GROWTH OF WEANLING QUARTER HORSES FED VARYING ENERGY AND PROTEIN LEVELS

S.R. Boren[1], D.R. Topliff[2], D.W. Freeman[2], R.J. Bahr[3], D.G. Wagner[4] and C.V. Maxwell[5]

Story in Brief

Fifteen Quarter horse weanlings were blocked by sex and birthdate and randomly allotted to one of three dietary treatments at 120 days of age, following weaning at 90 days of age. Concentrate diets were formulated to contain either low energy-low protein, high energy-low protein or high energy-high protein and fed in a 75:25 ratio with alfalfa hay in an effort to study the effects of protein to calorie ratio on growth, soundness and relative body composition to 300 days of age. Although no differences due to treatment were detected in skeletal growth or bone mineralization, foals fed the high energy-high protein concentrate were significantly heavier as compared to either those fed low energy-low protein or high energy-low protein diets, yet were in similar body condition as those fed the low energy-low protein diet. Weanlings fed the high energy-low protein diet were significantly thinner than those fed either of the other treatments. These data suggest that weanlings fed high energy-high protein rations can grow at fast rates without fear of developmental orthopedic diseases or of becoming excessively fat.

(Key Words: Equine, Growth, Nutrition, Weanling, Energy, Protein)

Introduction

Much debate has recently occurred over the ideal growth rate for maximum skeletal soundness in weanlings and yearlings. One side has argued that rapid growth rates brought on by high levels of nutrition are synonomous with unsoundness such as epiphysitis and osteochondrosis dissecans (OCD) while others have suggested that genetic predisposition to these problems is the major factor and that diet is only incidentally related. A recent survey of 19 breeding farms in Ohio and Kentucky suggested that nutritional imbalances of protein, calcium, phosphorus, copper and zinc may aggravate and accentuate OCD in yearlings (Knight et al., 1986). They also found that farms feeding commerically prepared rations without additional supplements had significantly fewer yearlings with OCD than those farms mixing their own rations. It is interesting to note that all farms were subjectively assessed to have some incidence of OCD regardless of breed, nutrition or management system again pointing to genetics as a prime factor. It was, therefore, the aim of this study to further investigate the role of energy and protein in the promotion of maximum, sound, true growth.

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[1]Graduate Assistant [2]Assistant Professor [3]Assistant Professor, Veterinary Medicine & Surgery [4]Regents Professor [5]Associate Professor

Materials and Methods

Fifteen weanling Quarter horses, eight fillies and seven colts, were weaned in pairs at about 90 days of age. From 90 to 120 days weanlings were preconditioned on the ration shown in Table 1 which was fed twice daily until 120 days of age at which time treatments were imposed. The treatment period lasted 180 days. The weanlings were blocked by sex and age in a complete randomized block design experiment and allotted to three treatments of five horses per treatment.

During the trial each weanling was allowed to exercise freely for approximately 1 hour at least every third day. Further, each individual weanling was exercised by walking and trotting on a longe line for approximately 3 hours per week. Weanlings were allowed, but not forced, to gallop while on the longe line.

Ingredient composition of the trial rations is also shown in Table 1 and nutrient compositions are shown in Table 2. The weanlings allotted to treatment 1 received a diet which had a protein to calorie ratio (PCR) of 52 g CP/Mcal digestible energy (DE), an energy density of 1.32 Mcal DE/lb and 14.5% crude protein (CP). Treatment 2 had a PCR of 42.5 g CP/Mcal DE, an energy density of 1.55 Mcal DE/lb and 14.5% CP. Treatment 3 had a PCR of 50 g CP/Mcal DE, an energy density of 1.55 Mcal DE/lb and 16.5% CP. Diets 1 and 3 had similar protein to calorie ratios but in differing absolute amounts. Diet 2 had the same CP as diet 1, but had an energy density similar to diet 3.

Calcium and phosphorus were balanced at a ratio of 2 to 1 with limestone and monosodium phosphate. Calcium was fed at 1.0% of the diet while phosphorus was fed .5% of the diet. Diets were 75% concentrate and 25% alfalfa hay. The weanlings were offered feed at 2.25% of their body weight daily and allowed 12 hours to consume their rations, at which time any feed refused was weighed back and recorded. All weanlings were fed in equal feedings at 6 a.m. and 6 p.m. in individual stalls.

Table 1. Ingredient composition of hay and concentrates fed to weanlings (Dry Matter Basis).

Ingredient	IFN	Pre-cond. diet	% of diet		
			1	2	3
Alfalfa hay	1-00-059	25.51	25.71	25.96	25.94
Corn	4-02-985	51.02	0	68.82	61.20
Oats	4-03-309	0	55.27	0	0
Soybean meal	5-04-604	18.37	3.45	2.73	10.58
Cotton hulls	1-01-599	0	12.44	0	0
Molasses	4-04-695	3.06			
Limestone	--	1.53	1.23	1.10	1.24
Monophosphate	--	0	.88	0	0
Salt	--	.51	1.03	1.38	1.03
Vitamin A	7-05-143	2200 IU/kg	2200 IU/kg	2200 IU/kg	2200 IU/kg

Table 2. Nutrient composition of hay and concentrates fed to weanlings (DM Basis).

Item	Diet		
	1	2	3
Crude protein, %	14.75	14.38	16.48
Digestible energy, Mcal/kg	2.8	3.23	3.28
CP g/Mcal DE	52.7	44.5	50.2
Calcium, %	1.03	.99	1.05
Phosphorus, %	.68	.51	.56
Zinc, ppm	13.15	20.74	21.41
Copper, ppm	7.86	7.26	7.77

Beginning at 120 days of age, six measurements were taken weekly as indicators of growth: (1) height at the withers, (2) height at the hip, (3) height at the hock, (4) height at the shoulder, (5) height at the knee, and (6) weight. All weanlings were evaluated for fat thickness ultrasonically at three anatomical sites at the beginning and end of the trial. The sites evaluated were (1) directly posterior to the midpoint of the scapula, (2) 2 in. lateral from the spinous process between the 12th and 13th ribs, and (3) over the rump 2 in. lateral from the midline at the center of the pelvic bone. In addition to ultrasonic measurements, weanlings were condition scored at the same time. Body condition scores were assigned a value of 1-9 on a scale of 1 = extremely thin to 9 = extremely fat. The digestibility of energy and protein was determined at 2, 4, and 6 months into the trial using chromic oxide as an indigestible marker.

Radiographs of the distal radius (DR) and third metacarpal (MC III), one anterioposterior (AP) view and one lateromedial (LM) view were also taken at 0, 3 and 6 months into the trial. In all views, an aluminum (Al) step wedge was exposed simultaneously as a reference standard. Bone densities were estimated at three anatomical sites one-half inch below the nutrient foramen of Mc III with a Wisconsin Densitometer. The sites measured were: A) the longest path through the bone cortex on the medial side, B) the path midway between the two peaks, and C) the corresponding lateral peak. Direct measurements of bone diameter (BD) and medullary cavity width (M) were taken as described by Meakim et al. (1981). Each radiograph was standardized by background density and all exposed steps of the Al wedge were measured for density. Corresponding wedge values were used in regression equations and radiographic bone aluminum equivalents (RBAE) were determined from these equations for each radiograph as an estimate of bone mineral content.

All radiographs were evaluated by a veterinary clinician with experience in evaluating clinical bone disorders. All radiographic views were evaluated simultaneously and the clinician had no previous knowledge as to the treatment or set of each weanling. Attention was placed on detection of osteochondrosis and physitis (epiphysitis) of the distal radius. Radiographs for each horse at 0, 3 and 6 months into the

trial were evaluated simultaneously for changes over time. Radiographs were evaluated for joint space and clarity of joint margination as well as subchondral bone density and signs of osteochondrosis. Physitis of the distal radius was detected by thickening of the cortex along the border of the metaphyseal region and increased lucency of the entire physis. In addition, overall conformation, bone densities and trabecular patterns were subjectively evaluated. Soft tissue assessment was made of joint pouches to detect joint hydrarthrosis and possibility of bone effuse.

Results and Discussion

Intake of DM, DE and CP are shown in Table 3. Although feed intake was designed to be the same proportion of body weight (2.25%/day), feed intake of weanlings in treatment 2 was significantly less. This may be due to the protein to calorie imbalance of the treatment 2 diet. Diets 1 and 3 had similar intakes and protein to calorie ratios (52.7 and 50.2 g CP/Mcal DE respectively). The higher energy density of diet 3 did not limit the weanlings intake. Mean daily intake of crude protein (CP) was 1.93, 1.52 and 2.17 lb while average daily intakes of DE were 16.5, 15.6 and 19.7 Mcal for the weanlings on treatments 1, 2 and 3, respectively.

Dry matter digestibilities of diets fed in treatments 2 and 3 were not significantly different (75.1 and 75.6%, respectively). DM digestibility of diet 1 was significantly lower with a mean of 61.9%.

Comparisons of protein digestibility showed a significant decline from diet 1 to 2 with means of 73.1 and 63.1%, respectively. Diets 2 and 3 tended to be different (P<.15) with means of 63.1 and 69.7%, respectively, while protein digestibility of diets 1 and 3 showed no significant differences. These data indicate that as PCR declines protein digestibility may also decrease. Protein digestibility appeared to be lower than values calculated from NRC (1978), which estimated digestible protein at 72-75%.

Table 3. DM intakes and digestibilities of diets fed to weanling horses (DM Basis).

	Diet			
Item	1	2	3	SE
DM intake, lb/day	13.1[a]	10.6[b]	13.2[a]	.3
Crude protein (CP) intake, lb/day	1.93[b]	1.52[a]	2.17[c]	45
Digestible energy (DE), Mcal/day	16.5[d]	15.6[d]	19.7[e]	1.2
DM digestibility, %	61.9[a]	75.1[b]	75.6[b]	1.5
Apparent CP digestiblity, %	73.1[b]	63.1[a]	69.7[b]	2.6
Gross energy digestibility, %	63.1[a]	74.4[b]	75.3[b]	1.8

[abc]Means in a row with different superscripts differ (P<.05).
[de]Means in a row with different superscripts differ (P<.10).

Energy digestibility of diets 2 and 3 showed no significant differences with mean values of 74.4 and 75.3%, respectively. The digestibility of diets 2 and 3 were significantly different from diet 1 with a mean of 63.1%. This difference was probably due to the higher percentage of crude fiber (CF) in diet 1 of 20.8% on a DM basis as compared to 9.6% CF for diets 2 and 3.

Relative body composition of the weanlings was compared by condition score and ultrasonic measurement of subcutaneous fat at three anatomical sites (Table 4). Weanlings on treatments 1 and 3 were not significantly different in condition score, but weanlings on treatment 2 were significantly thinner at 300 days of age.

Westervelt et al. (1976) indicated that the coefficient of simple correlation between percent body fat and ultrasonic fat thickness measurements of mature horses was .90. Whether the composition of mature horses and rapidly growing weanlings, estimated by subcutaneous fat thickness, is similarly accurate is unknown. Nevertheless, trends in ultrasonic fat scans for rump and back fat were similar to body condition scores. The weanlings on treatments 1 and 3 were not significantly different in fat gain over the rump or back area. No significant differences for fat gained in the rib area were detected for the weanlings on treatments 1, 2 or 3. These data are consistent with those of Westervelt et al. (1976) who found that rump and back fat were highly correlated (r = .99) but rib fat was not as closely associated with either (r = .6).

Bone measurement values from radiographs are shown in Table 5. No significant difference due to sex or treatment was found. Therefore, all radiographic bone aluminum equivalent (RBAE) values for bone density were combined to estimate changes over time and fit to an overall model for each variable measured.

Table 4. Influence of diet on condition scores and ultrasonic fat thickness of weanling quarter horses at 300 days of age using initial measurements as a covariate.

	Treatment			
Parameter	1	2	3	SE
Condition score 300 days of age	5.76[a]	5.05[b]	5.50[a]	.1
Rump fat, in. 300 days of age	.31[a]	.26[b]	.31[a]	.3
Back fat, in. 300 days of age	.29[a]	.28[b]	.29[a]	.2
Rib fat, in. 300 days of age	.27	.27	.27	.4

[ab]Means in a row with different superscripts differ (P<.05).

Table 5. Influence of diet on bone growth of weanling quarter horses between 120 and 300 days of age.

Parameter	Initial	Final	Difference
RBAE point A	17.87	22.76	4.89
RBAE point B	16.28	21.35	5.07
RBAE point C	18.60	23.72	5.12
AP cortical width, in.	1.20	1.31	.11
AP medullary width, in.	.67	.63	-.04
LM cortical width, in.	1.00	1.07	.07
LM medullary width, in.	.61	.50	-.11
Third metacarpal length, in.	10.87	10.98	.11

Mean lateral peak values (RBAEA) when viewed AP increased over time from 17.87 to 20.65 to 22.75 at four, seven and ten months of age respectively, while mean values for the midpoint peaks (RBAEB) increased from 16.28 to 18.64 to 21.35. Likewise, mean medial peak values (RBAEC) increased from 18.60 to 21.17 to 23.72 over the same period. These data indicate that bone density increases linearly to 10 months of age.

The overall fits and mean values for growth of MC III were linear for weanlings from 120 to 300 days of age. It was assumed that bone growth over the entire growth curve should be a quadratic function; however, the inflexion point of these overall growth curves for bone were likely not reached in this trial. It is apparent that bone growth must slow sometime after 10 months of age in Quarter Horses. This agrees with Meakim et al. (1981) who found decreased mineralization occurs after 10 months of age.

No signs of OCD existed for any weanling on any treatment at the distal radius or carpus region. One colt on treatment 1 showed signs of mild physitis of the dorsolateral aspect of the distal radial growth plate which worsened slightly until 210 days of age. The physitis detected was evident before the weanling began on treatment and diet did not appear to aggrevate his condition. No physical signs of lameness were detected at any time.

Average daily gains (ADG) are shown in Table 6. In this trial the weanlings on treatment 3 gained weight signficantly faster than the

Table 6. Influence of diet on average daily gain in weanling quarter horses.

	Treatment			
Parameter	1	2	3	SE
Average daily gain, lbs.	1.56^{bc}	1.30^{bd}	1.87^{a}	.04

^{ab}Means in a row with different superscripts differ (P<.05).
^{cd}Means in a row with different superscripts differ (P<.08).

weanlings on treatments 1 or 2. In addition, weanlings on treatment 1 gained weight more rapidly ($P<.08$) than did weanlings on treatment 2. The difference in growth rates may be explained by the lower daily intakes of protein by the weanlings on treatment 2. Feed intakes of weanlings on treatments 1 and 3 were not significantly different, but intake of CP and DE was significantly higher for weanlings on treatment 3. Therefore, it appears increased intakes of CP and DE can accelerate growth in weanlings without changing body composition as long as PCR remains above 50 g/Mcal DE. Further research is needed to identify the long term effects of rapid early growth in weanlings.

Literature Cited

Knight, D.A., et al. 1986. Correlation of dietary mineral to incidence and severity of metabolic bone disease in Ohio and Kentucky. Proc. of 23rd Amer. Assn. of Equine Prac. p. 445.

Meakim, D.W., et al. 1981. Estimation of mineral content of the equine third metacarpal by radiographic photometry. J. Anim. Sci. 53:1019.

NRC. 1978. Nutrient Requirements of Domestic Animals No. 6. Nutrient requirements of horses (4th revised ed.). National Academy of Sciences National Research Council. Washington, D.C.

Westervelt, R.G., et al. 1976. Estimating fatness in horses and ponies. J. Anim. Sci. 43:781.