Kentucky Equine Research®
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Advances in Equine Nutrition

Volume II

Edited by

J.D. Pagan

THE EFFECTS OF INTAKE LEVEL ON THE DIGESTIBILITY AND RETENTION OF COPPER, ZINC AND MANGANESE IN SEDENTARY HORSES

C. A. HUDSON, J. D. PAGAN, K.E. HOEKSTRA, A. PRINCE, S. GARDNER, R. J. GEOR
Kentucky Equine Research, Inc., Versailles, KY

Few studies have directly evaluated the effects of intake level on the true digestibility and retention of copper (Cu), zinc (Zn) and manganese (Mn). Furthermore, the manganese requirements of horses have not been established (NRC, 1989). To address these questions, four mature Thoroughbred horses (mean age [± SD] 13 ± 2.2 yr; weight 559 ± 47 kg) were studied in a 16-week longitudinal experiment that consisted of 4 periods, each with a 23-day adaptation period followed by a 5-day complete collection digestion trial. In Period 1, horses were fed an unfortified diet (basal Cu, Zn and Mn intake) consisting of 6.8 kg of alfalfa cubes and 3 kg of sweet feed (45% cracked corn, 45% whole oats, 10% molasses). In Periods 2, 3 and 4, respectively, the diet was fortified with a supplement providing 50%, 100% and 200% of the National Research Council [NRC] (1989) requirements for Cu, Zn and Mn. During each adaptation period, the horses were housed in box stalls at night and given paddock turnout during the day. Muzzles were worn to prevent grazing. During the 5-day digestion trial, the horses were fitted with harnesses that permitted the complete and separate collection of urine and feces. Composite samples of feed, urine and feces were stored and subsequently analyzed for Cu, Zn and Mn contents by ICP radial spectrometry. For each mineral, and over the four levels of intake, external balance data were calculated. Linear regression analysis was performed to determine the relationship between intake level and mineral retention (retention = intake - fecal and urinary losses). The Lucas procedure was used to estimate the contribution of endogenous losses to the apparent digestibility of each nutrient. With this procedure, slope of the linear regression of nutrient retention against level of intake is the true digestibility and level of intake when y = 0 is taken as the maintenance requirement.

Data (mean ± SD, n = 4) for intake, fecal and urinary losses, and retention are presented in Table 1.

The linear regression equations describing the relationship between Zn and Mn intake and retention were: Zn: $y = 0.235x - 53.1$ ($r^2 = 0.696$, $P < 0.001$) and Mn: $y = 0.537x - 291$ ($r^2 = 0.729$, $P < 0.001$). On the other hand, the relationship between copper intake and retention was best described by a sigmoidal curve. In particular, Cu supplementation at 200% NRC resulted in only a small increase in Cu retention compared to supplementation at 100% NRC (see Table 1). From the Lucas procedure, estimates of true digestibility for Zn and Mn were 23.5% and 53.7%, respectively, while daily endogenous losses were 53 mg and 291 mg. Estimates of daily maintenance requirements for Zn and Mn were 230 and 540 mg, respectively.

Table 1. External balance for copper (Cu), zinc (Zn), and manganese (Mn) at four different levels of intake.

Mineral		Intake (mg/day)	Fecal losses (mg/day)	Urinary losses (mg/day)	Retention (mg/day)
Cu	Basal	53 ± 0	36 ± 3	0	17 ± 7
	50%	152 ± 4	101 ± 9	0	51 ± 9
	100%	187 ± 18	96 ± 23	0	90 ± 21
	200%	289 ± 29	186 ± 51	0	103 ± 45
Zn	Basal	145 ± 0	169 ± 74	0	-24 ± 22
	50%	450 ± 6	392 ± 95	0	58 ± 54
	100%	608 ± 33	513 ± 112	101 ± 7	92 ± 17
	200%	983 ± 32	832 ± 234	145 ± 4	176 ± 88
Mn	Basal	252 ± 0	389 ± 143	0	-137 ± 87
	50%	749 ± 21	668 ± 204	0	71 ± 77
	100%	885 ± 90	688 ± 175	0	198 ± 108
	200%	1,338 ± 62	904 ± 254	0	434 ± 176

The data for Zn true digestibility, endogenous losses, and maintenance requirements are consistent with previously published values (Pagan, 1998). However, the corresponding values for Mn were approximately 40% higher than previous estimates (Pagan, 1998). The sigmoidal relationship between copper intake and retention precluded use of the Lucas procedure for estimation of maintenance requirements. However, when Cu retention was regressed against the 50% and 100% NRC levels of supplementation (daily intake of approximately 150 mg and 190 mg, respectively), the estimated maintenance requirement was 100 mg/day which is in accord with published recommendations (NRC, 1989).

References

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