Nutrient Content Of Nutritional Supplements Available For Use In Captive Lizard Feeding Programs

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To provide a nutritionally complete diet to insectivorous lizards, allow animal managers and nutritionists to evaluate their current diets, and provide complete diet information for all zoos to use, nutrient content of supplements used for invertebrate-based lizard diets was determined. The first step of this process was to develop a list of supplements commonly used and determine the extent to which their nutrient content was known (via survey). The second step was to determine the nutrient content of those supplements lacking information. Nutrient determinations included: proximates (DM, Fat, Crude Protein), energy, minerals (Ca, P, K, Mg, Na, Fe, Mn, Cu, I, Zn), and vitamins A, D, E, K, B_6, B_{12}, C, thiamin, riboflavin, niacin, pantothenic acid, and biotin. A summary of 15 supplements was complied, with only 2 having a complete set of known nutrient values.

Key words: diet information; nutritional content; lizards

INTRODUCTION

To ensure that exotic lizard populations are viable and sustainable on a long-term basis, animals must be offered a nutritionally sound diet. The diet must meet all of the nutrient requirements of the individual animal while providing food choices to complement its gut morphology and feeding strategy [Crissey, 1997]. The diet also must be palatable to the animal and relatively easy to obtain.

There is limited information available on the nutrient requirements of captive exotic lizards [Ward and Crissey, 1997]. Insect-eating lizards have posed nutritional problems for managers in the past, primarily with metabolic bone disease stemming from vitamin D and/or calcium deficiencies and more recently with calcification of soft tissues due to possible excessive quantities of these nutrients [Allen and Oftedal, 1994; Bernard and Allen, 1997; Donoghue and

Langenberg, 1994]. Additionally, there may be possible relationships of nutrients to some occurrences of reproductive failure, failure to hatch, and/or deformities of young [Boyer, 1996]. To examine the relationship, if any, of these problems to nutrition and to ensure adequate feeding regimes, it is essential that the nutrient composition of each component of the diet is known.

The nutrition of lizards in captivity depends primarily on the food items provided. Insects available commercially are limited in species and stage of development compared to the array available to free-ranging lizards. As in the wild, invertebrates can provide insectivorous lizards with sources of protein and fat. However, while adequate in protein and fat, the nutrient content of invertebrates provided to captive lizards will not meet nutrient needs unless supplemented.

It is well known that insects contain little calcium and may be lacking in any number of other nutrients. Data show that invertebrates analyzed (except the earthworm) contained inverse calcium to phosphorous ratio [Allen and Oftedal, 1994]. Historically, insects have been dusted with any number of products, usually to increase calcium. In more recent years, a dietary method of supplementation to insects has been used. If controlled well, dietary nutrients can be offered to the invertebrate prey that can fortify them as a nutrient source [Allen, 1989; Hunt et al., 2001; Ward and Crissey, 1997].

While it has become practice to fortify food insects, it is interesting that the nutrient content of many products potentially useful for supplementation remains unknown [Donoghue and Langenberg, 1994]. The purpose of this study was to determine the known nutrient content of selected supplements used in lizard diets, to determine unknown nutrients, and to evaluate these supplements for their ability to complement the nutrients available in invertebrate prey.

MATERIALS AND METHODS

A survey was sent to members of the American Zoo and Aquarium Association Lizard Taxonomic Advisory Group (TAG) in 1998 to determine the known nutrient content of the supplements used in their lizard diets. Additionally, manufacturer packaging was used for information and manufacturers also were contacted. Due to the proprietary nature of some product formulations, some manufacturers were reluctant to provide complete (or any) nutrient information. Samples with missing nutrient information were submitted for nutrient analysis (DM, fat, crude protein: Dairy One, Ithaca, NY and minerals: Nutritional Services Laboratory, Fort Worth Zoo, Fort Worth, TX).

RESULTS

Initial results indicated that Walkabout Dust for Invertebrates (Walkabout Farms, Pembroke, VA) and Mazuri Hi-Ca Cricket Diet (PMI, St. Louis, MO) had the majority of nutrient values listed in their manufacturer information. The nutrient content of the other products, while in use, was not provided by the

manufacturer. These remaining products were analyzed to determine nutrient content (Table 1). When a value is shown as missing, it has not been determined, but where it is actually zero (0), there is none of that nutrient in the product.

Comparing the known nutrient content of the supplements, there are vast differences among products (calcium levels ranging from 1.2 – 100%). Vitamin D may be absent in some, but as much as 80,000 IU/kg in others. These wide variations are evident among all products.

DISCUSSION

The practical implications of the results are two-fold. First, there is information lacking with respect to the nutrient content of supplements commonly fed to reptiles. Thus, when the supplements are used, the actual level of nutrients provided is unknown. This may result in under- or over-supplementation. Second, the known nutrient content of reptile supplement products varies widely so that the user must be cautious in supplement substitutions. It should be noted that in some cases, the product used might be purposefully missing a nutrient that was formulated that way depending on its intended use.

It also is important that the supplements be used to complement the nutrients contained in the base diet itself. If the base diet is comprised of insects, supplements must be selected with care. Table 2 [adapted from Allen and Oftedal, 1994] illustrates examples of the known nutrient content of invertebrates fed to insectivorous lizards.

Once the nutrient content of supplements is known, the supplements can be used in combination with insects and/or other diet items contributing to a nutritionally complete diet that meets the needs of the lizards consuming the diets. With this information complete, it is possible to determine if a diet is or was related to any suspected nutritional problems. Without this information, such a determination and correction of a problem is impossible.

CONCLUSIONS

1. Gaps currently exist in the information used to adequately utilize supplements in captive lizard diets. This information, in part, closes some of those gaps.
2. Supplements that lack complete nutrient information provided either by the manufacturer or lab analyses should not be used or used cautiously in order to avoid under- or over- supplementation.

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TABLE1. Nutrient content, analyzed (A) or provided by manufacturer (M), of selected supplements used in lizard diets (dry matter basis).

	Supplement[1]														
Nutrient	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Fat, %	4	-	-	-	-	-	3.9	-	-	3.08	-	9	-	18	9.6
Crude Protein, %	19	-	-	-	-	-	21	-	-	10.2	-	19.6	-	38	22
Calcium, %	9.6	37.1	2.5	23.5	6.7	10.5	6.5	29.4	11.4	22.6	100	8.3	4.7	1.4	13.3
Phosphorous, %	0.6	0.02	1.1	11.4	0	4.8	0.74	6.4	4.8	2.9	-	0.69	0.7	1	0.5
Potassium, %	0.93	0.2	1.8	1.9	0.1	-	1	0.2	-	0.43	-	0.88	1.4	1.88	1
Magnesium, %	0.35	0.3	0.3	0.3	0.07	0.04	0.23	0.2	0.04	0.21	-	0.25	0.2	0.12	0.1
Sodium, %	0.24	0.6	0.8	1.4	0.3	0.75	0.2	0.2	1.5	0.12	-	0.25	0.03	-	0
Iron, mg/kg	453	702	4425	653	2782	5.5	574	84	114	280	-	440	358	7.6	665
Manganese, mg/kg	311	274	403	99	2187	-	172.5	25	87.4	181	-	73	861	0.32	28
Copper, mg/kg	-	22	279	541	1163	423.1	26.3	20	11.3	12.1	-	12	316	0.69	60
Iodine, mg/kg	-	-	2.1	77.1	100	550	-	-	-	-	-	0.61	79.3	0.14	12
Zinc, mg/kg	253	0	362	856	1068	-	128	31	-	205	-	85	362	-	980
Vitamin A, IU/g	-	-	220	220	6600	220	-	257	45.4	339	-	13	2203	1188	155
Vitamin D3, IU/g	-	2.26	22.9	23	10	22	-	38	4.54	-	-	2.5	115	95	31
Vitamin E, mg/kg	-	-	0.22	200	6670	94802	-	100	-	356	-	2	10573	14	1270
Vitamin K, mg/kg	-	-	-	-	1330	-	-	102	-	-	-	0.26	52.9	-	11

TABLE 1. Nutrient content, analyzed (A) or provided by manufacturer (M), of selected supplements used in lizard diets (dry matter basis) (cont'd).

	Supplement[1]														
Nutrient	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Vitamin B6, mg/kg	-	-	67	70	667	9.98	-	-	2.06	-	-	5	1322	0.38	56
Vitamin B12, mg/kg	-	-	6.7	6.7	3033	0.15	-	-	0.03	-	-	0.014	8.8	0.008	0.81
Vitamin C, mg/kg	-	-	3084	3000	16670	2495	-	-	515	-	-	-	3965	66.5	5780
Thiamin, mg/kg	-	-	165.5	160	667	39.6	-	10	-	-	-	9.2	1762	0.38	56
Riboflavin, mg/kg	-	-	224.9	270	1670	79.2	-	30	-	-	-	8	1322	0.83	119
Niacin, mg/kg	-	-	660.8	660	10000	275	-	-	56.8	-	-	63	-	3.29	635
Pantothenic Acid, mg/kg	-	-	1869	1900	3300	110	-	220	-	-	-	16	-	3.85	478
Biotin, ug/kg	-	-	26432	26	-	-	-	-	-	-	-	0.17	-	99.7	925
Source of Values**	A/M	A/M	A/M	A/M	A/M	M	M	A/M	M	A	M	M	A/M	A	A

A = Ziegler Cricket Diet, Ziegler Bros., Gardeners, PA; B = Rep-Cal, Ca and D3, RepCal Research Labs, Los Gatos, CA;
C = Herptivite, RepCal Research Labs, Los Gatos, CA; D = Reptivite, RepCal Research Labs, Los Gatos, CA;
E = Nekton-Rep, Nekton USA, Clearwater, FL; F = Vionate Vit-Min, Gimborn Rich Health;
G = Marion Zoological Insect Supplement, Plymouth, MN; H = Reptical, TertraTerrafauna, Morris Plains, NJ;
I = Vionate Multivitamin, Gimborn Rich Health; J = Toronto Zoo Reptile Supplement, Toronto, Ontario Canada;
K = Rep-Cal, Ca, no D3, RepCal Research Labs, Los Gatos, CA; L = Mazuri Hi-Ca Cricket Diet, St. Louis, MO;
M = Vitolife, Tetra Terrafauna, Morris Plains, NJ; N = Pro Balance, Universal Pet Products, San Diego, CA;
O = Walkabout Dust for Invertebrates, Nutritional Support Services, Pembroke, VA

TABLE 2. Selected nutrient composition of invertebrates commonly fed to zoo animals (as % of dry matter)[1]

Nutrient	Mealworm Larvae	Fruitfly	Cricket Adult	Wax Moth Larvae	Earthworm
C. Protein, %	48	70	66	31	65
Lipid, %	36	13	17	61	7
Ash, %	4.6	4.5	6.1	1.8	10.3
Ca, %	0.07	0.10	0.18	0.03	1.18
P, %	0.60	1.05	0.86	0.39	0.90

[1]Adapted from Allen and Oftedal, 1994.