INFLUENCE OF COPPER SUPPLEMENTATION AND PELLETED VS.EXTRUDED CONCENTRATE ON GROWTH AND DEVELOPMENT OF WEANLING HORSES

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SUMMARY

Twenty-two weanlings of Thoroughbred and Quarter Horse type were fed three levels of copper supplementation and two forms of concentrate, extruded and pelleted, in a 112 day feeding trial. Starting age and weight were 134-21 days and 205+26 kg. Alecia Bermudagrass hay was fed at 1 kg/100 kg BW/day. The weanlings were fed their designated concentrate to appetite during two, 1.5 hr feeding periods daily. Copper supplements in pelleted form were fed prior to the regular portion of concentrate at 0.25 kg/hd/day and provided 0, 50, and 112 mg added copper daily. Least square means for the low, medium and high copper levels were: weight gain 86, 72, 76 kg; height gain 11.10, 10.72, 10.13 cm; girth gain 17.09, 17.32, 15.98 cm; length gain 14.15, 13.72, 13.23 cm; hip height gain 10.97, 11.15, 10.03 cm; daily grain 3.57, 3.32, 3.14 kg; daily hay 2.29, 2.29, 2.36 kg; total daily intake 5.86, 5.61, 5.51 kg; feed efficiency 8.41, 8.35, 8.39 kg/100 kg WT gain respectively. Least square means for extruded and pelleted concentrates were: weight gain 88, 75 kg; height gain 11.18, 10.11 cm ($p<.05$); girth gain 18.49, 15.11 cm; length gain 14.99, 12.42 cm; hip height gain 11.48, 9.93 cm ($p<.05$) ; daily grain 3.28, 3.41 kg; daily hay 2.29, 2.34 kg; total daily intake 5.56, 5.75 kg; feed efficiency 7.53, 9.24 kg/100 kg WT gain respectively. Rates of intake for extruded and pelleted concentrates were 36.56 g/min and 45.84 g/min respectively. Early differences ($p<.05$) in weight gain thru day 84 due to concentrate form decreased with time. Serum analysis was not indicative of level of bone mineralization. Bone density analysis did not reveal differences between levels of supplemental copper.

INTRODUCTION

In recent years, a relationship between low dietary copper and what is commonly known as metabolic bone disease has been suggested (Knight, et al.1985; Carbery, 1975; Bridges, et al. 1984). Copper is essential to angiogenesis in the epiphyses via the copper protein glycylhistyllysine. Therefore the mineralization of cartilage to form bone requires copper.

In a comparison of the digestibility of extruded, pelleted, and coarse concentrates in adult horses and ponies, Hintz, et al. (1985) found that the dry matter and energy digestibility of the extruded product was greater than the pelleted product. Protein digestibility was higher for the extruded feed vs. the coarse feed. However there is little or no information on the use of extruded concentrate in weanling horses.

This experiment was designed to examine the effect of three levels of copper on growth and bone development in weanling horses. The effect of concentrate form, pelleted vs. extruded, on animal growth performance was also examined.

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PROCEDURE

Twenty-two Thoroughbred and Quarter Horse foals were weaned at 112 days of age and started on a 2x3 factorial experiment one to three weeks later. Initial body weight, withers height, hip height, body length, girth, serum and radiographs of the left third metacarpal were taken. Weights and body measurements were recorded every 14 days. Weights, measures, serum and radiographs were repeated on the final day of the experiment. Pellets A, B, or C, fed at a rate of 0.25 kg/hd/day, provided respectively 0, 57, or 110 mg Cu/hd/day. After consumption of the copper supplemented pellets, the weanlings were fed their designated concentrate individually to appetite during two, 1.5 hr feeding periods daily. Orts were weighed daily. Alecia Bermudagrass hay was group fed at 1 kg/100 kg BW/day in two equal feedings. Plain salt blocks were provided in each pen. Trace mineral content of serum and feed samples were determined by atomic absorption. Radiographs were prepared for analysis via the technique of Meakim, et al. 1981. Radiographs were analyzed for bone density using the densitometry capability of the Image Analyser (Southern Micro Instrument Inc., Atlanta, GA). One foal did not accept the ration and was deleted from the trial.

RESULTS

Copper Intake Study

Composition of the copper supplements, extruded and pelleted concentrates, and the hay are shown in table 1. The designated intakes of supplemented copper were insured by feeding the copper supplement first at each feeding period. Only after the animals had consumed all of the supplement were the extruded and pelleted concentrates fed. Feed and nutrient intakes are shown in table 2. No differences in intakes were noted for the three copper levels except for total daily copper intake which was analysed to be 0, 97, and 159 mg/animal/day.

Copper intake did not influence weight, height, girth, length or hip height gains (table 3). Serum copper, calcium, and zinc levels did not reflect the level of daily copper intake. The lack of differernce between initial and final serum copper levels indicates the foals were not in a copper deficient state.

Examination for joint disease did not reveal differences among treatments. Bone denisitometery analysis of radiographs of the left third metacarpal did not show differences between treatments.

Concentrate Form Study

Rates of intake for the extruded feed and pelleted feed were 36.6 g/min and 45.8 g/min respectively. Weanlings fed the extruded concentrate had significantly greater weight gains thru day 84 ($p<.05$). At the end of the experiment the foals fed extruded concentrate continued to show a trend toward greater gains. An increase in feed efficiency of 18.51% was seen in the extruded (7.53 kg/100 kg WT gain) over the pelleted feed (9.24 kg/100 kg WT gain). Animal acceptance of the extruded concentrate differed little from the pelleted concentrate. The data suggest extruded concentrate is at least equal to pelleted concentrate as a feed for weanling horses.

CONCLUSIONS

The results of this study did not show a difference in bone density between the treatment groups. Results of serum analysis suggest serum Cu level is not indicative of bone mineralization. The lack of difference between initial and final serum copper levels indicates the foals on the control diet were not copper deficient (Carbery, 1978; Bridges, et al. 1984). There were no clinical signs of joint disease. The data suggest supplemental Cu enhances the level of bone mineralization in growing horses. This experiment indicates the need for further study of the relationship between Cu deficiency and metabolic joint disease.

This experiment shows the extruded form of concentrate to be at least equal to or better than the pelleted form of concentrate in the growth performance of weanling horses. Further examnination of the digestibility of extruded verses pelleted concentrate for young horses may indicate more differences between the two forms of feed.

LITERATURE CITED

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TABLE 1. Concentrate and Supplement Composition and Analyses of the Concentrates, Supplements and Hay

	Supplements and Concentrates A, B, C, E, P
Corn, gr	48.33
Soybean meal (48%)	20.00
Wheat middlings	20.00
Alfalfa, dehy (17%)	5.00
Molasses (30 lb. Prot.)	2.00
Limestone, gr	1.30
Lignin sulfonate	1.25
Dical. Phos.	0.75
Salt	0.5
Ca prop.	0.25
Vitamin premix[1]	0.12
Trace mineral premix	0.50
	100.00

Analyses	Supplements A	B	C	Concentrates E	P	Alecia Bermuda Hay
Dry matter, %	86.6	88.5	87.3	88.3	87.2	90.6
Dig. Energy, Mcal/kg[2,3]	3.09	3.09	3.09	3.09	3.09	1.98
Crude Protein, %[3]	21.3	20.3	20.8	18.7	17.8	5.8
Calcium, %[3]	0.98	1.01	0.97	0.80	0.74	0.32
Phosphrous, %[3]	0.85	0.72	0.71	0.81	0.72	0.40
Copper, ppm[3]	8.00	228	510	12.4	19.1	8.60
Zinc, ppm[3]	69.5	74.1	72.8	73.6	89.3	21.0
Molybdenum, ppm[3]	1.72	2.60	5.45	3.15	3.28	1.94

[1]Vitamin premix provided 20,922 IU Vit.A, 1,236 IU Vit.D, 25.7 IU Vit.E/kg.
[2]Calculated from NRC 1978.
[3]Dry matter basis.

TABLE 2 Daily Intake

	Copper Supplement mg added Cu/day			Conc. Form	
	0	50	112	E	P
Concentrate intake, kg	3.57	3.32	3.14	3.28	3.41
Supplement intake, kg	0.25	0.25	0.25	0.25	0.25
Hay intake, kg	2.29	2.29	2.36	2.29	2.34
Total intake, kg	6.11	5.86	5.75	5.82	6.00
Dry Matter intake					
Concentrate, kg	3.13	2.91	2.76	2.90	2.97
Supplement, kg	0.22	0.22	0.22	0.22	0.22
Hay, kg	2.07	2.07	2.14	2.07	2.12
Total, kg	5.42	5.20	5.12	5.19	5.31
Crude Protein intake[2]					
Concentrate, kg	0.57	0.53	0.50	0.61	0.61
Supplement, kg	0.05	0.05	0.05	0.05	0.05
Hay, kg	0.13	0.13	0.14	0.13	0.14
Total, kg	0.75	0.71	0.69	0.79	0.80
Dig. Energy intake[1]					
Concentrate, Mcal	9.67	8.99	8.53	8.96	9.18
Supplement, Mcal	0.68	0.68	0.68	0.68	0.68
Hay, Mcal	4.10	4.10	4.24	4.10	4.20
Total, Mcal	14.45	13.77	13.45	13.74	14.06
Calcium intake[2]					
Concentrate, g	24.10	22.41	21.25	23.20	22.00
Supplement, g	2.16	2.22	2.13	1.76	1.63
Hay, g	7.30	7.30	7.60	6.60	6.80
Total, g	33.56	31.93	30.98	31.56	30.43
Phosphorous intake[2]					
Concentrate, g	24.10	22.41	21.25	23 50	21.40
Supplement, g	1.87	1.58	1.56	1.67	1.67
Hay, g	9.20	9.20	9.40	8.30	8.50
Total, g	35.17	33.19	32.21	33.47	31.57
Zinc intake[2]					
Concentrate, mg	339.4	315.3	299.1	213.2	265.2
Supplement, mg	15.3	16.3	16.0	15.9	15.9
Hay, mg	48.1	48.1	49.6	43.6	44.5
Total, mg	402.5	379.7	364.7	272.7	484.4
Molybdenum intake[2]					
Concentrate, mg	10.1	9.4	8.9	9.1	9.8
Supplement, mg	0.38	0.57	1.20	0.72	0.72
Hay, mg	4.4	4.4	4.6	4.0	4.1
Total, mg	14.9	14.4	14.7	13.8	14.6
Copper intake[2]					
Concentrate, mg	71.1	66.1	62.7	35.9	56.7
Supplement, mg[3]	1.8	123.1	172.7		
Hay, mg	19.7	19.7	20.3	17.8	18.2
Total, mg	92.6	275.0	255.7	53.7	74.9

[1] Dig. Energy calculated from 1978 NRC.
[2] Nutrient intake calculations are based on analysed values for the concentrates and hay.
[3] Supplemental copper not included

TABLE 3 Least Square Means and Standard Errors for Gains in Weight Height, Girth, Length, and Hip Height

	Supplement Level			Conc. Form	
	A	B	C	E	P
Weight gain, kg	85.8	82.3	76.2	88.0	74.9
SE	7.3	7.3	6.8	6.2	5.7
Height gain, cm	11.1	10.7	10.1	11.2[a]	10.1[b]
SE	0.41	0.41	0.38	0.36	0.33
Girth gain, cm	17.1	17.3	16.0	18.5	15.1
SE	1.9	1.9	1.8	1.7	1.5
Length gain, cm	14.1	13.7	13.2	15.0	12.4
SE	1.6	1.6	1.5	1.3	1.2
Hip Height gain, cm	11.0	11.1	10.0	11.5[a]	9.9[b]
SE	0.61	0.61	0.56	0.51	0.46

[ab]Values with unlike superscripts are different ($p<.05$).

TABLE 4 Influence of Copper on Bone Density

	SUPPLEMENT		
	A	B	C
Medial Peak, mm Al			
Initial	20.13 ± 2.28	18,14 ± 1.40	23.69 ± 6.43
Final	19.88 ± 2.39	21.96 ± 2.16	21.18 ± 3.06
Diff.	0.95 ± 2.36	3.82 ± 2.71	4.56 ± 6.84
Midpoint, mm Al			
Initial	16.83 ± 1.41	14.48 ± 0.98	21.51 ± 5.49
Final	18.27 ± 2.63	18.43 ± 5.54	18.00 ± 2.12
Diff.	1.45 ± 2.75	3.96 ± 5.45	-3.50 ± 6.09
Lateral Peak, mm Al			
Initial	17.83 ± 1.59	14.98 ± 0.72	22.22 ± 5.32
Final	19.01 ± 3.51	18.56 ± 1.83	19.63 ± 3.78
Diff.	1.18 ± 4.08	3.59 ± 2.22	-2.59 ± 7.37
Estimated bone mineral[1], g/2 cm section			
Initial	13.80 ± 1.50	11.78 ± 2.95	18.96 ± 4.49
Final	15.99 ± 2.55	15.69 ± 3.64	17.44 ± 5.94
Diff.	0.30 ± 3.18	1.12 ± 3.66	-1.06 ±10.03

[1]Estimated bone meneral content was calculated using the following equations:

EBM = 0.87 RBAE - 2.35 for medial peak
EBM = 0.98 RBAE - 1.47 for midpoint
EBM = 0.93 RBAE - 2.86 for lateral peak

TABLE 5 Influence of Copper Intake on in Serum Calcium, Copper, and Zinc

	SUPPLEMENT		
	A	B	C
Calcium ,mg/dl			
Initial	11.38 ± 0.66	11.31 ± 0.87	11.33 ± 0.28
Final	11.50 ± 1.14	11.01 ± 0.75	10.08 ± 2.16
Diff.	0.12 ± 1.25	-0.27 ± 1,12	-1.06 ± 2.40
Copper, ug/ml			
Initial	1.63 ± 0.29	1.47 ± 0.09	1.56 ± 0.38
Final	1.39 ± 0.29	1.34 ± 0.22	1.22 ± 0.29
Diff.	-o.24 ± 0.48	-0.14 ± 0.25	-0.34 ± 0.29
Zinc, ug/ml			
Initial	0.87 ± 0.26	0.78 ± 0.18	1.01 ± 0.24
Final	0.82 ± 0.29	0.86 ± 0.33	1.01 ± 0.28
Diff.	-0.08 ± 0.11	0.07 ± 0.32	0.01 ± 0.23