

Horse Species 1

117 Soaking hay in water to reduce soluble carbohydrate concentrations prior to horse feeding. K Martinson^{*1}, C Sheaffer¹, and H Jung^{1,2}, ¹University of Minnesota, St. Paul, ²USDA-ARS, St. Paul, MN.

Administering high concentrations of fructan to horses has resulted in laminitis. Cool season grasses accumulate fructan, which is estimated as the difference between water soluble carbohydrates (WSC; sucrose, fructose, glucose, fructans) and ethanol soluble carbohydrates (ESC; sucrose, fructose, glucose). Reducing fructan content in hay is critical for susceptible horses. The objective was to determine loss of WSC, ESC, and fructan from different hay types soaked in warm or cold tap water for various lengths of time. Five hays were evaluated; early bud (AB) and full flower (AF) alfalfa, mixed alfalfa orchardgrass (AO), and vegetative (VO) and mature (MO) orchardgrass. Soaking treatments included cold (22°C) and warm (39°C) water for 15, 30, and 60 min; cold tap water for 12 h; and a non-soaked control. One 'flake' from each of 6 bales was randomly assigned to treatments. Hays were weighed, placed in mesh bags, and submerged in 25 L of fresh tap water. After soaking, flakes were drained for 30 min before drying at 60°C for 72 h. Each flake was ground and sent to a forage testing laboratory for WSC and ESC analysis. Data was analyzed using Proc Mix in SAS. Hays contained 81, 73, 114, 134, 129 g/kg WSC; 57, 48, 88, 68, and 66 g/kg ESC; and 24, 25, 27, 66 and 63 g/kg fructans (AB, AF, AO, VO, and MO, respectively). However, alfalfa does not contain fructan and AB and AF results probably reflect WSC extracted pectin. Soaking reduced WSC, ESC and fructan content in all hays ($P < 0.001$), except AO fructan. Except AB WSC and AO fructan, 15 min cold water soaking resulted in the least reduction of WSC, ESC, and fructan ($P < 0.001$), while the 12 h cold soak had the greatest reductions ($P < 0.001$). Soaking AF, AO, MO, and VO in warm water for 60 min had greater reductions in WSC compared with 60 min in cold water ($P < 0.001$). Reductions in MO fructan content were greater after soaking in warm vs. cold water for 60 min ($P < 0.001$). Forage type, soaking length, and water temperature all affected reductions in WSC, ESC, and fructan. Hay soaking is a viable method to reduce WSC, ESC, and fructan in hays.

Key Words: WSC, ESC, fructan, horse, hay soaking

118 Fasting length and hay type on metabolic parameters in the horse. A. M. Bruce* and E. L. Wagner, Auburn University, Auburn, AL.

Several metabolic disorders in the horse have been associated with postprandial fluctuations of insulin and glucose in response to the composition of feedstuffs consumed. Many studies have been conducted on altering grain form, type or feeding method to minimize the glycemic response to a meal; however there is a lack of research focusing on hay feeding protocols. The objectives of this study were 1) to examine changes in blood glucose and insulin in response to different fasting intervals and 2) to compare the effects of warm season and cool season hays on those same blood parameters. Six mature geldings were utilized in a 2 × 3 factorial design experiment. The horses were fed either bermudagrass hay (warm season) or fescue hay (cool season) during each of the fasting treatments. The 3 fasting periods consisted of a no fast where the horses would be offered ad libitum hay throughout the night, a short fast where the animals would receive hay until 2200 h with hay re-introduced at 0600 h, and a long fast where the animals would be offered hay until 2200 h and not offered any hay until the 0700 h morning feeding. All horses received concentrate and additional

hay at 0700 h. Following a 6 d treatment adaptation, horses were fitted with an indwelling jugular catheter to facilitate a 7 h serial blood draw in conjunction with the morning feeding. Area under the curve (AUC) was calculated by the trapezoidal method for blood insulin and blood glucose concentrations. Insulin and glucose AUC were compared using the GLM procedure of SAS. No significant differences ($P < 0.05$) in AUC for blood glucose or insulin concentrations were seen between warm season and cool season hay. Fasting length did not alter blood glucose or insulin AUC concentrations. Fasting length and hay type do not significantly alter the blood insulin and glucose values in the horse; allowing the horse owner to use the method that is most convenient.

Key Words: horse, fasting length, hay type

119 Effects of endophyte-infested fescue seed consumption on post exercise recovery of horses in humid climates. J. A. Ford*, G. W. Webb, S. P. Webb, H. M. Hurshman, E. L. Walker, and B. Onyango, Missouri State University, Springfield.

The objective of this study was to determine the effect of endophyte consumption on horses subject to a standardized exercise test (SET) in humid conditions. Nine quarter horses (422–568 kg) were assigned into 2 groups of 5 and 4 to equalized skill level. During the first of 2 28 d periods, the groups were randomly assigned to E+ (endophyte-infested seed) or E- treatments (endophyte-free KY-31 seed) and exposed to the opposite treatment during the second 28 d, which followed immediately after the first. Horses were fed alfalfa hay, commercial sweet feed and either E+ or E- ground fescue seed. A molasses-water solution was used to mix the seed with the grain and encourage intake. Diets contained 12% seed, resulting in 459 ppb ergovaline for the E+ diet. Three days a week horses were subjected to a 25 min conditioning program: walk, trot, lope, stops, turns, and suppling exercises. Two days a week horses were trained on a mechanical cow for 5 min (20–25 turns) except on d 14, 28, 42, and 56 when they were ridden on the SET. The SET consisted of 40 turns in 4 min and was designed to raise the horse's heart rate (HR) beyond the anaerobic threshold (~150 bpm). During the SET, humidity averaged 80.3% and temperature averaged 27.3°C. Parameters measured on SET days were HR, respiration rate (RR), rectal temperature (RTemp), and blood lactate (Lac). Data were analyzed by ANOVA with treatment considered a fixed effect and all other effects considered random. Post SET values for Lac confirmed the horses were performing anaerobic work. Treatment had no effect on Lac, RTemp or HR at any time measured. There was a horse effect ($P \leq 0.05$) on post SET RR, HR, and Lac but not RTemp. There was no horse × treatment interaction for these variables. RR did not vary by treatment at rest or 1 min post SET. During the periods when horses consumed E+ seed, RR were higher at 5 and 10 min post SET ($P \leq 0.005$). There was no period effect, period × treatment or period × horse interaction. Horses that consumed E+ versus E- seed maintained higher respiration rates after a SET in which they were subjected to anaerobic work in humid conditions.

Key Words: horse, fescue, exercise

120 Digestibility of oats in horses using the substitution approach. A. D. Woodward*¹, A. Willyard¹, A. Buckley¹, J. Liesman¹, C. F. M. de Lange², and N. L. Trottier¹, ¹Michigan State University, East Lansing, ²University of Guelph, Ontario, Canada.

Limited published information regarding apparent whole tract N digestibility of oats fed as a single protein source is available in horses due to the dietary obligate requirement for forages. The objective of the study was to estimate the apparent whole tract N digestibility of oats using the substitution approach. Six mature Arabian geldings (450 kg) were allocated to 6 diets over 6 time periods in a 6×6 Latin square design. Diets were composed of varying ratios of timothy grass hay and oats fed at 1.6% BW (DM basis), i.e., 1.6:0, 1.45:0.15, 1.3:0.3, 1.15:0.45, 1:0.6, and 0.85:0.75. Diets were formulated and fed to provide equal amounts of CP per kg BW (DM basis); percentage dietary CP contribution from hay and oats were 100:0, 91:9, 83:17, 74:26, 66:34, and 55:45, respectively. Each period consisted of 11-d adaptation to the diet followed by collection of all feces and urine every 8 h over 3 d. Feed, fecal and urine samples were analyzed for N. Apparent whole tract N digestibility was regressed against the contribution level of CP from oats to the total diet, i.e., 0, 9, 17, 26, 34, and 45%. As the level of oats inclusion and contribution of CP from oats increased, apparent whole tract N digestibility tended to increase ($P = 0.08$). The relationship was defined as $y = 0.15 (\pm 0.05)x + 51.90 (\pm 1.45)$ ($R^2 = 0.72$, $P < 0.001$), where y is the intercept and represents the apparent N digestibility of timothy grass hay and x represents the level of CP contribution from oats to the diets. The apparent N digestibility of oats, estimated with $x = 100$, was 67%, and timothy grass hay, with $x = 0$, was 52%. In conclusion, apparent whole tract N digestibility of oats is 67%. The oats N digestibility value estimated using the substitution approach will allow the formulation of equine diets on a digestible protein basis to more efficiently meet protein requirements of horses receiving oats in addition to forages.

Key Words: horse, oat nitrogen digestibility, substitution approach

121 Effect of dietary energy manipulation on mares and their foals: Performance and hormones of mares in late gestation. K. N. Winsco^{*1}, J. A. Coverdale¹, and C. J. Hammer^{2,3}, ¹Department of Animal Science, Texas A&M University, College Station, ²Department of Animal Sciences, North Dakota State University, Fargo, ³Center for Nutrition and Pregnancy, Fargo, ND.

To investigate the effect of dietary DE manipulation on performance and reproductive hormones of mares in the last third of pregnancy, 30 Quarter Horse mares (538 to 695 kg of BW and 4 to 19 yrs of age) were blocked by expected foaling date. All mares were allowed ad libitum access to coastal bermudagrass pasture and randomly assigned within block to one of 2 dietary treatments: pasture (P) or pasture + concentrate (PC; concentrate fed at 0.75% BW on an as-fed basis). Treatments began 110 d before expected foaling date and terminated at parturition. Blood samples were collected every 14 d until parturition and analyzed for progesterone (P4), estradiol (E2), and cortisol (CORT) concentrations. Mare performance parameters (BW, BCS, and rump fat (RF)) were also recorded every 14 d. Data were analyzed using the PROC MIXED procedure of SAS. There was no influence of dietary treatment on mare BW. However, RF and BCS decreased ($P \leq 0.01$) in mares fed P compared with PC. There was no effect of dietary treatment on P4, E2, or CORT concentrations ($P \geq 0.10$). Regardless of diet, plasma P4 concentrations increased steadily over time ($P < 0.01$) from d 70 to d 112 (2.26 to 8.61 mg/ml). There was a tendency for a treatment by time interaction ($P < 0.10$) with plasma P4 concentrations rising sharply in PC mares beginning at d 70 and being greater ($P < 0.05$) than P mares at d 84. Serum CORT was also influenced by time ($P < 0.01$) with concentrations rising sharply before parturition. In addition, there was a treatment by time interaction ($P < 0.05$) with P mares having a rapid decline in plasma CORT until d 42. Serum E2 concentrations decreased sharply over time ($P < 0.01$) from d 42 to d 70 (311.23 to 223.98 pg/ml).

In addition, there was a treatment by time interaction ($P < 0.05$) with PC mares having lower ($P < 0.05$) E2 concentrations than P mares at d 56 and 70. In summary, these data indicate that dietary DE manipulation of mares in late gestation influenced BCS and rump fat values, but not mare BW. Furthermore, dietary manipulation of DE altered mare hormonal response before parturition.

Key Words: mares, energy, pregnancy

122 Evaluation of the capacity for maternal transfer and foal synthesis of long-chain polyunsaturated fatty acids. L. K. Warren^{*}, J. Kivipelto, and E. Gettinger, University of Florida, Gainesville.

Long-chain polyunsaturated fatty acids (LCPUFA), particularly 20:4 ω 6 and 22:6 ω 3, are necessary for normal neural development and are important regulators of cell function. Equine diets typically lack LCPUFA, thus foals presumably acquire LCPUFA via placental transfer, milk or through bioconversion of 18:2 ω 6 and 18:3 ω 3 precursors. Eighteen Thoroughbred ($n = 11$) and Quarter horse ($n = 7$) mares and foals were used to assess the capacity for maternal transfer and foal synthesis of LCPUFA. Mares were offered Coastal bermudagrass hay *ad libitum* and individually fed 1.5% BW/d of concentrate (16.7% CP, 3.8% fat, 10.2% ADF). Fatty acid (FA) composition of colostrum and umbilical cord plasma collected at foaling and milk, plasma and red blood cells (RBC) collected from mares and foals at 5 and 50 d of age was determined. Capacity for LCPUFA bioconversion was estimated as the ratio of 20:3 ω 6/18:2 ω 6 (Δ 5-desaturase activity) and 20:4 ω 6/20:3 ω 6 (Δ 6-desaturase) in plasma. Data were evaluated using the mixed procedure of SAS (v. 9.2). Mare diets were devoid of LCPUFA. LCPUFA were not detected in colostrum, but were present as < 1 g/100 g FA in milk. Cord plasma was higher ($P < 0.01$) in LCPUFA, and lower ($P < 0.01$) in 18:2 ω 6, total ω 6, 18:3 ω 3, and total ω 3 than foal and mare plasma at d 5 and 50. Foal plasma and RBC were higher ($P < 0.01$) in LCPUFA, total ω 3 and 18:3 ω 3, and lower ($P < 0.01$) in total ω 6 and 18:2 ω 6 than mare plasma and RBC at d 5 and 50. Foal and mare plasma were higher in Δ 5-desaturase activity ($P < 0.01$) and lower in Δ 6-desaturase ($P < 0.01$) than cord plasma. Higher LCPUFA in cord plasma indicates capacity for synthesis by the mare and selective placental transfer to the foal. Higher LCPUFA in foal plasma compared with mare plasma likely reflects mobilization of FA deposited in utero, intake from milk, and synthesis of LCPUFA from precursors consumed in milk. Greater Δ 5-desaturase activity in foal compared with cord plasma indicates capacity for 20:4 ω 6 and 20:5 ω 3 synthesis by the foal. However, low Δ 6-desaturase activity in foal plasma suggests fetal stores of LCPUFA are critical to support pre- and postnatal development of neural tissues.

Key Words: DHA, essential fatty acids, horse

123 Profiling the change in fecal microbial populations of mares and foals over time. J. E. Earing^{*1}, A. C. Durig¹, G. L. Gellin², M. D. Flythe², and L. M. Lawrence¹, ¹University of Kentucky, Lexington, ²USDA-ARS, Lexington, KY.

The gastrointestinal tract of the mature horse contains a complex community of microorganisms, many of which aid in digestion. Little information is available concerning the establishment of these microbial populations in young horses. The limited research that has been conducted has utilized culture-dependant methods, but culture-independent methods have revealed that cultivation underestimates species diversity. Polymerase chain reaction-denaturing gradient gel electrophoresis (PCR-DGGE) is a molecular technique that can be used to evaluate diversity in microbial communities. The objective of this study was to compare the microbial profiles of the feces of mares and foals using

PCR-DGGE in an attempt to describe bacterial colonization in the equine gut. The hypothesis was that foals would be born sterile, and would be indistinguishable from mares by 12 wk of age. Nine mare/foal pairs were used for the study. Fecal samples were collected from each mare and foal as the foal matured; samples were subjected to PCR-DGGE. Comparisons between mares and foals were made using UPGMA cluster analysis and reported as percent similarity. The mean similarity between mares and their foals was 11% on the day of parturition (d 0; n = 2), 51% on d 1 (n = 4), 52% on d 4 (n = 3), 67% at wk 2 (n = 4), 71% at wk 6 (n = 5), and 70% at wk 12 (n = 5). These results indicate that most of the colonization events occurred within the first few days of the foal's life, which is consistent with a study utilizing culture-based techniques. By wk 2, the mean similarity between mares and foals was numerically higher than the mean similarity among mares (61%), suggesting that by 2 wk of age the bacterial species found in the foal's gut are similar to those found in the mature horse. While PCR-DGGE can be used to examine the diversity of bacteria present in the gut, it does not estimate the relative abundance of the bacterial populations. Also, the presence of bacterial DNA in feces suggests, but does not prove, colonization of the gut by the respective bacterial populations.

Key Words: DGGE, horse, microbes

124 Stallion spermatozoal parameters of motility and conception rates on a large commercial ranch. A. L. Garcia¹, H. A. Brady*¹, M. A. Ballou¹, D. D. Varner², C. C. Love², and G. Blodgett³, ¹Texas Tech University, Lubbock, ²Texas A&M University, College Station, ³6666 Ranch, Guthrie, TX.

Stallion ejaculate values and variability over a breeding season based large numbers are not available for clinical and research use. Further, there are conflicting reports on the predictive value of motility for fertility in the horse. The objectives of this study were to evaluate ejaculates from a large number of stallions over an entire breeding season with advanced techniques and to evaluate the relationships of motility to conception rates of mares. Semen collections (n = 602) from a total of 19 stallions at a ranch in Guthrie, Texas, were evaluated over the 2008 breeding season. Ejaculates were evaluated using a new advanced system, the NucleoCounter (Chemometric, Allerød, Denmark) and the IVOS system (Hamilton Thorne, Beverly, USA). The mean total sperm, concentration, and gel-free volume were 11.25 billion (± 2.5), 247.6 million/ml (± 72.1) and 50.42 mL (± 15.1), respectively. It was determined there were high inter- and intra-stallion variability in parameters of motility studied. Highest intra-stallion variables were moderately progressive cells (cv = 42.7) and total concentration (cv = 37.7) and the least variable parameters were flagellar beat frequency (BCF) (cv = 5.7) and % linearity (cv = 8.0). Highest inter-stallion variables included mount attempts (cv = 47.5) and % moderately progressive cells (cv = 30.5), and the least variable parameters included the BCF (cv = 7.6) and % straightness (cv = 9.6). An odds-ratio procedure and backward logistical regression procedure was used to calculate the influence of motility and concentration parameters on the pregnancy outcome. A total of 328 on-the farm mares were bred by A.I. with a 91% pregnancy rate. No correlation between motility parameters and the pregnancy binomial status was found; however, all stallions were very fertile and the on-site breedings were under consistent management. In summary, this study has provided important clinical standards on ejaculate values based on a large group of ejaculates using advanced techniques. These values have important clinical implications for more accurate standards within the breeding soundness examination of the stallion.

Key Words: stallion, spermatozoa, motility

125 Weight estimation in miniature horses and Shetland ponies. AM Bruce*, EL Wagner, and PJ Tyler, Auburn University, Auburn, AL.

Reliable weight estimation in the small breeds of horses is critical to the animals' well-being. To properly feed or medicate, bodyweight needs to be as accurate as possible to reduce the risk of error. The 2 common weight estimation practices used for average sized horses are commercially available weight tapes and an established formula, where estimated weight (lbs), (kg) = (heartgirth² × body length)/(330 in³), (11880 cm³). The objectives of this study were 1) evaluate the accuracy of the weight tape and current formula in estimating body weight of the small breed horse and 2) calculate a more exact formula for miniature horses and Shetlands. Fifty-four miniature horses and 15 Shetland ponies of varying ages were measured. Actual weight was determined via a calibrated electronic livestock scale. Other measurements included height at the withers, body length as measured from the point of the shoulder to the point of the buttock, heart girth, and weight tape. Mean age of the animals was 4.23 ± 3.47 years, with a mean height of 92.21 ± 10.36 cm, and a mean body condition score of 6.3 ± 0.85 based on a 9 point scale. Paired *t*-tests were used to compare the tape weight and formula weight with the actual weight. There was a significant difference ($P < 0.05$) between the tape weight (112.66 ± 33.99 kg) and the actual weight (108.71 ± 31.44 kg). The difference between actual weight and the formula estimated weight (100.52 ± 30.83 kg) was also significant. Linear regression was used to determine a more accurate denominator for the formula. Using the new denominator of 11061 cm³ (307 in³) a new mean estimated weight of 108.12 ± 33.16 kg was calculated, which was significantly different from weight calculated by the previous equation. The new denominator appears to be a more accurate method of estimating weight in miniature horses and Shetland ponies. To validate the new equation more miniature horses and Shetland ponies need to be evaluated.

Key Words: weight estimation, body measurements, miniature horse

126 Evaluation of body weight estimation methods in horses. E. L. Wagner* and P. J. Tyler, Auburn University, Auburn, AL.

Weight tapes and body weight estimation formulas are routinely used to help determine the body weight of a horse when a scale is not available. The formula incorporates measurements of body length and heart girth circumference to estimate body weight in mature horses, where estimated weight (lbs), (kg) = (heartgirth² × body length)/(330 in³), (11880 cm³). Two variations of the body length measurement have been published. One measures the distance from the point of the shoulder to the ischial tuberosity (point). The other measures the distance from the point of the shoulder to the midpoint of the distance between the widest part of the stifle and the tail when viewed from the rear (stifle). The objective of this study was to evaluate the accuracy of a commercial weight tape and the body weight estimation formula using both body length measurements in estimating weight of adult horses. Seventy-one horses of various breeds were weighed on a portable livestock scale. Horses were measured for height at the withers, heart girth circumference and body length using the point and stifle measurements. A commercial weight tape was used to estimate body weight on 36 of the horses. Statistical analysis was performed by paired *t*-tests and simple linear regression using STATA statistical software with significance set at $P < 0.05$. Mean height was 159.34 ± 9.27 cm with a mean scale weight of 516.94 ± 81.93 kg. Point body length was significantly longer than stifle body length (170.56 ± 9.27 cm and 161.99 ± 8.14 cm, respectively). This resulted in a significant difference between the formula estimated weights using the 2 length measurements. The 2 formula weight estimations (n = 71)

and the weight tape estimation (n = 36) were significantly different from the actual weight and from each other. The mean difference between actual weight and tape weight (n = 36) was 65.35 ± 46.23 kg, whereas the differences between actual weight and the formula estimations (n = 71) were 19.83 ± 38.99 kg for the point measurement and $43.44 \pm$

39.74 kg for the stifle measurement. The estimation formula using body length measurement with the ischial tuberosity endpoint most closely estimates the actual body weight of the horses.

Key Words: horse, weight estimation