

## Horse Species: Equine Advancements

**620 Novel approach to measuring internal scrotal temperature in stallions utilizing a thermal sensory device.** J. D. Mawyer\*, R. K. Gordon, C. A. Cavinder, M. M. Vogelsang, C. C. Love, S. P. Brinsko, T. L. Blanchard, and S. R. Teague, *Texas A&M University, College Station.*

Past studies investigating testicular heat stress due to exercise or insulation in the stallion have utilized thermistor probes to measure scrotal surface temperatures (SST). Although such devices are effective, a more efficient measurement of testicular thermal stress would be subcutaneous scrotal temperature (SQST). The objective of this study was to utilize a thermal sensory device to measure SQST in the stallion during exercise and correlate it with subcutaneous neck (SQNT), rectal (RCT), and ambient temperatures (AMBT), as well as % humidity (HUM), and temperature-humidity index (THI). Thermal sensory microchips (Digital Angel, Inc., St. Paul, MN) were surgically implanted into the subdermis of the necks and scrotums of 8 miniature stallions. Stallions were assigned to a non-exercised (Non-Ex; control;  $n = 4$ ) or exercised (Ex;  $n = 4$ ) group. A motorized equine exerciser was used to work stallions 30 min/d for 4 d/wk during a 12-wk period from July–October. Temperatures (SQST, SQNT, RCT, and AMBT) were recorded before exercise, immediately after intense exercise, and 1 and 2 h post-exercise. Humidity data was obtained later to determine THI. Data were not normally distributed; therefore, a Spearman's Rank Order correlation analysis was used. No deleterious effects were observed from implantation of thermal sensory microchips. Subcutaneous scrotal and RCT showed the highest correlation ( $R = 0.761$ ). Scrotal temperature was also correlated to SQNT, AMBT, and THI ( $P < 0.0001$ ) (Table 1). Thermal sensory microchips are a safe and effective way to measure SQST to monitor testicular heat stress.

**Table 1.** Mean correlations (Rs) of SQST, SQNT, RCT, AMBT, HUM, and THI

	SQST (°C)	SQNT (°C)	RCT (°C)
SQNT (°C)	0.476*		
RCT (°C)	0.761*	0.453*	
AMBT (°C)	0.625*	0.513*	0.558*
HUM (%)	-0.074*	-0.263*	-0.025
THI (°C)	0.629*	0.453*	0.573*

\* indicates  $P < 0.0001$ .

**Key words:** stallion, subcutaneous scrotal temperature, exercise

**621 Electrolyte and pH response to submaximal training in Quarter and Miniature Horses.** R. M. Legere\* and J. S. Pendergraft, *Sul Ross State University, Alpine, TX.*

Plasma electrolyte concentration and pH response was compared in Quarter Horses (QH) and Miniature Horses (MH) to evaluate the miniature horse as an exercise physiology model for full size horses during submaximal exercise and training. Four QH, 8 to 16 yr of age ( $439 \pm 14$  kg), and 4 MH, 10 to 17 yr of age ( $95 \pm 16$  kg), with each size consisting of 2 mares and 2 stallions, were blocked within breed by age and initial body weight. Horses were subjected to 2 standardized exercise tests (SETs) in a  $2 \times 2$  factorial design. Between SETs horses performed 6 weeks of biweekly submaximal training bouts, with 3 2-week stages of increased training time. The SET and training bouts were scaled using the Froude pendulum model to provide equivalent workouts for all horses at customized speeds, based on height at the

withers, and performed on the Kagra Mustang 2200 high speed equine treadmill. Whole blood was sampled via jugular venipuncture into lithium heparin treated tubes at 11 points before, during, and in recovery after each SET. Plasma was immediately separated using the Iris StatSpin centrifuge and analyzed by the Idexx VetStat Electrolyte and Blood Gas Analyzer. Differences in plasma pH, bicarbonate ( $\text{HCO}_3$ ), chloride (Cl), potassium (K), and sodium (Na) were analyzed using a PROC MIXED procedure for repeated measures (SAS Inst. Inc., Cary, NC). No sex effect or horse size difference was observed for pH,  $\text{HCO}_3$ , Cl, K, or Na. As expected, all parameters varied ( $P < 0.001$ ) over time before, during, and after exercise bouts. No difference was seen for Cl between SETs. Na was higher ( $P < 0.001$ ) and K was lower ( $P < 0.001$ ) for SET2 than SET1. Both pH and  $\text{HCO}_3$  were numerically higher ( $P < 0.001$ ) for SET2 compared with SET1, which suggests adaptations to training. Results suggest that miniature horses could be used as a research model to measure electrolyte and pH response during submaximal training for full size horses.

**Key words:** miniature, submaximal, electrolyte

**622 Effects of intra-articular lipopolysaccharide injection on circulating leukocyte population in yearling horses.** C. L. Mueller\*, D. H. Sigler, J. A. Coverdale, N. D. Cohen, M. M. Vogelsang, C. A. Cavinder, and J. L. Lucia, *Texas A&M University, College Station.*

The immature skeletal structure of a young horse in training is subject to repeated stress which induces inflammation and may ultimately lead to articular degradation. Further characterizing this process may allow for development of preventative strategies to improve future performance and longevity. Intra-articular injection of lipopolysaccharide (LPS) has been used successfully as a method of inducing temporary inflammation in skeletally mature horses to mimic progression of joint disease. However, little information exists regarding its application to the young equine. The objective of the current study was to evaluate the circulating leukocyte population in yearling horses following an intra-articular LPS injection. Nineteen yearling Quarter Horses were utilized in a randomized complete block design. Horses were blocked by age, sex, and BW and treatments were randomly assigned within block. Treatments were an injection of 0.25 ng ( $n = 7$ ) or 0.5 ng ( $n = 6$ ) of LPS or sterile lactated Ringer's solution ( $n = 6$ ; control). The LPS was obtained from *Escherichia coli* 055:B. Blood was collected at pre-injection hr 0 and at 2, 6, 12, and 24 h post aseptic injection of the left radial carpal joint. Peripheral blood smear slides accompanied plasma samples for determination of total leukocyte count and differential. Leukocyte analysis was performed by Texas Veterinary Medical Diagnostic Laboratory (College Station, TX). Data were analyzed using PROC MIXED (SAS v 9.1; SAS Inst. Inc., Cary, NC). No treatment effects were observed; however total circulating leukocytes increased over time ( $P = 0.04$ ) with highest values at 6 and 12 h post injection. Similarly, an increase over time was observed in subpopulations of monocytes ( $P = 0.002$ ) beginning at 12 h post injection and in platelets ( $P = 0.01$ ) at 12 and 24 h post injection. The results indicate that regardless of treatment a mild immune response was elicited, likely due to repeated arthrocentesis. Future experiments need to consider effects of arthrocentesis, even in control animals, and dosage of LPS injections for young horses.

**Key words:** joint inflammation, leukocyte, horse

**623 Role of cellular sodium transport in nonglandular equine gastric ulcer disease.** F. Andrews<sup>\*1</sup>, A. Peretich<sup>2</sup>, R. Reese<sup>2</sup>, L. Abbott<sup>2</sup>, and M. Dhar<sup>2</sup>, <sup>1</sup>Louisiana State University, Baton Rouge, <sup>2</sup>University of Tennessee, Knoxville.

Gastric ulcers are common in horses. Volatile fatty acids (VFAs), from bacterial fermentation of carbohydrates, decrease sodium transport (NAT), by inhibiting NA-K ATPase (NAKA) across nonglandular (NG) mucosa, which leads to ulceration. The purpose of this study was to determine the role of NAT and NAKA in NG ulcers. NG gastric mucosa were collected from 10 euthanized horses. NG tissue bioelectric properties were measured in Ussing chambers while exposed to normal Ringer's solution (NRS, control), a VFA mixture containing concentrations found 2 h after feeding sweet feed (0.5 Kg/Kg BW) (VFA-AF) and a VFA mixture containing high acetic acid (40 mM) (VFA-HAc) at pH 1.5, 4, or 7 for 330 min. Tissues were removed and examined under light microscopy and frozen in liquid nitrogen for determination of NAKA $\beta$ 1 subunit gene mRNA-expression RT-PCR. Unpaired *t*-tests were used to determine differences in relative expression of NAKA using standard software.  $P < 0.05$  was considered significant. NG mucosa exposed to the VFA mixture-AF, showed a decrease in bioelectric properties (PD and I<sub>sc</sub>), similar to tissue exposed to NRS at the same pH. However, NG mucosa exposed to VFA mixture-HAc showed an immediate decrease in bioelectric properties and NG cell swelling was noted in tissues exposed to the VFA mixture-HAc. When tissues were grouped together there was no difference in relative expression of mRNA for NAKA. However, relative expression of mRNA for NAKA was significantly decreased in horses ( $n = 5$ )  $< 5$  years of age when compared with horses ( $n = 5$ )  $> 12$  years of age and controls. Results suggest that VFAs present in gastric juice from excessive grain feeding, at pH  $\leq 4.0$ , result in changes in barrier function and may be related to alternations in NAKA and may be age-dependent. This may account for the age bias in NG gastric ulcer disease.

**Key words:** horse, gastric ulcers, volatile fatty acids

**624 Effect of concentrate form on gastric ulcer syndrome in horses.** L. R. Huth<sup>\*</sup>, D. H. Sigler, C. A. Cavinder, and N. D. Cohen, Texas A&M University, College Station.

Equine gastric ulcer syndrome (EGUS) is common among equine athletes of various disciplines and has been linked to decreased performance. Incidence among racehorses has been reported to be over 90%, performance horses at 60%, and endurance horses at 67%. In swine, concentrate form and smaller particle size increase ulceration; thus, the objective of this study was to investigate the effect of concentrate type on EGUS. Quarter Horse yearlings ( $n = 19$ ; 12–18 mo) were blocked by initial EGUS score on a scale of 0 to 4 (0 = no ulceration or hyperkeratosis, 4 = extensive, deep ulceration) and sex, and utilized in a 77-d crossover design with 2 28-d periods separated by a 21-d washout period. During the first 28-d period, horses were separated into 1 of 2 treatment groups that were all fed Bermuda grass hay and either pelleted or textured concentrate. After the initial 28-d period, horses were all fed pelleted feed and Bermuda grass hay for a 21-d washout period and then treatment groups were switched for the final 28-d period. The rations were a commercially available, pelleted 14.3% CP concentrate and 14.4% CP textured concentrate formulated for this study. Data were analyzed using PROC MIXED (SAS) and effects of horse, treatments (pelleted or textured), period (1st vs 2nd; switchback) and all interactions were considered. Results were considered significant at  $P < 0.05$ . At the beginning of the study, baseline EGUS scores were

not different between horses assigned to either treatment (mean EGUS scored of 1.1); however, upon treatment, horses fed textured feed acquired a reduced incidence of ulceration as compared with those fed pelleted (mean EGUS score of 1.1 vs 1.6, respectively;  $P = 0.02$ ). Degree and incidence of ulceration was influenced by concentrate form as yearlings fed pelleted feed had higher mean ulcer scores than those fed textured feed. Textured feed reduced the EGUS score, possibly due to larger particle size. Also, EGUS scores for both groups in the second period (switchback) were lower, which may be attributed to yearlings being accustomed to the housing, feeding, and management practices during the second period.

**Key words:** horse, ulcer, diet

**625 Development of a nutritional model to predict digestible energy requirements for broodmares based on body condition changes.** V. V. Cordero<sup>\*</sup>, C. A. Cavinder, L. O. Tedeschi, and D. H. Sigler, Texas A&M University, College Station.

Nutritional models have been developed for beef and dairy cattle to estimate energy balance based on changes in body condition score. These models have not been developed or fully evaluated in horses to date. The objective of this study was to develop a model to predict changes in body weight (BW), rump fat (RF) thickness, and overall % body fat (BF) to maximize profitability and productivity by accurately predicting energy balance of mares. The evaluation of the model was performed using non-lactating Quarter Horse mares ( $n=20$ ; 4 to 18 yr of age). The initial BW ranged from 376 to 553 kg, with an initial body condition score (BCS) of 3.5 to 7.0 (scale of 1 - 9; 1 = emaciated, 5 = moderate, and 9 = obese). The BCS, RF thickness, and BW were measured for each mare prior to the commencement of the feeding trial and once/wk thereafter for the duration of a 30 d feeding trial. The pre-trial BCS was used to assign mares to 1 of 4 treatment groups ( $n=5$ /group) and fed to alter BCS by 1 unit as follows: Group 1, 4 up to 5; Group 2, 5 down to 4; Group 3, 6 up to 7; and Group 4, 7 down to 6. Initial BCS, target BCS, %BF, and BW data was collected from each mare and input into the model. Mares (non-lactating; 10 open, 10 early gestation) were individually fed according to the DE suggestions proposed by the model in order to achieve the targeted BCS change within 30 d. The forage provided was a Coastal Bermudagrass hay and the concentrate was a 12% CP pelleted horse feed (Brazos County Producer's Co-Operative Association, Bryan, Texas). Results showed a 79.8% correlation between BCS and BF in which for every change in 1 BCS (either increasing or decreasing) a change in the same direction of 1.05 percentage units of BF can be expected. All mares' observed final %BF values finished with less than a 20% variation from the model-predicted values ( $r^2=0.61$ ), less than 10% variation from BCS values ( $r^2=0.91$ ), and less than 32kg variation from final EBW values ( $r^2=0.94$ ). An equine nutritional model will enhance feeding management and also reduce the costs of unnecessary over-feeding while maintaining broodmares at a nutritional level to achieve optimum reproductive efficiency.

**Key words:** body condition score, digestible energy, broodmares

**626 Equine grazing preferences of twelve cool season grasses.** K. Martinson<sup>\*</sup>, E. Allen, and C. Sheaffer, University of Minnesota, St. Paul.

The objective was to evaluate the relationship between equine grazing preferences and forage quality of 12 perennial, cool season grasses. The experimental design was a randomized complete block with 4 rep-

licates. Grasses included tall fescue (*Schedonorus phoenix*), meadow fescue (*Festuca pratensis*), quackgrass (*Elytrigia repens*), smooth bromegrass (*Bromus inermis*), meadow bromegrass (*Bromus biebersteinii*), reed canary grass (*Phalaris arundinacea*), perennial ryegrass (*Lolium perenne*), timothy (*Phleum pratense*), Kentucky bluegrass (*Poa pratensis*), creeping foxtail (*Alopecurus arundinaceus*), and orchardgrass (*Dactylis glomerata*). Four adult horses were grazed on May 18, June 16, July 19, August 16, September 14, and October 11. Horses grazed 2 replicates (21 × 31-m) for 8-h on day one, and 2 replicates for 8-h the following day. Forage subsamples were harvested to a 9 cm height from duplicate 0.25 m square areas to assess crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and non-fiber carbohydrates (NFC). Grass removal on a scale of 0 (no grazing) to 100 (100% grazed) was visually assessed by 2 trained researchers to determine preference. Forage quality and removals were averaged throughout the season. Data were analyzed using MIXED, ANOVA or PROC REG procedures of SAS. Grasses differed in ADF, NFC ( $P < 0.01$ ) and in palatability ( $P < 0.01$ ). Timothy was most preferred (82%), while orchardgrass and meadow bromegrass were least preferred (47 and 38%, respectively). Timothy had lower ADF (240 g/kg) and higher NFC values (217 g/kg), while orchardgrass and meadow bromegrass had higher ADF (281 and 298 g/kg, respectively) and lower NFC values (142 and 154 g/kg, respectively). To investigate the relationship between grass removal and forage quality, univariate regressions of percent grass removal on forage quality components were performed. ADF ( $P < 0.01$ ) was negatively and NFC ( $P = 0.02$ ) was positively associated ( $R^2 = 0.53$  and  $0.43$ , respectively) with horse preference. Grasses differed in forage quality and palatability to grazing horses. Horse preference for specific grasses was partially explained by lower ADF and higher NFC forage levels.

**Key words:** forage quality, horse, preference

**627 A comparison of two conventional horse feeders with the Pre-Vent feeder.** M. Carter\*, T. Friend, J. Coverdale, S. Garey, A. Adams, and C. Terrill, *Texas A&M University, College Station.*

Feed waste, choke, and sand colic are economic and health issues that present concerns for horse owners across the industry. A new feeder on the market claims to reduce these issues by reducing the speed at which a horse can eat, and the amount of feed dropped and eaten off the ground by the horse. This study compared the Pre-Vent feeder (PV) with commonly used rubber tub (T) and hanging bucket (B) feeders. The PV has 8 cup-like structures 12.7 cm in diameter with a depth of 8.89 cm molded into the bottom of the feeder. It is claimed that the cups will make the horse use its lips and tongue to retrieve the feed, and hence reduces the amount of feed that a horse can eat at one time. Nine Quarter Horse geldings were used to determine time spent eating and feed wastage from the 3 types of feeders. Each horse was fed a 12% crude protein pellet diet at 0.75% bodyweight per day from one of the 3 feeders twice a day for 3 d, and then switched to the next feeder following a 3 × 3 replicated Latin square design ( $n = 9$ ). The horses were brought from pasture twice daily, and placed in individual 3 × 3 m concrete-floored feeding stalls. Data were analyzed using a GLM with individual animal, day fed, time fed, and feeder type as independent variables to predict time spent eating and feed wastage (dropped

on stall floor), followed by pair-wise comparisons. Horses spent more time eating ( $31.15 \pm 0.72$  min,  $P < 0.0001$ ) from PV than B ( $19.39 \pm 0.72$  min), and T ( $18.87 \pm 0.72$  min) feeders. When fed from PV, horses wasted significantly less feed ( $3.2 \pm 0.98\%$  of their ration) than when fed from B ( $10.2 \pm 0.98\%$ ,  $P < 0.0001$ ), and from T ( $7.0 \pm 0.98\%$ ,  $P < 0.007$ ). One of the 9 horses was particularly wasteful, losing  $22.6 \pm 1.7\%$  of his feed overall. When fed from the PV, he lost a mean of 8.7% of his ration, compared with 32.8% when fed from B, and 26.2% when fed from T. Residual feed left in PV could not be compared statistically with the other treatments because PV had the only recoverable residuals, which averaged  $0.20 \pm 0.04\%$  of each horse's ration. The PV is a useful device for increasing time spent eating and reducing feed wastage.

**Key words:** Pre-Vent feeder, horse, time eating

**628 Evaluation of a granulated paper waste product as a suitable bedding material for horses.** A. G. Youngblood\*<sup>1</sup>, B. J. Rude<sup>1</sup>, J. D. Davis<sup>1</sup>, D. L. Christiansen<sup>1</sup>, C. Mochal<sup>1</sup>, P. M. Ward<sup>2</sup>, and P. L. Ryan<sup>1</sup>, <sup>1</sup>Mississippi State University, Starkville, <sup>2</sup>Rutgers University, New Brunswick, NJ.

Twelve mares (BW =  $540 \pm 46.8$  kg) were used for three 14 d trials comparing granulated paper-clay mix (GP) to pine pellets (PP) and wood shavings (WS) as a bedding for horses. After each trial, mares were re-randomized for each subsequent trial. During d 1 through 5 stalls were cleaned daily of feces only. On d 6 stalls were re-bedded with clean bedding and feces and saturated bedding (wet spots) were removed daily through d 14. If needed, clean bedding was added to maintain depth of bedding. Additional GP and WS were needed, but not PP. Due to apparent decreased absorptive capacity, WS were added; however, GP was added mostly because of loss of bedding during the removal of feces and wet spots. Horse and stall (AM and PM) cleanliness scores were assigned daily (1 to 5; 1=clean and 5=heavily soiled). Horses were subjected to a nasal swab (d 5 and 14) and tracheal wash (d 14) during each trial. Tracheal washes were scored from 1 to 5 (1=none and 5=chronic) for cytology, aerobic bacteria and fungal growth. Piled bedding was used to acquire NH<sub>3</sub> and pH (5 d and 14 d). Individual horse was considered the experimental unit, and data was analyzed as a complete random design, using the GLM procedures of SAS. Horse cleanliness was not different ( $P > 0.10$ ) among bedding types. For A.M. and P.M. stall cleanliness, PP (2.79, 3.12; respectively) was cleaner ( $P = 0.0014$ ) than both GP (3.30, 3.74; respectively) and WS (3.09, 3.47; respectively). Initial pH was greater ( $P = 0.0001$ ) for both GP and WS compared to PP and all bedding types increased with use. No differences ( $P > 0.10$ ) were found for ammonia on d 5 (between 3.3 and 88.5 ppm) or d 14 (between 7.3 and 42.7 ppm). Amount of bacteria (cfu) found in the nasal cavity was not different ( $P > 0.05$ ) among bedding types on d 5 (between 107,413 and 148,575 cfu) or d 14 (between 152,500 and 191,775 cfu). No differences ( $P > 0.05$ ) were found for cytology and aerobic bacteria scores within the tracheal wash. However, WS (1.67) and PP (1.67) had less ( $P = 0.0474$ ) fungal growth than GP (2.17). Results indicate the use of GP as a bedding material for horses has potential.

**Key words:** equine, bedding material, granulated paper-clay mix