Implications

Dietary protein level must be adequate to meet the needs of the exercising horse. Additional protein over maintenance is needed for muscle hypertrophy, repair of muscle fibers and maintenance of new muscle mass as well as replacing any nitrogen lost in sweat. Excess protein may be detrimental however, due to increased production of urea which will increase urination and exacerbate water losses during exercise. Urea conversion to ammonia in the stable can irritate the respiratory tract of the confined horse. Also, protein is thermogenic so high intakes will increase the heat load. Moreover, protein is acidogenic because its oxidation yields sulfate and phosphate and will increase the endogenous acid load. Increasing hydrogen ion concentration in the muscle fiber as well as increased core temperature contributes to fatigue during strenuous exercise. Restricting dietary protein may reduce or avoid these harmful effects of protein but risk deficiency. Although studies have found that horses are able to maintain their body weight on very low levels of protein, the type and quality of the protein should be evaluated carefully. Supplementing the diet with any limiting amino acids can improve the quality of the protein without increasing the overall protein level and can avoid an adverse effects on muscle hypertrophy with limiting amino acids.

Results of these studies have shown that a level of 7.5% CP supplemented with lysine and threonine was adequate for exercising horses for a period up to 26 weeks. Plasma total protein and albumin levels were maintained within normal ranges reported for horses. Plasma urea-N, urine urea and urine uric acid varied with dietary protein level as expected. Creatinine levels were not different in the first study and were higher for low protein only in combination with high fat for the second experiment. This may represent more lean body mass in the LPHF group.

Furthermore, the lower level of protein moderated acid-base responses during repeated sprints. Low protein resulted in higher pH, HCO₃⁻, Na⁺, K⁺ and a tendency for
Higher SID. The influence of the LP diet on pH and HCO\textsubscript{3}\textsuperscript{-} was mainly due to SID more so than the HP diet which was influenced mainly by pCO\textsubscript{2}. This difference in SID points to changes in metabolism due to the lower level of protein that affected acid-base balance. It was interesting to note that the effect of protein was particularly evident in combination with high fat diets such as was found in the second experiment. This shows a connection between fat adaptation and protein metabolism.

Lowering protein can also alter DCAD because protein contains sulfur and phosphorus. This fact was evident in the first experiment but not the second. Widening the DCAD has been found to increase pH and HCO\textsubscript{3} levels in blood and may delay fatigue. This can be achieved by increasing cations or lowering anions. Replacing NaCl with sodium bicarbonate can increase cations (Na\textsuperscript{+}) and lower anions (Cl\textsuperscript{-}) however, this may be problematic for the horse exercising in the heat that loses a large amount of sweat because sweat contains high levels of chloride. An alternative method to increase cations or lower anions would be to restrict dietary protein.

Fatigue is linked to higher cellular [H\textsuperscript{+}], low blood glucose and muscle glycogen depletion. Fat has been found to spare glucose and muscle glycogen and lowering protein has been found in these experiments to lower [H\textsuperscript{+}] in plasma therefore, restricting protein especially in combination with high fat may be the best dietary combination for the exercising horse.