ABSTRACT: Recently, the Food and Drug Administration and Association of American Feed Control Officials approved Black Soldier Fly (BSF) larvae as a feed ingredient for poultry. The objectives of this work were 1) to formulate nutritionally balanced hen diets with BSF larvae meal and BSF larvae replacing corn and soybean meal, and 2) measure the impact of the dietary BSF treatments on hen performance and egg quality. In two experiments, BSF larvae meal (Exp 1, larvae with oil expressed) and BSF larvae (Exp 2, whole larvae) were fed to White Leghorn hens from 51 to 55 and 60-64 wks of age, respectively. The 216 hens were divided into 4 groups of 54 hens with one control group and 3 treatment groups. The hens were fed iso-caloric, iso-nitrogenous diets that had 3 dietary treatment levels of BSF larvae meal (8, 16 and 24%) and 3 levels of the larvae (6, 12 and 18%). Data were analyzed by one-factor ANOVA with the GLM procedure of SAS software (SAS, 2012) for the main effect of diet. Tukey’s multiple comparison was used for mean separation when the F-test was significant ($P<0.05$). Results obtained from Exp 1 found a negative impact when hens were fed BSF larvae meal at levels greater than 16%. Hens fed a diet devoid of soybean meal and completely replaced with meal had reduced feed consumption and egg production ($P<0.05$). Percent egg production averaged 85.14% for the control, 8 and 16% meal fed treatments and was significantly greater than hens were fed 24% meal at 77.01%. However, intermediate dietary meal levels (8 and 16%) had no negative impact on performance parameters and were not significantly different than hens fed the control diet. Yolk color was also significantly higher among the larvae meal treatments compared to the control. In Exp 2 hen body weight averaged 1737g, egg production 85.02% and egg size 64.17g and were not significantly impacted by the BSF larvae diets compared to the control ($P > 0.05$). However, feed intake and feed conversion (kg egg/kg feed) were significantly reduced by greater dietary levels of larvae ($P < 0.05$). Measures of egg quality including blood spots, meat spots and yolk color were not impacted by the treatment diets ($P > 0.05$), although egg specific gravity was higher ($\bar{x}=1.075$ vs. 1.073) and albumen height ($\bar{x}=7.99$ vs. 8.55) and Haugh units ($\bar{x}=87.54$ vs. 91.28) were lower among the treatment eggs compared to the controls ($P < 0.05$). Egg yolk fatty acid profile was also impacted by the BSF larvae dietary treatments. Greater amounts of yolk fatty acids C12:0, C14:0, C14:1n5 and C21:0 were realized with increasing dietary levels of larvae ($P < 0.05$), however, there was no impact of the treatments on C18:2, linoleic acid or C18:3n3, alpha-linolenic acid ($P > 0.05$). It appears from these experiments that both BSF larvae and meal can be used as dietary sources of energy, protein, and amino acids for hen maintenance and egg production although there may be upper dietary limits. Furthermore, egg yolk fatty acid profiles can be impacted based upon the dietary levels of BSF larvae in the diet to reflect a more desired fatty acid profile at the manufacturer’s discretion.
EFFECTS OF BUTYRATE ON NITROGEN CORRECTED APPARENT METABOLIZABLE ENERGY OF BROILER CHICKS

Becky Y. Tran*, Michael Persia
Virginia Tech
Department of Animal and Poultry Sciences
175 West Campus Drive,
Blacksburg, VA 24061

*Email: beckyt3@vt.edu

ABSTRACT: In recent years, there has been pressure to find alternatives that can either replace or reduce the use of antibiotics in the poultry industry. As the intestines are the largest organ of the body, intestinal health has a tremendous effect on overall performance and nutrient utilization. Butyrate is a short-chain fatty acid that has the potential to promote the growth and proliferation of intestinal cells as a method to improve performance in the absence of feed antibiotics. The supplementation of a protected butyrate (designed to delay absorption of butyrate until it reaches the intestine) to growing broiler chicks should increase the intestinal health of broiler chickens resulting in an increase in nitrogen corrected Apparent Metabolizable Energy (AMEn). A control and protected butyrate diet were formulated and fed to six cages of 8 Cobb 500 broiler chicks for each treatment in this preliminary experiment. Chicks were provided ad libitum access to experimental diets and water. The chicks were wing banded and weighed individually at day 0, 16. Feed offered and refused was measured over the 16 day experimental period. On experiment day 14, the excreta pan below each cage were cleaned of excreta and clean paper was added. Excreta samples were taken from excreta collected from 14 to 16 days. Excreta samples were dried and analyzed for gross energy, nitrogen and titanium. Although there were no significant differences in body weight gain (P = 0.46) and mortality corrected feed conversion ratio (P = 0.70) between treatments, this was not unexpected as no challenge was provided to the birds and growing conditions were sanitary. However, the AMEn tended to be increased by 105 kcal/kg when butyrate was added to the diet in comparison to the control fed broilers (P = 0.10). This positive AMEn response could be due to increased intestinal health resulting in the increased nutrient absorption. Although not a direct replacement of antibiotics, it appears that butyrate can be used to potentially promote intestinal health resulting in increased nutrient absorption of broiler chickens.
ABSTRACT: An extract of the mushroom Agaricus blazei (ABE) was provided to commercial laying hens as the water supplement Agaricus Bio-CX manufactured by Atlas World USA, Inc. Pasadena, CA. Three levels of supplementation corresponding to 0.5, 1.0 and 3.0 times the manufacturer’s recommendations were provided to 10 replicate cages of hens per treatment and compared to Control birds receiving pure water during a 3 period (28 days/period) study. Body weight, feed intake, water intake, egg production and egg quality including egg weight, albumen height, Haugh units, specific gravity, blood spots, meat spots and yolk color were measured each period. Data were analyzed by one-factor ANOVA with the GLM procedure of SAS software (SAS, 2012) for the main effect of diet. Tukey’s multiple comparison was used for mean separation when the F-test was significant (P<0.05). The results indicated that the ABE had no significant impact on body weight or feed consumption during the 3-period study (P > 0.05). Egg production averaged 78.87% in period 1, 77.17% in period 2 and 74.08% in period 3, however, there were no significant differences due to the ABE treatments (P > 0.05). Feed conversion was not impacted by the ABE supplement in any time during the 3 periods (P > 0.05). Water consumption averaged 159.5 g/bird/day in period 1, 164.0 in period 2 and 164.5 in period 3, however, there were no significant treatment differences (P > 0.05). Neither was the water to feed intake ratio affected by the ABE treatments (P > 0.05). For egg quality no significant treatment effects on specific gravity, egg weight, blood or meat spots were observed (P > 0.05). In period 3, egg yolk color was significantly affected, but resulted in no biological significance with the levels of inclusion of ABE in the water (P > 0.05). In period 2, there was a linear impact of ABE on albumen height (P= 0.0057) and Haugh units (P =0.0126) suggesting lower quality with great inclusion of the ABE. Finally, no mortality was observed in the 3-period study (P > 0.05). These results suggest that ABE provided at 0.5, 1.0 and 3.0 times the manufacturer’s recommendations, had no negative impacts on standard measures of hen performance and do not indicate any safety hazard.
ABSTRACT: Grazing muzzles are a popular and effective management tool used to prevent weight gain in obese-prone equids. Concerns have been raised over the possible negative impacts they may have on horse welfare; muzzles interfere with social activities by masking facial expressions and prevent grooming and biting. The objective of this study was to assess the effects of grazing muzzles used for different lengths of time on voluntary exercise and physiological stress of horses housed in a herd. Six mature miniature horses (initial BW of 114.9 ± 11.4 kg and BCS of 6.0 ± 0.8) were studied during the fall 2018. The study was a 3x3 Latin Square design with two horses receiving one of three treatments over three 21 d periods. Treatments were no muzzle (M0), muzzled for 10 hr (M10, 0830 to 1830 h), or muzzled for 24 hr (M24). After 10 d acclimation to research conditions, horses were housed as a herd on a 0.6 ha grass pasture for 24 hr/d. Each day at 0800h, horses were groomed, fed a vitamin and mineral supplement, and then had muzzles re-applied at 0830h. Reaction to muzzle application was scored daily using a 1 (accepts) to 5 (strongly rejects) scale. Body morphometrics of horses and forage characteristics including height were assessed at start and end of each period. Physiological responses to muzzling were assessed weekly using salivary cortisol concentrations and changes in heart rate (HR) and heart rate variability (HRV). Voluntary exercise was measured for 24hrs on days 13 and 20 of each period using a GPS device. Data were analyzed as repeated measures with treatment and week as main effects. Muzzling horses for 24 hrs/d resulted in an average weight loss of 0.5 kg compared M0 and M10 horses which both gained an average of 1.5 kg (P = 0.01). There were no effects of treatment on body condition score, cresty neck score, abdominal circumference, or girth circumference. Muzzling horses for 24 hrs/d resulted in a lower HR compared to M0 horses (P = 0.01) and a higher HRV compared to M0 and M10 horses (P = 0.01, P = 0.03, respectively). There were no effects of treatment on muzzle acceptability score, salivary cortisol concentrations, or amount of voluntary exercise. Muzzling horses for 24 hrs/d was effective at preventing weight gain, whereas muzzling for 10 hrs was not. Compensatory grazing after muzzles were removed may explain weight gain experienced by M10. Changes in HR and HRV in M24 demonstrated an altered response of the autonomic nervous system most likely related to the effects of feed restriction and BW loss.
MICROBIOME EFFECTS ON METABOLIC EFFICIENCIES IN EASY AND HARD KEEPERS

Alexa Johnson* and Amy Biddle
University of Delaware
Department of Animal and Food Sciences
045 Townsend Hall
Newark DE, 19716 USA

*Email: alexaj@udel.edu

ABSTRACT: Horses with two classically differing metabolic tendencies are referred to as “easy keepers” (EK) or “hard keepers” (HK). These tendencies are often related to the Henneke Body Condition Scoring system where an EK easily maintains a BCS ≥ 6 and HK is a ≤ 4 and struggles to maintain a BCS of 5. A third classification is the “medium keepers” (MK) who can easily maintain a BCS=5. The goal of this study is to determine how the microbiome contributes to these metabolic tendencies by identifying differentially abundant bacteria in each group and inferring functional differences. Samples of fecal matter from 97 horses (63 EK, 22 MK, and 12 HK) underwent microbiome profiling via 16S rRNA gene sequencing; the keeper status was self-reported by equine owners. No significant differences were seen in bacterial α and β diversities between keepers. Keeper status significantly correlated with differing microbial compositions with 11 genera and 5 pathways across all groups and 12 genera and 162 pathways detected between EK and HK. Differing genera found between EK and HK included Solibacillus, Acinetobacter, and Akkermansia. Reduced abundances of Bacilli (lactic acid producers), Gammaproteobacteria and Verrucomicrobiae (utilizers of amino acids (AA) and secondary metabolites) in HK suggests that these animals are less efficient at accessing nutrients in the hindgut. KEGG functions were inferred using PICRUSt, and significant differences were determined at $p$-adj < 0.05 using negative binomial distribution in DeSeq2. Significant KEGG IDs were then mapped to KEGG pathways using KEGG mapper. Across all groups, KOs associated with Starch and Sucrose Metabolism were most different, however metabolism of specific amino acids, secondary metabolites, and key transporter groups were distinct between keeper groups. HK contained the least bacterial and KO ID abundances, followed by EK and MK respectively. Based on these data, we hypothesize that MK are the most efficient at nutrient digestion and host absorption, and that reduced bacterial abundance and functionality in HK leads to insufficient nutrient levels to support a healthy microbiome and maintain horse condition.
POLYHALITE REDUCES URINE PH IN NON-LACTATING COWS WITHOUT AFFECTING DRY MATTER INTAKE

Emily S. Richardson*¹, Gonzalo Ferreira¹, Robert J. Meakin²
¹Department of Dairy Science, Virginia Tech, Blacksburg, VA,
²Sirius Minerals, Scarborough, England

*e-mail: remily95@vt.edu

ABSTRACT: Polyhalite is a natural mineral that could be fed as an acidogenic product to induce metabolic acidosis and prevent hypocalcemia in dairy cows after calving. The objectives were to determine if feeding polyhalite is an effective means of reducing urine pH and if feeding polyhalite negatively affects dry matter intake during the prepartum period. Twenty-four non-lactating and pregnant Holstein cows entering their second or greater lactation were fed one of four experimental close-up diets. The experimental diets included (DM basis) 48% corn silage, 25% grass hay, and 27% of one of four pelleted concentrates, which provided: 1) no acidogenic product (CON), 2) 200 g/day of polyhalite (LOW), 3) 400 g/day of polyhalite (HIGH), and 4) 250 g/day of calcium chloride (CHL). At 21 days before their expected calving date (ECD), cows were transferred from the far-off to the close-up group. While in the close-up group, cows were fed individually using a Calan gate feeding system. Dry matter intake was measured individually on a daily basis. On days -21, -14, -7, and 0 relative to ECD, urine samples were collected after vulva stimulation in the morning before feeding. Urine pH was determined immediately after collection using a portable pH meter. Data were analyzed with Proc MIXED of SAS. The statistical model included the fixed effects of diet, day, and diet by day and the random effects of block and block by diet. Both variables were tested using the autoregressive covariance structure for repeated measures (cow = subject). Urine pH differed among diets (P < 0.01). Cows consuming CON and LOW had the highest urine pH (8.06 and 8.02, respectively), and cows consuming HIGH and CHL had the lowest urine pH (6.35 and 6.70, respectively). Dry matter intake did not differ among diets (13.7 kg DM/d; P > 0.83) but decreased towards calving (P < 0.01). Dry matter intake towards calving decreased similarly for all diets (P > 0.76). In conclusion, feeding polyhalite is an effective means for inducing metabolic acidosis without reducing dry matter intake. Based on these results, polyhalite should be fed at a dose of 400 g or more per cow per day to reduce urine pH.
IMPLEMENTATION OF A CHEW-SENSOR BASED TECHNOLOGY AS A TOOL FOR EQUINE GRAZING RESEARCH: A PILOT STUDY

Jennifer R. Weinert*, Jessica Werner, and Carey A. Williams
Rutgers, The State University of New Jersey
Department of Animal Science
84 Lipman Dr., Bartlett Hall
New Brunswick, NJ 08901

*Email: Jennifer.weinert@rutgers.edu

ABSTRACT: Field studies characterizing grazing activity in horses primarily rely on observational protocols, which may limit the quantity and accuracy of collected data. The objective of this study was to validate an automated chew-sensor technology, the EquiWatch System (EWS), based on the RumiWatch System (Itin+Hoch GmbH, Liestal, Switzerland), for detecting grazing behaviors of horses on pasture and to demonstrate potential applications of the EWS in equine grazing research. Eight mature standardbred mares were used in this study. In validation phase I, two horses per day were fitted EWS halters and observed over two 2-hour periods using one-minute scan sampling with four replications per horse. In phase II, twelve 5-min grazing videos were recorded per horse and subsequently viewed at half-speed to count prehensile bites (PB) and mastication chews (MC). Agreement between visual observations and the EWS output was evaluated using the CORR procedure in SAS (v.3.7.1. SAS Institute, Inc., Carey, NC). The correlation between observed and system-recorded grazing time was high (concordance correlation coefficient [CCC] = 0.997). While the EWS was not able to differentiate between and accurately count PB and MC, there was high agreement between the sum of PB and MC and total chews reported by the EWS (CCC = 0.979). Following validation, a pilot study was conducted utilizing the EWS to assess grazing behavior of horses with unrestricted access to late-fall cool-season mixed grass pasture (PAS) vs. horses offered ad libitum grass hay (HAY). The same eight mares, fitted with EWS halters, were assigned to either PAS or HAY in a randomized cross-over design in which each 7-day treatment period was preceded by a 1-week acclimation to the new forage type. Hourly and 24-h summaries were generated by the EWS software. For subsequent analysis, EWS data was trimmed to four days per treatment to avoid potential biases from inclement weather (snow or heavy rain) or a meal effect on days when hay was replenished in HAY. Data was analyzed in SAS using PROC MIXED with horse as the random factor and day as a repeated measure. Horses spent more time engaged in feeding behavior on PAS (14.8 ± 0.5 h/d) than on HAY (11.3 ± 0.5 h/d; P<0.0001). Total chews (PAS 75,742 ± 2257; HAY 46,400 ± 2257) and chewing rate (PAS 83.8 ± 1.6; HAY 67.6 ± 1.6 chews/min) also differed by forage (P < 0.0001). The duration of feeding bouts was longer in PAS (102.6 ± 7.7 min/bout) than HAY (76.8 ± 7.7 min/bout; P < 0.0001), while the number of feeding bouts per day was greater in HAY (11.4 ± 1.2 bouts/d) compared to PAS (9.35 ± 1.2 bouts/d; P = 0.05). In analysis of 24-hr feeding patterns, there was a significant forage*time interaction for both feeding time and chewing rate (P < 0.004). These results demonstrate that the EWS can generate data necessary for more fully characterizing feeding behavior in horses, while additionally suggesting that forage type influences these behaviors. Future studies implementing this tool could provide greater understanding of biological, environmental and nutritive factors driving grazing behavior in horses.