Zinc Source Influences Zinc Retention In Hair And Hair Growth In The Dog[1]

JOHN A. LOWE*[2] JULIAN WISEMAN** AND D. J. A. COLE**

*Gilbertson & Page, Welwyn Garden City, Herts, United Kingdom AL7 1LF; **University of Nottingham, Sutton Bonington Campus, Sutton Bonington, Leics, United Kingdom LE12 5RD

EXPANDED ABSTRACT

Indexing Key Words:

• dog • zinc • chelate • calcium • hair

Zinc absorption has been shown to vary as a function of the source of the zinc in the diet (Ho and Hdiroglou 1977, Ashmead et al. 1985, Wedekind and Baker 1990, Wedekind et al. 1990) and, in dogs, as a function of the presence or absence of dietary antagonists (Robertson and Burns 1963).

Zinc absorption also varies as a function of the actual quantity of zinc in the diet (Mejborn 1990), the effect being with respect to the absolute amount of zinc absorbed with increasing dietary zinc, in contrast to the percentage absorption that may remain unchanged.

Problems may, however, arise as a result of increasing the zinc content of a diet in an attempt to increase zinc absorption form the gut. The increase in zinc content of the diet may result in interaction with another mineral causing a reduction in absorption of that mineral. Increasing dietary zinc above the minimum recommended, however, remains common practice to counteract antagonist effects on zinc absorption (NRC 1985) in many commercial diets.

It has been suggested that when dietary zinc is supplied in the form of a chelate with amino acids, rather than from inorganic sources, a greater proportion of zinc is absorbed. Depending on the amino acids used to chelate the zinc, the retention of zinc in tissues may be increased (Ashmead et al. 1989) and the undesirable effects that dietary antagonists exert on zinc absorption may be negated.

Thus the inclusion of a zinc chelate in a diet for dogs may allow for the improvement of zinc absorption irrespective of the presence of dietary antagonists without the need to increase the total zinc supply in the diet.

The purpose of this study was to compare two sources of zinc, zinc-amino acid chelate (2 mol metgly:1 mol Zn) containing 20% Zn (ZM) and a zinc-polysaccharide complex consisting of zinc sulphate complexed with alkali-modified brewers wort (the liquid portion of malted grain), 16.7% Zn (ZP) as a replacement for Zn from zinc oxide when added to a commercial diet formulation.

Materials and methods. Each zinc source was added to a typical commercial diet formulation (**Table 1**) that contained no added zinc. An equivalent of an additional 50 mg $Zn \cdot kg^{-1}$ as either ZO, ZM or ZP was provided, which achieved the recommendation for commercial dog foods as stated by the NRC (1985). The treatments were then duplicated, with the inclusion of 20 $g \cdot kg^{-1}$ of additional calcium (+C).

Four adult Beagle dogs, 9.1–12 kg body wt, were acclimatized to the diet with 50 mg $\cdot kg^{-1}$ of additional zinc from zinc oxide for 2 wk. During this period the amount of diet required to maintain weight in each dog was determined. The diet was then fed at this rate for the duration of the study. Water containing 0.51 mg $Zn \cdot l^{-1}$ was available in measured quantities on a free choice basis for drinking.

Zinc balance, hair growth and hair zinc content was determined for each treatment in a 6×4 randomized block design and analysis of variance determined accordingly ($P < 0.05$). Each treatment period consisted of a 20-d precollection phase and a 5-d collection for feces, using Indigo Carmine in a marker to marker technique. On the day before the first treatment pe-

[1] Presented as part of the Waltham Symposium on the Nutrition of Companion Animals in association with the 15th International Congress of Nutrition, at Adelaide, SA, Australia, on September 23–25, 1993. Guest editors for this symposium were Kay Earle, John Mercer and D'Ann Finley.

[2] To whom correspondence and reprint requests should be addressed.

0022-3166/94 $3.00

riod, a sample of hair was shaved from the dog's neck using a 10-cm^2 template. Thereafter the same patch was shaved on the last day of each period. The hair was handled and prepared for analysis by the method of Mundt and Stafforst (1987).

All samples were analyzed for zinc using a Pye Unichem SP9 Atomic absorption spectrometer (Cambridge, UK). Hair samples were also screened under both light and electron microscopes and a representative sample photographed.

Results. The results are summarized in **Table 2.** Fecal zinc excretion was significantly ($P < 0.05$) greater in the presence of calcium except when the supplemental zinc was supplied as the amino acid chelate. Zinc excretion was significantly ($P < 0.05$) greater in dogs fed the zinc from zinc oxide than with zinc from the other two sources. The rate of growth of hair and the amount of zinc deposited in the hair was greater ($P < 0.05$) in dogs fed diets containing zinc as the amino acid chelate (with or without added calcium), than dogs fed zinc as zinc oxide or as a zinc polysaccharide complex.

Conclusions. The amount of zinc absorbed was defined in this study as the difference between consumed zinc, supplied in the diet and that excreted in the feces. The resulting amount was considered to be available. The extent of availability being reflected by an increase in the zinc content and retention in hair.

The results indicate that the negative effect of calcium on zinc absorption can be overcome by the use of supplemental zinc supplied as either a zinc-amino acid chelate or a zinc polysaccharide complex without increasing the total zinc supply.

In addition, supplemental zinc from the zinc amino-acid chelate resulted in dogs growing more hair of a higher zinc content than when they were fed zinc from either zinc oxide or a zinc-polysaccharide complex. This indicates that the zinc from the amino acid chelate may be more available to the dog.

TABLE 1

Composition of the basal diet ($g \cdot kg^{-1}$)

Corn	550.0	Moisture	101
Poultry meat meal	120.0	Oil	120
De hulled (48%)	163.0	Protein	209
Soybean		Fiber	28
Tallow	36.0	Phosphorus	9.4
Soybean oil	36.0	Calcium	11.9
Dicalcium phosphate	17.5	Zinc	0.056
Sodium chloride	2.0	Gross energy	18.06[2]
Premix[1]	3.0	Ash	62
Beet pulp	12.5		
Wheat middlings	60.0		

[1] Premix (Gilbertson & Page, Welwyn Garden City, UK), designed to meet the micronutrient requirements of the dog with the exception of zinc, providing per kg of diet: 15,000 IU vitamin A; 1500 IU vitamin D; 200 mg vitamin E; 3 mg vitamin K; 4 mg B-1; 7 mg B-2; 3 mg B-6; 30 mg niacin; 14 mg pantothenic acid; 1.5 mg folic acid; 225 μg biotin; 55 μg B-12; 130 mg choline chloride; 60 mg iron; 8 mg copper; 25 mg mangenese; 0.75 mg cobalt; 1.75 mg iodine; 0.2 mg selenium.

[2] Expressed in $MJ \cdot kg^{-1}$.

TABLE 2

Effect of zinc source and calcium content of the diet on zinc absorption, retention and hair growth

Treatments	Faecal zinc	Hair growth rate	Zinc deposited in hair
	$mg \cdot kg^{-1} \cdot d^{-1}$	$mg \cdot d^{-1} \cdot 10\ cm^{-2}$	$\mu g \cdot 25\ d^{-1} \cdot 10\ cm^{-2}$
ZO	3.03[b]	4.775[b]	10.83[b]
ZO+C	4.02[a]	3.000[d]	7.28[c]
ZM	2.75[d]	6.025[a]	21.09[a]
ZM+C	2.74[d]	6.063[a]	21.15[a]
ZP	2.59[e]	5.215[b]	11.73[b]
ZP+C	2.90[c]	4.183[c]	9.91[b]
SED	0.02	0.244	0.90

SED, standard error of the difference. Means in the same column with different superscripts differ significantly at $P < 0.05$. ZO, 50 mg $Zn \cdot kg^{-1}$ from zinc oxide; ZM, 50 mg $Zn \cdot kg^{-1}$ from zinc amino acid chelate; ZP, 50 mg $Zn \cdot kg^{-1}$ from zinc-polysaccharide complex; +C denotes the addition of 20 g $Ca \cdot kg^{-1}$; 4 dogs per treatment.

LITERATURE CITED

Ashmead, H. D., Graff, D. J. & Ashmead, H. H. (1985) In: Intestinal Absorption of Metal Ions and Chelates. CC Thomas, Springfield, IL.

Ashmead, H. D., Graff, D. J., & Ashmead, H. H. (1989) Amino Acid Chelated Compositions for Delivery to specific Biological Tissue Sites. U.S. Patent 4863898.

Ho, S. K. & Hdiroglou, M. (1977) Effects of dietary chelated, sequestered zinc and zinc sulphate on growing lambs fed a purified diet. Can. J. Anim. Sci. 57: 93–99.

Mejborn, H. (1990) Endogenous zinc excretion in relation to various levels of dietary zinc intake in the mink (*Mustela vison*) J. Nutr. 120: 862–868.

Mundt, H. C. & Stafforst, C. (1987) Production and composition of dog hair. In: Nutrition, Malnutrition and Dietetics in the Dog and Cat (Edney, A. T. B., ed.), BVA, London.

National Research Council (1985) Nutrient Requirements of Dogs. Natl. Acad. Sci., Washington, DC.

Robertson, B. T. & Burns, M. J. (1963) Zinc metabolism and the zinc deficiency syndrome in the dog. Am. J. Vet. Res. 24: 997–1001.

Wedekind, K. J., Hortin, A. E. & Baker, D. H. (1990) Bioavailability of Zn in a zinc methionine chelate. J. Anim. Sci. 68 (Suppl. 1) 394 (abs.).

Wedekind, K. J. & Baker, D. H. (1990) Zinc bioavailability in feed grade sources of zinc. J. Anim. Sci. 68: 684–689.