Response of Yearling Quarter Horses to Varying Concentrations of Dietary Calcium

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Story in Brief

Fifteen yearling Quarter Horses were used in a split-plot designed experiment to determine the effects of varying levels of calcium (Ca) on mineral metabolism. Horses were blocked by sex and weight, and then randomly assigned to one of three treatments (high, basal, low). Experimental diets were formulated to contain Ca levels at 85% (low), 100% (basal), and 115% (high) of NRC requirements. Diets consisted of corn, soybean meal and cottonseed hulls fed at a 70:30 ratio with native prairie grass hay at 2.5% of body weight. The 25-wk trial consisted of three 72-h collection periods at d 0 (Period I), d 90 (Period II) and d 180 (Period III) during which complete urine and fecal collections were taken. Balance data from this experiment indicate that calcium requirements may be higher than current NRC recommendations as horses increase in age from 12 mo (yearling) to 18 mo (long yearling).

Key Words: Calcium, Mineral Metabolism, Growing Horses

Introduction

Calcium metabolism and requirements are of great interest in the horse industry, especially concerning growing horses. Calcium requirements for growing horses were estimated from research performed in ponies (Jordan et al., 1975; Schryver et al., 1970). Krook and Maylin (1988) reported a nutrient is generally required in inverse proportion to body weight. Therefore, the data from 200-kg ponies may not be applicable to 500-kg horses when expressed as mg of nutrient per kg of body weight. The objective of this study was to evaluate the effects of feeding various levels of calcium on mineral metabolism in yearling horses.

Materials and Methods

Fifteen yearling Quarter Horses were used in a split-plot designed experiment to evaluate the response of calcium (Ca) metabolism to varying concentrations of Ca in the diet. Horses were blocked by sex and weight, and then randomly assigned to one of three treatments (high, basal, and low). Horses were fed approximately 2.5% of their body weight per day in total ration. Experimental diets consisted of corn, soybean meal and cottonseed hulls fed in a 70:30 ratio with prairie grass hay (Table 1). Diets were formulated to contain Ca levels at 115% (high, H), 100% (basal, B), and 85% (low, L) of NRC requirements. The 25-wk trial consisted of three 72-h collection periods at d 0 (Period I, 12 mo of age), d 90 (Period II, 15 mo of age), and d 180 (Period III, 18 mo of age) during which complete urine and fecal collections were taken. Daily aliquots of feces and urine were taken to make a composite from which subsequent mineral analysis was performed. Fecal mineral analysis was performed using Inductively Coupled Plasma Spectroscopy (ICAP 61 Thermo Jarrell Ash). Urinary Ca and P were analyzed using a Vitros 250 analyzer (Johnson & Johnson Clinical Diagnostics, Inc., Rochester, NY). Data were analyzed using general linear models procedure of SAS (SAS Inst. Inc., Cary, NC) with horse,

treatment, and period as main effects. Least squares means were calculated for each treatment within a given period and the p-diff procedure of SAS was used to test for differences between treatment means.

Table 1. Composition of treatment diets, as fed basis			
	Treatments		
Ingredients (%)	High	Basal	Low
Ground corn	40.50	40.10	39.50
Soybean meal	14.00	14.20	13.60
Cottonseed hulls	14.60	15.00	16.40
TM salt	.30	.30	.30
Limestone	.50	.40	.20
Dicalcium phosphate	.10	---	---
Prairie grass hay	30.00	30.00	30.00
Nutrient			
DE, Mcal/kg	2.80	2.81	2.79
CP,%	15.4	15.1	14.5
Ca, %	.48	.42	.32
P, %	.34	.31	.30

Results

The response of average daily gain (ADG) and body weight (BW) of yearling horses consuming varying amounts of Ca are reported in Table 2. During the first 90 d of the trial (Period I to Period II), there was no significant difference in ADG across treatments. However, during the last 90 d (Period II to Period III), horses consuming the high diet had a higher (P<.05) ADG than those fed the low diet. Additionally as horses moved from 15 mo of age to 18 mo of age (long yearlings), there was a significant increase in average daily gains for all treatments.

Table 2. Response of average daily gain (ADG) and body weight (BW) of yearling horses to varying concentrations of calcium[a]				
Item	High	Basal	Low	SEM
Period I (12 mo)				
ADG, kg/d	N/A	N/A	N/A	N/A
BW, kg	321.20	336.40	335.40	17.91
Period II (15 mo)				
ADG, kg/d	.31[d]	.31[d]	.34[d]	.03
BW, kg	345.20	361.60	362.60	17.91
Period III (18 mo)				
ADG, kg/d	.71[be]	.66[bce]	.58[ce]	.03
BW, kg	415.00	427.80	423.20	17.91

[a]Values are least squares means.

[b,c]Means within a row with different superscripts differ (P<.05).

[d,e]Means within a column with different superscripts differ (P<.05).

Data for Ca intake, excretion and retention are shown in Table 3. Horses consuming diets H and B had significantly higher intake and fecal excretion of Ca than horses on the low diet during Periods I and II. During Period III, similar results were observed for Ca intake while fecal excretion of Ca decreased significantly between the high (22.25 g/d), basal (17.21 g/d) and low (12.82 g/d) diets. Urinary excretion of Ca was not different (P>.05) between horses consuming diets H, B and L during all three periods. During Period I, retention of Ca was higher (P<.05) in horses consuming Diets H and B vs Diet L. Furthermore, those horses fed Diet H retained more C (P<.05) than horses fed Diet L during Period II. During Period III, there was a tendency (P<.10) for horses consuming the basal diet to have a higher Ca balance than those on the low diet. Horses consuming the high Ca diet also had a numerically higher retention of Ca than those on the low, though not significant.

Table 3. Calcium balance of yearling horses consuming various amounts of calcium[a]

Period I	Treatment			
Calcium	High	Basal	Low	SEM
Intake, g/d	28.13[b]	25.35[b]	19.33[c]	1.35
Fecal, g/d	17.13[b]	15.47[b]	11.73[c]	1.33
Urine, g/d	2.92	2.97	4.86	.65
Retention, g/d	8.07[b]	6.90[b]	2.74[c]	1.69
Absorption, g/d	11.20[b]	9.80[bc]	7.60[c]	1.51
Digestibility, %	39.60	38.80	38.80	4.57
Period II				
Intake, g/d	32.87[b]	29.14[b]	21.05[c]	1.35
Fecal, g/d	18.56[b]	17.66[b]	12.51[c]	1.33
Urine, g/d	1.45	1.54	1.04	.65
Retention, g/d	12.86[b]	9.93[bc]	7.49[c]	1.69
Absorption, g/d	14.40[b]	11.60[c]	8.80[c]	1.51
Digestibility, %	43.00	39.00	40.00	4.57
Period III				
Intake, g/d	37.75[b]	34.12[b]	24.10[c]	1.57
Fecal, g/d	22.25[b]	17.21[c]	12.82[d]	1.33
Urine, g/d	3.85	3.30	4.46	.65
Retention, g/d	11.64[ef]	13.59[e]	6.82[f]	2.32
Absorption, g/d	15.49	16.90	11.28	1.52
Digestibility, %	40.36	49.55	46.04	5.49

[a]Values are least squares means.

[b,c,d]Means within a row with different superscripts differ (P<.05).

[e,f]Means within a row with different superscripts differ (P<.10).

Discussion

Concerning calcium balance, the increased retention of Ca (on an absolute basis, g/d) in horses consuming Diet H during Periods I and II is similar to previous studies which have shown an enhanced Ca balance in horses consuming supplemental Ca (Buchholz et al., 1999; Nielsen et al., 1998; Schryver et al., 1970). This increased retention of Ca observed in the present study may be due to the increased ($P<.05$) intake of Ca in horses fed the high diet. Schryver et al. (1970) found that as Ca intake increased from 29 mg/kg BW on the low diet to 242 mg/kg BW on the high, retention of Ca increased from –7.5 mg/kg BW to 56 mg/kg BW, respectively.

During Period III, horses consuming the high and basal diets experienced an increased absorption and retention of Ca, both on an absolute (g/d) and body weight basis (mg/kg BW) which were similar to Periods I and II. These results may indicate an increased requirement of calcium during this period as compared to Periods I and II. This conclusion is further supported by data from Table 3, which demonstrates that horses consuming the high and basal diets experienced an increase in absorption, retention and digestibility of Ca during Period III as compared to Periods I and II. Furthermore, the average daily gain (ADG) of all yearlings increase high (0.71 kg/d), basal (0.66 kg/d) and low (0.58 kg/d) during Period III. This increased gain may indicate an increased requirement for Ca as horses move from a yearling (12 mo of age, Period I) to a long yearling (18 mo of age, Period III).

Both intake and absorption values calculated in this study are above current NRC estimates of 27 g/d (intake) and 13.5 g/d (absorption) for long yearling horses (18 mo) that are not in training. It appears from these data that horses consuming diets at (basal) or above (high) NRC recommendations for Ca, as a percentage of total intake, may be enhancing absorption of Ca during Period III to meet increased requirements related to the enhanced average daily gain during this time. One explanation for this could be that as horses move from 15 mo of age (Period II) to 18 mo of age and enter their long yearling year and experience a significant increase in average daily gain the demand for supplemental calcium increases with a low Ca digestibility than that suggested by NRC.

Conclusion

Results from this study demonstrate an increased Ca retention with increased intake during all three periods. During Period III however, horses consuming diets at or above NRC recommendations, as a percentage of the total diet, experienced an increased absorption and retention with lower digestibility of Ca during this time of significantly increased ADG. These data may indicate the need for increased NRC recommendations for Ca in long yearling (18 mo) horses not in training.

Literature Cited

Buchholz, M.A. et al. 1999. Proc. 16th Equine Nutr. Physiol. Symp. 12-17.

Jordan, R.M. et al. 1975. J. Anim. Sci. 40:78.

Krook, L. and G.A. Maylin. 1988. Cornell Vet. 98(Suppl.11):1.

NRC. 1989. Nutrient Requirements of Horses. 5th ed. National Academy Press, Washington, DC.

Neilsen, B.D. et al. 1998. J. Equine Vet Sci. 18:397.

Schryver, H.F. et al. 1970. J. Nutr. 100:955.

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