPLE respectively at 3-d intervals. Weighing of birds was done weekly to obtain weight gain, Feed was given ad libitum. Blood sampling was carried out at the sixteenth week of experiment. The data obtained were subjected to one-way ANOVA; i.e., a completely randomized design (CRD) of SAS (2001), the only factor being FPLE. The results show that FPLE significantly ($P < 0.05$) increased feed intake and weight gain with birds in group with 90 mL FPLE/L water having higher values than other groups. For haematology, packed cell volume (PCV), red blood cell count (RBC) and white blood cell count was not affected by FPLE. However for serum chemistry, serum total protein, albumin, creatinine and cholesterol were significantly ($P < 0.05$) increased by FPLE. For urea there was no significant change, while globulin was significanly ($P < 0.05$) reduced by FPLE addition. FPLE has been proven to be a haematinic in rats and broiler chickens; this present result further strengthens this assertion. The values obtained for the organ-gizzard were significantly influenced by FPLE with size decreasing with increase in FPLE without compromise in final live weight of the birds. This result suggests that FPLE as used in this study contains certain substances that makes it convenient for birds to “grind” their feed without corresponding big size gizzard. It can therefore be concluded that up to 90 mL FPLE/L of drinking water can be tolerated by cockerel chickens from chick phase to growing-finishing phase.

Key Words: fluted pumpkin leaf, serum chemistry, carcass yield