HORSE SPECIES

0385 Effects of high starch and sugar diets on postprandial inflammatory proteins in horses.

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Diets high in starches and sugars (HS) are linked to metabolic disorders in horses. Further, overconsumption of starch can result in digestive disturbances and laminitis. We hypothesize that high starch intake reduces intestinal pH and thus the integrity of the epithelial tight junctions, enabling lipopolysaccharide (LPS) to cross into the blood stream. For this experiment, plasma samples were obtained from mares ($n = 6$) consuming a diet high (HS) low (LS) in starch and sugar (Table 0385). Horses consumed 20% of their DE requirement as concentrate and 80% as mixed grass/legume hay (Table 0385). Concentrate was offered individually in 2 equal feedings (0800 and 1400 h) while hay was group fed in 2 equal feedings following concentrate consumption. Samples were collected on d 1 and on d 90 at 0, 1, 2, 3, and 4 h postconsumption of the assigned diet (0800 feeding), as part of a larger study that investigated postprandial starch responses. Plasma samples were then analyzed for LPS, tumor necrosis factor-α (TNF), interleukin (IL)-6, and IL1β. Lipopolysaccharide was analyzed using a commercial colorimetric assay, TNF and IL1β were analyzed using commercial ELISAs, and IL6 was analyzed using individual antibodies and a previously validated method. Each plasma factor was analyzed using repeated measures (SAS v. 9.3, SAS Inst. Inc., Cary, NC) for fixed effects and interactions of hour, day, and diet, with h 0 values as a covariate. Lipopolysaccharide concentrations were lower in HS horses on d 90 than on d1 ($P < 0.02$) but were otherwise unchanged. IL1β concentrations increased in HS horses 1 h postfeeding compared with LS horses ($P < 0.03$), without any differences between diets at other hours ($P > 0.55$). IL6 concentrations were influenced by hour ($P < 0.01$) but not diet ($P > 0.78$), whereby all horses had elevated IL6 concentrations 1 h postfeeding compared with h 0 ($P < 0.01$). TNF tended to be higher in HS horses than LS horses ($P = 0.07$) but was not influenced by day of study or hours postfeeding ($P > 0.51$). Consuming a high starch and sugar diet briefly elevates plasma IL1β, but this is most likely not due to elevated LPS concentrations. Of further interest was the finding that all horses, regardless of diet, had elevated postprandial IL6 concentrations.

Key Words: interleukin-1β, high-starch diet, horse, inflammation

Table 0385. Diet composition

Nutrient, %DM basis	LS	HS	Hay
Water soluble carbohydrates	6.8	8.4	6.7
Starch	3.0	50.6	2.2

0386 Evaluation of conjugated linoleic acid supplementation on markers of joint inflammation and metabolism in young horses challenged with lipopolysaccharide.

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Seventeen yearling Quarter horses were used in a randomized complete block design to evaluate potential of dietary CLA to mitigate intra-articular inflammation and cartilage metabolism following a single inflammatory insult. Horses were blocked by age, BW, and sex and randomly assigned to treatment for a 56-d trial. Treatments consisted of a commercial concentrate offered at 1% BW (as-fed) supplemented with either 1% soybean oil (CON; $n = 6$), 0.5% soybean oil and 0.5% CLA (LOW; $n = 5$; Lutalin, BASF Corp.), or 1% CLA (HIGH; $n = 6$; 55% purity) top-dressed daily. Horses were fed individually at 12-h intervals and offered 1% BW daily (as-fed) coastal bermudagrass (*Cynodon dactylon*) hay. On d 42, a lipopolysaccharide (LPS) challenge was conducted. Carpal joints were randomly assigned to receive intra-articular injections of 0.5 ng LPS derived from *Escherichia coli* 055:B5 or sterile lactated Ringer's solution as a contralateral control. Synovial fluid samples were taken via arthrocentesis at preinjection h 0 and 6, 12, 24, 168, and 336 h postinjection, and were analyzed for prostaglandin E_2 (PGE_2), carboxypeptide of type II collagen (CPII), and collagenase cleavage neopeptide (C2C) using commercial ELISA kits. Vitals, including heart rate, rectal temperature, and respiration rate were monitored at 0, 6, 12, and 24 h; and carpal circumference and surface temperatures were also recorded. Data were analyzed using PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Vitals were not significantly different across treatments ($P \geq 0.13$) and remained within normal ranges throughout the LPS challenge. Synovial PGE_2 concentrations were not influenced by dietary treatment ($P = 0.15$). Synovial C2C concentrations were influenced by treatment ($P = 0.05$) with LOW and HIGH horses having lesser C2C than CON. Across all treatments C2C concentrations varied over time ($P < 0.01$) with values decreasing from 0 to 6 h, peaking at 12 h and decreasing to 336 h. Levels of synovial CPII tended to be influenced by treatment ($P = 0.10$) with LOW and HIGH horses having greater concentrations compared with CON. Regardless of diet, CPII concentrations increased over time ($P < 0.01$) with levels peaking at 24 h and decreasing to 336 h. In

conclusion, CLA supplementation did not influence PGE_2 concentrations following the LPS challenge; however, horses receiving CLA had lesser C2C and greater CPII concentrations, indicating less degradation and greater synthesis of cartilage in response to acute inflammation.

Key Words: conjugated linoleic acid, synovial, lipopolysaccharide, cartilage

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0387 Age-related effects on markers of inflammation and cartilage metabolism in response to an intra-articular lipopolysaccharide challenge.

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Eighteen Quarter horses were utilized in a randomized complete design to evaluate age-related effects on inflammation and cartilage turnover after induction of a single inflammatory insult using lipopolysaccharide (LPS). Treatments consisted of age with yearlings ($n = 3$ males, $n = 3$ females), 2 and 3 yr olds ($n = 2$ males, $n = 4$ females), or mature 5 to 8 yr olds ($n = 2$ males, $n = 4$ females) for a 14-d experiment. For 14 d before the start of the experiment, all horses were housed in individual stalls and fed diets that met or exceeded NRC (2007) requirements. On d 0, horses were challenged with an intra-articular injection of LPS. Radial carpal joints were randomly assigned to receive LPS using 0.5 ng LPS solution obtained from *Escherichia coli* O55:B5, or sterile lactated Ringer's solution as a contralateral control. Synovial fluid was collected before LPS injection (0 h) and 6, 12, 24, 168, and 336 h postinjection. Samples were later analyzed using commercial ELISA kits for prostaglandin E_2 (PGE_2), collagenase cleavage neoepitope (C2C), and carboxypeptide of type II collagen (CPII). Rectal temperature (RT), heart rate (HR), and respiratory rate (RR) were monitored before sample collection over the first 24 h, and carpal circumference and joint surface temperature were recorded. Data were analyzed using PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). All values for RT, HR, and RR were within normal range and unaffected by treatment ($P \leq 0.21$). Joint circumference was not influenced by treatment ($P = 0.84$), but circumference and surface temperature increased ($P \leq 0.01$) across all treatments in response to intra-articular LPS. Synovial PGE_2 levels were influenced by age with yearlings tending to have lesser ($P = 0.09$) values than 2 and 3 yr olds and mature horses. This was particularly evident at 12 h, when PGE_2 values peaked for all horses and yearlings had lesser values ($P \leq 0.01$) than mature horses. Synovial C2C was influenced by treatment, with yearlings and 2 and 3 yr olds having lesser ($P \leq 0.01$) concentrations than mature horses. Synovial CPII was influenced by treatment at 24, 168, and 336 h, with yearlings having lesser concentrations ($P \leq 0.01$, $P \leq 0.06$, and $P \leq 0.03$, respectively) compared with 2 and 3 yr olds and mature horses. These results indicate that inflammation and corresponding cartilage turnover in response to LPS administration vary with age.

Key Words: lipopolysaccharide, horse, synovial fluid, prostaglandin E_2, type II collagen, collagenase cleavage neoepitope

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0388 The effect of restricted diet and slow-feed hay nets on body weight and morphometric measurements in adult horses.

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Horses evolved to consume several small, frequent meals throughout the day. However, modern horse care has resulted in many horses being stalled for large portions of the day, and meal fed, therefore decreasing their ability to forage. This management scheme has likely contributed to the increase in obesity in the equine population. The use of slow-feed hay nets represents an opportunity to extend foraging time while restricting forage intake. Therefore, the objective of this study was to determine if restricted feeding, coupled with increased time to forage, would lead to weight loss in overweight adult horses. Eight adult Quarter horses (BW 562 kg ± 2 kg) were used in a completely randomized design, with 4 horses assigned to a control (C) of feeding hay off the stall floor, and 4 horses assigned to feeding from a slow feed (3.2-cm openings) hay net (SN). Horses were fed at 1.08% BW, split evenly between 2 meals. A ration balancer was fed at recommended levels during the morning feeding. Body weight, via a livestock scale, and BCS were measured on d 0, 7, 14, 21, 28, and 35. Morphometric measurements, including neck and girth circumference and cresty neck score, a system developed to estimate the level of adiposity on the crest of the neck using a 0 to 5 scale, were taken on d 0, 14, 21, and 35. Ultrasound measurements of average rump fat, longissimus dorsi (LD) depth, and LD thickness were taken on d 0, 21, and 35. Data were analyzed using the Proc Mixed procedure of SAS (SAS Inst. Inc., Cary, NC). All horses lost weight over the 35-d period ($P < 0.0001$); however, no difference was observed between the SN and control. Horses on the SN lost an average of 40 kg, while horses on the C lost an average of 32 kg. There was no difference observed in BCS, neck and girth circumference, or cresty neck score during the study or between treatments ($P \geq 0.25$). Additionally, no differences were observed in rump fat, LD depth, or LD thickness during the study or between the treatments ($P \geq 0.32$). While all horses lost weight on the restricted diet, the use of a slow feed hay net did not have an effect on weight loss or morphometric measurements during the 35-d study.

Key Words: restricted diet, weight loss, slow-feed hay net

0389 Influence of diet fortification on mature horses at maintenance: Performance characteristics.

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Twenty mature horses (413 to 551 kg and 5 to 10 yr) were utilized in a randomized complete block design to evaluate the effect of dietary fortification on performance variables and immune status in mature horses. Horses were blocked by BW, with BCS, age, and sex randomly assigned and evenly distributed across treatments for a 154-d trial. Dietary treatments consisted of a pellet meeting NRC 2007 requirements (Control; $n = 10$), or the same pellet (Fortified; $n = 10$) including: enhanced AA, increased vitamin E, complexed trace minerals, prebiotic (140 g per d dehydrated *Saccharomyces cerevisiae* yeast fermentation product), and probiotic (min 2.3 million CFU/kg each of *Lactobacillus acidophilus, L. casei, Bifido bacterium bifidium,* and *Enterococcus faecium*) fermentation products dehydrated. Dietary treatments were offered individually at 0.25% BW at 12-h intervals. Horses were housed by block and maintained in adjacent dry lots with ad libitium access to coastal Bermudagrass (*Cynodon dactylon*) hay. Body weight and BCS were obtained every 14 d, with concentrate adjusted accordingly. Ultrasound images were obtained every 28 d to determine rump fat (RF), longissimus dorsi area (LDA), and longissimus dorsi fat thickness (LDF). Blood samples were also collected at 28-d intervals to determine circulating white blood cell counts (WBC) utilizing a Celdyne 3700 cell counter (Abbott Industries, Abbott Park, IL). Data were analyzed using the PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Body weight and BCS were not influenced ($P = 0.11$ and $P = 0.25$, respectively) by dietary treatment. However, all horses gained BW and BCS throughout the trial ($P \leq 0.01$). Longissimus dorsi area and LDF were greater ($P \leq 0.01$) for horses fed Fortified pellets compared with Control. Similarly, RF measurements increased ($P \leq 0.01$) in the Fortified diet beginning at d 56 of the trial. Whole blood WBC was greater ($P \leq 0.01$) in the Fortified diet when compared with Control. These results indicate the addition of fortification may improve the ability of horses to mount an immune response as well as increase muscling and rump fat when fed to mature horses.

Key Words: organic trace mineral, amino acid probiotic, horse, immune response

0390 The effect of small-square feeder design on hay waste, herd weight change, and economics during outdoor feeding of adult horses.

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Hay waste during feeding represents a costly expense for horse owners. Researchers have investigated hay waste associated with feeding round-bales and small-square bales in boxstalls, but none have investigated the waste of small square-bales fed outdoors. The objectives of this study were to determine hay waste, herd weight change, and economics of small square-bale feeders when used in outdoor feeding of adult horses. Feeder designs included a hayrack ($280), slat feeder ($349), basket feeder ($372), and a no-feeder control. Two feeders of each type were placed in 4 separate, outdoor, dirt paddocks. Twelve adult mares (BW 503 ± 36 kg) were divided into 4 similar groups each containing 3 mares. Groups were rotated through the 4 paddocks in a Latin Square design. Herds remained in each paddock for 7 d, including 2 d of acclimation and 5 d of data collection. Horses were weighed immediately before and after the 5 d data collection period; the difference was herd weight change. Horses were fed grass hay at 2.5% of the herd body weight split evenly at 0800 and 1600 h. Waste hay on the ground was collected daily before each feeding, dried, and weighed. Any hay remaining inside the feeder was collected, dried, weighed, and subtracted from the amount fed. The daily amount of hay removed from the ground was considered waste. The number of months to repay the feeder cost (payback) was calculated using hay valued at $250/t, and improved efficiency over the control. Mean hay waste was 13, 5, 2, and 1%, for the control, hayrack, basket feeder, and slat feeder, respectively. All feeders resulted in less hay waste compared with the control ($P \leq 0.0001$), and a difference was measured between the hayrack and slat feeder ($P = 0.0175$). Herd weight change was different among all feeders ($P \leq 0.0074$). Herds gained 10 and 7 kg when feeding from the basket feeder and hayrack, and lost 3 and 11 kg when feeding from the slat feeder and control. The basket feeder, hayrack, and slat feeder paid for themselves in 11, 11, and 9 mo, respectively, with the slat feeder resulting in a shorter payback ($P \leq 0.0140$). Use of a small square-bale feeder resulted in less hay waste compared with the control, and all feeders paid for themselves within 11 mo. This information will aid horse owners when purchasing small square-bale feeders.

Key Words: hay waste, hay feeder, payback

0391 Influence of ambient temperature and relative humidity on recovery from exercise in young horses. J. L. Lucia*[1], K. S. Carlson[1], M. J. Anderson[1], K. W. Walter[2], K. J. Stutts[1], M. M. Beverly[1], and S. F. Kelley[1], *[1]Sam Houston State University, Huntsville, TX, [2]Truman State University, Kirksville, MO.*

Heat stress affects many livestock species, but horses are a particular concern due to the regular exercise they receive. To determine the influence of ambient temperature on exercise recovery in young horses, fourteen Quarter horses (2 to 5 yr; 338 to 540 kg) were utilized in a randomized complete block design. Horses were blocked by BW, age, and sex, and randomly assigned to 1 of 2 groups that included horses performing a 25-min standardized exercise test at either 0600 h (AM; $n = 7$) or 1300 h (PM; $n = 7$). The ambient temperature for the AM was 23.31°C (83.9% relative humidity), while the ambient temperature for the PM was 34.70°C (40.8% relative humidity). Whole blood lactate (LAC), total plasma protein (TP), heart rate (HR), respiration rate (RR), rectal temperature (RT), and ocular temperature (OT) were obtained immediately following (0 min) exercise, and during a recovery period (5, 15, and 30 min post-exercise). Differences in parameters measured were determined using the PROC MIXED procedure in SAS (SAS Inst. Inc., Cary, NC). Clinical parameters, including HR, RR, and RT, were greater ($P = 0.03$) in the PM beginning at 5 min of recovery and remained elevated at 30 min postexercise when compared with the AM. Additionally, OT was higher ($P \leq 0.01$) in the PM at 0 min, and values remained higher through 30 min postexercise. Similar to OT, LAC was greater ($P \leq 0.01$) at 0 min in the PM (12.72 ± 1.84 mmol/L) compared with the AM (4.94 ± 1.84 mmol/L), with lactate values in the PM (8.79 ± 1.13 mmol/L) continuing to be greater than the AM (2.25 ± 1.13 mmol/L) at 30 min following exercise. No differences were detected in TP ($P = 0.18$) between exercise groups, suggesting the exercise intensity did not alter extracellular fluid loss within plasma. Respiration rate, OT, and RT remained elevated through recovery, demonstrating an impaired ability to dissipate heat due to the higher ambient temperature during exercise. Lactate values in the PM illustrated that horses exercising at a higher ambient temperature required an increased recovery time due to the increased demands of anaerobic metabolism. Understanding the physiological responses during recovery of exercise at different temperatures may enable industry professionals to adapt daily exercise regimens to better prepare the equine athlete to perform at their full potential.

Key Words: heat stress, exercise, equine

0392 Commercial application of the follicular ablation technique in mares. S. E. Buist*, A. K. Sexten, D. M. Grieger, C. A. Blevins, J. S. Stevenson, and J. M. Kouba, *Kansas State University, Manhattan.*

Two experiments were conducted to determine the practicality of utilizing ultrasound-guided follicular ablation in a commercial setting. The objective of the initial experiment was to investigate the efficacy of follicular ablation as a technique for ovulation synchronization when compared with a standard progesterone and estrogen (P&E) protocol. Twenty nonpregnant mares were assigned to an ablation (AB) or P&E group. Briefly, AB mares ($n = 10$) were subjected to ablation for removal of all follicles larger than 10 mm on d 0 and administered PGF2α twice on d 5. Mares were administered hCG on d 11 and subjected to ultrasound twice per day until ovulation was detected. Mares in the P&E group ($n = 10$) were scanned at initiation of the protocol and received P&E IM once a day for 10 d. On d 10, mares received PGF2α and ultrasound monitoring began on d 15. On d 18, mares were administered hCG and evaluated twice per day until ovulation was detected. The interval from initiation of synchronization to ovulation (10.4 vs. 19.1 d, $P < 0.0001$) and the interval from hCG administration (1.2 vs. 2.3, $P < 0.0001$) was shortened in the AB group. Ablation may be an acceptable nonsteroidal alternative to the conventional P&E protocol. The objective of the second experiment was to determine if ablation could lengthen the postpartum interval to ovulation to increase the chance of conception postfoaling. Eighteen postpartum mares were assigned to an AB or control (CON) group. On d 6 postpartum, AB mares ($n = 9$) were subjected to follicular ablation for removal of all follicles larger than 10 mm. Mares were administered PGF2α twice on D11 and monitored via ultrasound once per day until a follicle $\geq$ 35 mm was detected, at which time they received hCG. Following hCG, mares were monitored twice per day until ovulation was detected. The CON mares were evaluated using ultrasound, beginning d 4 postpartum and continuing every other day until a follicle $\geq$ 30 mm was detected, and scanning frequency increased to once per day. When a follicle $\geq$ 35 mm was identified, mares were administered hCG and monitored twice per day until ovulation was detected. Ablation lengthened the interval from foaling to ovulation (15.9 vs. 10.0, $P = 0.003$). Increasing the interval from foaling to ovulation is known to increase conception rates; therefore, the application of this procedure could be utilized to optimize the timing of breeding to improve conception outcomes. These experiments demonstrate commercial application of follicular ablation and are evidence for incorporating this procedure in a commercial setting.

Key Words: mares, follicle ablation, postpartum ovulation