humidities (RH) varying from 20.4 to 40.5ºC and 12 to 39%RH, respectively, resulting in temperature-humidity indexes (THI) ranging from not stressful (50) to very stressful (84). Data was collected for four physiological parameters: rectal temperature (RT), surface temperature (ST), respiration rate (RR), and sweating rate (SR). Regression equations were created to quantify relationships between variables. The variability in RR and SR can be described by changes in T_{db}, 50.3% and 53.8%, respectively, and THI, 49.6% and 55.2%, respectively, as cattle need to increase heat loss during thermal stress. THI is used commonly to classify the potential stress of an environment, and 75% of the variability in ST can be explained by changes in THI. ST can also be used to accurately predict both RR ($R^2 = 0.557$) and SR ($R^2 = 0.435$) whereas RT is not precise for SR ($R^2 = 0.035$). Stepwise regression analysis yielded equations for SR with RH, bodyweight, presence or absence of solar radiation, T_{db}, RR, and RT as predictors ($R^2 = 0.517$) and for RR with ST and RT as predictors ($R^2 = 0.429$). Overall, surface temperature is a more predictive measure of heat dissipation through evaporative methods than rectal temperature and can be used as a tool to evaluate environments in order to prevent productive losses due to heat stress in dairy cattle.

Key Words: Heat Stress, Surface Temperature, Dairy Cattle

508   Evaporative heat loss from pigs at different temperature and relative humidity. T.T. Huynh[1,2], J. A. Aarnink*[2], W. A. Verstegen[3], J. J. Gerrits[3], M. J. Heetkamp[4], and B. Kemp[4], [1]*Department of Animal Health, Ho Chi Minh city, Viet Nam*, [2]*Livestock and Environment, Wageningen University and Research Center, the Netherlands*, [3]*Animal Nutrition Group, Wageningen University and Research Center, the Netherlands*, [4]*Adaptation Physiology, Wageningen University and Research Center, the Netherlands*.

The distribution of evaporative water from respiration and from the skin at high ambient temperature (T) and relative humidity (RH) was studied using twelve groups (10 gilts per group) in partially slatted pens (40%) inside respiration chambers. The climate chamber was programmed so that T remained constant within a day. Each day, T was increased by 2°C from low (16°C) to high (32°C). RH was kept constant at 50, 65 or 80 %. The pigs' initial BW was 61.7 kg (58.0 to 65.5 kg). Total water evaporation (WE) was determined by measuring RH in the incoming and outgoing air and the total air flow. WE per m^2 wet floor area was estimated by weighing water buckets and video observations. WE by respiration was estimated from the measured respiration rate, the volume per respiration stroke, and the RH of the exhausted air. Furthermore, skin temperature (ST) and total heat production was measured and wallowing observed. The animals had free access to feed and water. The T above which evaporative heat loss (EH) started to change was determined (inflection point temperature (IPt)).

On average IPt for WE was 20.3°C. Results showed no effect of RH on IPt. At 32°C and 80 %RH, most (67%) of the total EH from our pigs was achieved as heat loss by respiration. There were differences in regression coefficients of WE by respiration: 0.15, 0.11, and 0.08 for 50, 65, and 80 %RH (p<0.05), respectively. The findings show that at high RH the pigs depended on EH from the skin. They wetted their skin by wallowing. Wallowing was observed earlier in the 80 %RH group than in the 50 and 65 %RH groups (p<0.05). This resulted in lower ST of the pigs at 80 than at 50 and 65 %RH (p < 0.05).

It was concluded that at high T and RH pigs have less possibilities to lose heat by respiration. They compensated it by employing skin moisture evaporation. The implication is that pigs at high T, especially in combination with a high RH, should be able to wet themselves. For animal welfare and environmental reasons it is important that the pigs do not have to do so with their own excreta. Water should be available for the pigs, in a water bath or from sprinklers.

Key Words: Evaporation, Heat Stress, Pig

Ruminant Nutrition: Dairy—Feed Additives

509   'Rumen-up': New plants and plant extracts to decrease methane and nitrogenous emissions from ruminants and to alleviate nutritional stress. R. J. Wallace[1], R. Ningrat[1], K. Becker[2], E. Hoffman[2], S. Muetzel[2], N. Selje[2], S. Lopez[3], D. E. Beever[4], K. E. Kliem[4], R. Morgan[4], F. L. Mould[4], C. Duffy[5], M. Frehner[6], and R. Losa*[6], [1]*RRI, Aberdeen, UK*, [2]*Inst An Prod Un, Hohenheim, Germany*, [3]*Dept Prod An Un, Leon, Spain*, [4]*Dept Agric Un, Reading, UK*, [5]*Alltech Irland Ltd, Dunboyne, Irland*, [6]*CRINA SA, Gland, Switzerland*.

The aim of this EC FP5 project was to develop new plants (plant extracts) as dietary additives for ruminants. Five hundred plant materials were collected, based on criteria such as traditional uses and phytochemical content. They were evaluated for their ability to prevent lactic acidosis and bloat, to decrease formation of the greenhouse gas, methane, and to decrease nitrogen excretions by inhibiting ruminal proteolysis and protozoal activity. The samples were also investigated to ensure that potentially useful samples had no detrimental effect on the other basic functions of the fermentation, such as fiber digestion and volatile fatty acid production. A total of 23 samples were identified to have potential for development as feed additives which could manipulate fermentation in one or more of the target areas without having detrimental effects on overall fermentation. A smaller number of samples was then taken forward for more detailed experimentation on persistence and dose response. These included *Bellis perennis* (antiprotozoal), *Carduus pycnocephalus* (antimethane), *Gentiana asclepiadea* (antiprotozoal), *Knautia arvensis* (antiproteolytic), *Lactuca sativa* (antiacidosis), *Peltiphyllum peltatum* (antiproteolytic) and *Urtica dioica* (antiacidosis). None of the short-listed samples gave any indication of toxicity. Generally, the materials were not potent at low concentrations. Most would have to be included in the diet at 3-5%. Differential solvent extraction and HPLC are being used to identify the likely active phytochemical components. Antimicrobial effects of samples are being assessed using both cultural and molecular profiling. Production-type trials are being carried out with three of the most promising samples. http://www.rowett.ac.uk/rumen_up/.

Key Words: Plant Extracts, Ruminants, Methane and Nitrogen

510   Effect of a specific blend of essential oils on the colonization of starch-rich substrates by rumen microorganisms. S. Duval*[1], N. McEwan[2], R. Graham[2], R. Wallace[2], and C. Newbold[1], [1]*The Institute of Rural Science, Aberystwyth, Wales, UK*, [2]*Rowett Research Institute, Aberdeen, Scotland, UK*.

A number of studies have found that essential oils (EO) are able to manipulate ruminal fermentation. Our group has previously shown that a commercial blend of EO was able to decrease the rate of degradation of some starch-rich supplements in the rumen. It was suggested that this effect may have been due to the EO decreasing the colonization of the substrates by rumen bacteria, and particularly by *Ruminobacter amylophilus*. *R. amylophilus* is one of the major starch degraders in the rumen, and its growth in pure culture was inhibited by the EO blend to a greater extent than many other rumen bacteria. In the present study wheat, maize and barley were incubated for 6 h, in the rumen of sheep receiving a diet of grass silage plus a high or low protein concentrate, plus or minus a commercial EO mixture (CRINA RUMINANTS fed to supply 110 mg per sheep per day) fed in a 4 x 4 latin square. DNA was extracted from the samples using a commercial kit and was used as template for 16S rDNA PCR-DGGE and real time PCR. Cluster analysis of DGGE band polymorphism showed that the treatment (supplementation with EO and the protein content of the concentrate) explained most of the similarity in the attached bacteria. Real time PCR enabled precise quantification of *R. amylophilus* and its abundance relative to total bacteria. Colonization by *R. amylophilus* was significantly affected by the substrate but there was no effect of essential oils. These results support the observation that EO influence the attachment and colonization of starch rich substrates in the rumen but do not support the hypothesis that this effect was mediated via *R. amylophilus*.

Key Words: Rumen, Essential Oils, Colonization

511 Impact of rumensin premix on reproductive performance in dairy cows. T. Duffield*[1], S. LeBlanc[1], D. McClary[2], H. Green[2], and J. Wilkinson[2], [1]*University of Guelph*, *Guelph, ON, Canada*, [2]*Elanco, Greenfield, IN.*

Reproductive data were gathered from 966 Holstein dairy cows in a field trial at 9 sites in North America. Primiparous and multiparous cows were randomized to receive 0, 8, 16, or 24 ppm of monensin in the diet from 3 weeks before expected calving, through lactation, into the dry period and for 7 days into the subsequent lactation. At all sites the voluntary waiting period was 50 days in milk (DIM) and breeding was stopped at 200 DIM. No hormonal aids for breeding were allowed until 135 DIM and cows receiving hormonal therapy for a reproductive tract condition prior to 135 DIM could not be bred on an estrus within 6 days of therapy. Health events were recorded comprehensively. Previous evaluations of these data have not employed survival analysis or considered covariates that might have confounded the results. Survival analysis was performed using proportional hazards regression controlling for within-site clustering. Covariates (parity, at-calving events, and pre-breeding diagnoses) were screened for their association with the probability of non-pregnancy beyond 200 DIM. Variables meeting a $P<0.25$ cutoff were included in a backward elimination multivariable survival model of pregnancy rate. 869 cows entered the breeding period. There was no univariate association of treatment with time to pregnancy, but there were tendencies for reduced reproductive performance (hazard ratio (HR) = 0.93, P=0.28; HR=0.86, P=0.10; HR=0.88, P= 0.11 for 8, 16, 24 ppm respectively, relative to control). The final model included parity, retained placenta, dystocia, apparent anestrus, and cystic ovaries in addition to the treatment variables, and controlled for clustering. Accounting for these covariates, there was no significant effect of treatment on time to pregnancy (HR = 0.93, P=0.26; HR=1.00, P=0.99; HR=0.93, P= 0.27 for 8, 16, 24 ppm respectively, relative to control). It was concluded that Rumensin did not significantly influence reproductive performance, which is consistent with several peer-reviewed publications.

Key Words: Reproduction, Monensin

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513 Effects of a *Yucca Schidigera* extract on microbial metabolism in continuous culture of rumen contents. J. Clark*[1], T. Miller-Webster[1], W. Hoover[1], and B. Clyburn[2], [1]*Rumen Fermentation Profiling Laboratory, West Virginia University*, *Morgantown, WV*, [2]*Distributors Processing, Inc.*, *Porterville, CA.*

Two experiments were conducted using dual flow continuous cultures to evaluate the effect of a *Yucca schidigera* extract product, Micro-Aid® (MA) on microbial metabolism and efficiency. In both experiments fermenters were maintained at constant temperature (39°C), solids (4.55%/h) and liquid (13%/h) dilution rates. Fermenters were fed 25 g DM four times daily at 6-h intervals. The diets contained 17 – 18% CP, 34% NDF and 30% nonstructural carbohydrates (NSC). Culture pH was allowed to cycle after feeding and was recorded at 0.5 h intervals. Fermentation periods consisted of 6-d for adaptation and 3-d for sampling. Treatments for Exp. 1 were: no additive (Control, C), and MA (2.60 mg/d, MA1). Exp. 2 included an additional treatment, MA2 (5.2 mg/d). In Exp. 1 digestion of ADF was significantly increased, 58.4 vs. 54.5 ($P < 0.04$) and digestion of NSC, decreased, 81.2 vs. 83.2, ($P < 0.02$) by the addition of MA. Digestion of DM, OM, NDF, CP, total volatile fatty acids (VFA) and average fermentation pH were unaffected by treatment. Non-ammonia-N was higher for MA ($P < 0.006$) due to greater production of microbial nitrogen. Microbial efficiency expressed in g micN/kg CHO digested was numerically improved by the addition of MA (44.8 vs. 52.5). In Exp. 2 MA2 tended to increase digestion of DM and CP ($P = 0.15$ and 0.16, respectively) while digestion of NSC was significantly decreased ($P < 0.006$) relative to the control and MA1. No differences due to treatment were noted in VFA production or fermentation pH in Exp. 2, however, microbial nitrogen and microbial efficiency (micN/kg CHOD) increased ($P < 0.09$, and $P < 0.08$, respectively) with addition of MA. Values were 1.92, 1.97, and 2.33 g; 43.0, 44.9, and 53.4 for C, MA1 and MA2, respectively. Under the conditions of these experiments MA appears to have potential as a rumen enhancing compound and was most effective when fed at 5.2 mg/d.

Key Words: *Yucca schidigera*, Continuous Culture, Microbial Efficiency

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512 Effect of a low-moisture buffer block on subacute ruminal acidosis (SARA) in lactating dairy cows. K. M. Krause*[1], G. R. Oetzel[1], and D. V. Dhuyvetter[2], [1]*University of Wisconsin*, *Madison*, [2]*Ridley Block Operations, Ridley Inc.*, *Mankato, MN.*

The objective of this study was to evaluate the effect of a low-moisture buffer block (BB; ~40% buffer and alkalinizers) on ruminal pH and milk production in cows challenged with SARA. Sixteen ruminally cannulated cows were randomly assigned to the treatment (access to BB) or the control (no BB) group. Ruminal pH was recorded each minute; DMI, milk yield and milk composition were measured daily. The trial lasted 12 d and consisted of a 3-d baseline period (without BB; d 1-3), after which the 8 treatment cows had access to BB, 4-d period to evaluate response to BB (d 4-7), 1-d of 50% restricted feeding (d 8), 1-d of challenge feeding (addition of 4 kg wheat/barley pellet to baseline TMR; d 9), and a 3-d recovery period (d 10-12). Intake of BB averaged 0.33 kg DM/ cow/d and was highest ($P=0.05$) on d 8. Total DMI (TMR plus BB) was not affected by treatment, but DMI tended to be higher during the recovery period for cows with access to BB (19.7 vs. 18.0 kg/d, $P=0.12$). Challenging cows with SARA decreased milk yield from 28.5 to 23.7 kg/d (from d 4-7 to d 9; $P<0.001$). Cows with access to BB tended to drop less in milk when comparing d 4-7 to the recovery period (1.5 vs. 4.2 kg milk/d; $P=0.08$). The SARA challenge decreased ruminal pH in all cows from 6.15 on d 4-7 to 5.78 on d 9 ($P<0.001$). Drop in ruminal pH from d 4-7 to the SARA challenge (d 9) was less ($P=0.03$) for cows with access to BB than control cows (0.20 vs. 0.55 pH units). Cows with access to BB tended to have higher mean ruminal pH during recovery (6.26 vs. 6.07; $P=0.13$). Cows with access to BB spent fewer hours (6.04 vs. 9.25 hr/d; $P=0.05$) and had less area (111.2 vs. 200.0 min x pH/d; $P=0.03$) below pH 5.5 during the SARA challenge (d 9). Cows with access to BB increased less in time ($P=0.03$) and area ($P=0.11$) below pH 5.5 from d 4-7 to the recovery period than did control cows. Access to BB reduced duration and severity of a SARA challenge and tended to assist cows in returning to pre-SARA levels.

Key Words: Buffer Block, Subacute Ruminal Acidosis, Dairy Cows

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514 The effect of method of dietary addition of a fibrolytic enzyme on the performance of lactating dairy cows. D. Dean*, A. Adesogan, C. Staples, K. Arriola, S. Kim, K. Krueger, M. Huisden, S. Chikagwa, and B. Amaral, *University of Florida*, *Gainesville.*

The objective was to investigate whether the strategy used to apply a cellulase enzyme (Promote; Cargill; Minnetonka, MN) to feedstuffs influences the performance of lactating dairy cows. The ration consisted of Tifton 85 bermudagrass silage, corn silage, and concentrate (35, 10 and 55% DM basis respectively). Ingredients were mixed and fed as a totally mixed ration (TMR) in ad libitum amounts twice daily. Thirty Holstein cows (129 average days in milk) were assigned randomly to the following five treatments: 1) control (no enzyme addition), 2) enzyme applied to bermudagrass at ensiling (1.3 g/kg of DM), 3) enzyme applied to a concentrate mix every week, 4) enzyme applied to bermudagrass silage at feeding, and 5) enzyme applied to the TMR at feeding. Cows received approximately 4 g/cow per day of enzyme when added at feeding. The experiment was a partially balanced, completely randomized design consisting of two-28 d periods, with 14 d for adaptation and 14 d for data collection. Least significance difference analysis was conducted. Mean intake of DM (21.5, 20.9, 21.9, 19.8, and 22.1 kg/d; SE=0.9), DM intake as a proportion of BW (3.44, 3.30, 3.53, 3.17, and 3.61% of BW), and gain in BW (7.7, 7.6, 19.0, 6.5, and 10.3 kg/28 d; SE=5.8) for treatments 1 to 5, respectively, did not differ. Mean milk production was 33.7, 31.9, 31.0, 30.9, and 32.3 kg/d (SE=1.0) for cows fed treatments 1 to 5 respectively, with control cows tending to produce more milk than cows fed treatments 3 or 4 (P<0.051). Milk fat concentrations were 3.74, 3.79, 3.39, 3.78, and 4.21% (SE=0.14) for treatments 1 to 5 respectively, with means for cows fed enzyme-treated TMR greater than those fed diets 1, 3, and 4 (P<0.05). Milk true CP concentrations were 2.96, 2.91, 3.13, 3.01, and 3.0% (SE=0.10) for treatments 1 to 5 respectively, and did not differ. Strategy of adding a cellulose-type enzyme to the dietary ingredients influenced milk yield and component concentrations

Key Words: Fibrolytic Enzyme, Bermudagrass, Dairy

515 Effect of an enzyme mixture on dairy cow performance. S. Ghasemi* and A. A. Naserian, *Ferdowsi University, Mashhad, Khorasan, Iran.*

The use of enzymes as additives in ruminant diets has received considerable research interest recently following positive responses observed in feeding trials. The objective of present study was to determine the effects of an enzyme mixture (Natuzyme, Bioproton, PTY. LTD.), on dairy cow performance. Nine lactating Holstein cows, in early lactation, were randomly assigned to treatments in a 3×3 Latin squares design. Treatments were, 1) no enzyme 2) enzyme was added to concentrate portion of the TMR (0.5 kg/ton) 3) enzyme was added to concentrate portion of the TMR (1 kg/ton). Cows averaged 53.88 ± 8.19 days in milk. The cows were given ad libitum a TMR composed of 34% forage (20% alfalfa, 14% corn silage) and 66% concentrate (25% barley, 8% corn, 7% cotton seed, 6% soybean meal, 9% cotton seed meal, 5% beet pulp, 4.3% bran, 0.2% urea, 0.5% lime, 0.2% premix, 0.2% salt, 0.6% fat meal). Data were analyzed using General Linear Models procedure of SAS V6.12 for ANOVA to evaluate differences among experimental groups, means compared with Duncan test. Milk production, protein, lactose and digestibility of dry matter, were higher in cows fed enzyme compared to those fed control diets, but it was not significant. Dry matter intake was significantly higher in control group ($P \leq$ 0.05), feed efficiency was significantly higher in treatment groups($P \leq 0.05$). Milk production increased 4.5% in cows received enzymes in comparison with control group. So, data showed that the enzyme can improve dairy cow performance.

Effect of enzyme on cow performance

Treatment	1	2	3	SEM
Dry matter intake(kg/d)	25.56[a]	24.02[c]	24.76[b]	0.17
Milk production(kg/d)	32.86	33.2	34.34	0.65
Protein(%)	3.34	3.37	3.35	0.01
Lactose(%)	4.64	4.65	4.66	0.05
Fat(%)	3.59	3.4	3.64	0.14
Digestibility of dry matter(%)	78.22	80.4	79.03	0.01
Feed efficiency	1.29[b]	1.38[a]	1.38[a]	0.02

Key Words: Enzyme, Dairy Cow, Nutrition

Sheep Species

516 Analysis of probability distribution of some serum and hematological variables of dairy sheep. C. Dimauro[1], P. Bonelli[2], N.P.P. Macciotta[1], P. Nicolussi[2], C. Patta[2], and G. Pulina*[1], [1]*Università di Sassari, Italia*, [2]*Istituto Zooprofilattico per la Sardegna, Italia.*

Serum and hematological parameters are widely used in nutrition and in health diagnosis of farm animals. They are also used to check the metabolic and health status of animals involved in scientific trials. Usually these variables are analyzed by standard ANOVA methods and statistical inference is based on the assumptions of normal distribution and of homoscedasticity of variance. Because of the strict metabolic control, it is not logical that these parameters should adapt to a normal distribution. To check this hypothesis, a set of about 700 observations for serum and about 1000 observations for hematological parameters have been analyzed for direct or transformed normality, for agreement to the Central Limit Theorem (CLT) and for the nearest distribution shape. The variables taken into account are listed in table 1. Results show that few variables are normally distributed and in general, they can not be normalized by using the usual transformate (lnx, 1/x, $\sqrt{x}$), but most of them follow the CLT.

	Direct Normality	Transformed Normality	CLT	Nearest Distribution Shape
Serum Parameters				
Alkaline phosphatase	No	No	No	Lognormal
Creatine phosphokinase	No	No	Yes	Lognormal
Glucose	No	No	Yes	Normal
Urea nitrogen	No	No	Yes	Gamma
Cholesterol	No	Yes (lnx)	Yes	Lognormal
Hematological Parameters				
Hemoglobin	No	No	Yes	Lognormal
Hematocrit	Yes	No	Yes	Normal
Mean corpuscular volume	No	No	No	Loglogistic
Mean corpuscular hemoglobin	No	Yes (1/x)	Yes	Loglogistic
Platelets	No	Yes (Öx)	Yes	Weibull
Granulocytes	No	Yes (Öx)	Yes	Gamma

Key Words: Probability Distribution

517 Comparison of East Friesian and Lacaune sheep breeds for dairy production. D. L. Thomas*, Y. M. Berger, R. G. Gottfredson, and T. A. Taylor, *University of Wisconsin, Madison.*

East Friesian (EF) and Lacaune (LA) dairy sheep germplasm (semen, embryos and sheep) was imported into North America (NA) in recent years to improve milk production of dairy sheep flocks. No studies have been reported on comparative performance of these two breeds in NA, and few studies are available from other countries. Progeny of 14 EF and 6 LA rams, representing all EF and LA lines in NA, were compared from 1999 through 2004 for growth, reproduction, and milk production at the Spooner Agric. Res. Sta. F1 lambs were produced by mating EF or LA rams to Dorset-cross, Rambouillet and Polypay ewes. EF- and LA-sired F1 ewes, and subsequent generations of crossbred ewes, were mated to both EF and LA sires to produce animals of a higher % dairy breeding with various combinations of EF and LA breeding. Growth, reproduction, and milk production data were available on 1794, 942 and 402 animals, respectively. Data were analyzed with PROC MIXED of SAS with sire breed and other appropriate effects fitted as fixed effects and ewe and sire fitted as random effects. EF-sired lambs had heavier ($P < 0.05$) birth and 30-d weights than LA-sired lambs (5.05 vs. 4.64 and 14.3 vs. 13.3 kg, resp.). 150-d weights were not significantly different between the two breeds but were slightly greater for LA-sired lambs. Breeds did not differ for ewe fertility, but EF-sired ewes had larger ($P < 0.05$) litter sizes than LA-sired ewes (1.85 vs. 1.69 lambs/ewe, resp.). EF-sired ewes lactated for 4% more days and produced 7.5% more milk than LA-sired ewes, but these differences were not significant. LA-sired ewes produced milk with a higher ($P < 0.05$) % fat and % protein than EF-sired ewes (6.3 vs. 5.8% and 5.2 and 4.8%, resp.). There were no significant differences between breeds for kg of milk fat and milk protein. EF-sired ewes would be expected to be more profitable than LA-sired ewes, due to their greater lamb production. However, the advantage of EF-sired ewes would be lessened, although not eliminated, if payments for milk were based on fat and protein content.

Key Words: Dairy Sheep, East Friesian, Lacaune

518 Reproductive performance and milk yield in Awassi and its crosses with either Charollais or Romanov breeds. R. Kridli*[1], A. Abdullah[1], N. AL-Smadi[1], and M. Momani-Shaker[2], [1]*Jordan University of Science and Technology, Irbid, Jordan*, [2]*Czech University of Agriculture, Prague, Czech Republic.*

The objective of this study was to evaluate the effect of Awassi or Awassi crossbred breed types on reproductive performance, milk production and composition and udder measurements. One hundred, 2- to 6-year-old multiparous ewes of three genotypes [Awassi (A; n = 30), F_1 Romanov-Awassi (RA; n = 36) and F_1 Charollais-Awassi (CA; n = 34)] were used in the study. Upon lambing, ewes and their offspring were placed in a large pen in which they remained until the end of the experiment. Body weights (BW) and body condition scores (BCS) of all experimental ewes and BW of their lambs were recorded at the beginning of the study (one wk postpartum) and weekly thereafter, until the end of the ex-

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