A Comparison Of Dietary Intake In Captive, Jamaican Iguanas (*Cyclura collei*) At Four United States Zoos

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The dietary intake of captive, Jamaican iguanas (*Cyclura collei*) was measured at four institutions including four U.S. zoos, Indianapolis Zoo (*n* = 1, 1.2 iguanas), Fort Worth Zoo (*n* = 2, 2.2 iguanas), Sedgwick County Zoo (*n* = 3, 1.2 iguanas), and San Diego Zoo – CRES (*n* = 3, 3.3 iguanas). The diets offered at all four zoos consisted mainly of a type of reptile salad, containing a variety of fruits, vegetables, and leafy greens, with or without the use of nutritionally complete feeds and other supplements. The diets offered and food remaining were measured and nutrient content for both determined in order to calculate nutrients consumed. Mean body mass (BM) ranged from 0.77 kg to 2.61 kg and mean daily dry matter intake (DMI) per animal ranged from 3.98 to 8.05 g•kg BM^{-1}. The average nutrient content of the diets offered on a dry matter basis (DMB) was 16.26 – 26.95% crude protein (CP), 13.13 – 24.29% acid detergent fiber (ADF), 16.20 – 28.90% neutral detergent fiber (NDF), 2.23 – 3.83% crude fat, 1.15 – 2.44% calcium (Ca), and 0.38 – 0.60% phosphorus (P). The average nutrient content of the diets consumed was 11.24 – 19.94 %crude protein (CP), 5.90 – 30.40% acid detergent fiber (ADF), and 7.97 – 35.33% neutral detergent fiber (NDF), 1.52 – 4.04% crude fat, 0.38 – 3.56% calcium (Ca), and 0.38 – 0.60% phosphorus (P). These data provide a basis for the establishment of a database, which will provide valuable information to improve nutritional husbandry of captive Jamaican iguanas. Additional studies are underway to further define the feeding ecology and nutritional needs for this species.

Key words: reptile; nutrient intake; body mass

INTRODUCTION

The critically endangered status of the Jamaican iguana, as ranked by the IUCN/SSC West Indian Iguana Specialist Group, has led to the establishment of captive breeding programs, both in Jamaica and in United States zoos. To date none of the captive animals have successfully reproduced. This may be related to an inadequate diet. Knowledge of basic biology, including nutrient needs, is

necessary to develop an appropriate husbandry protocol for captive animals. Therefore it is imperative that captive diets are analyzed and the results compared to information available on general iguana nutrition in order to evaluate the efficacy of captive nutrition programs for Jamaican iguanas.

The most in depth information in current literature on iguana diets is for the green iguana (*Iguana iguana*) and diets developed for many herbivorous lizards in captivity have been based on this information [Allen et al., 1982; Baer et al., 1993; Allen and Oftedal, 2002]. These data may not be applicable to an island dwelling species, such as the Jamaican iguana (*Cyclura collei*), which has a much more limited range and possibly a more specialized diet. Preliminary data are available on the types and nutrient content of plants consumed by this species in the wild, although these data are incomplete [Ward et al., 1999]. Some data are available for comparison on the diets fed to captive populations of Jamaican iguana held at the Hope Zoo, Kingston, Jamaica [Ward et al., 1999]. The purpose of the current study was to begin an evaluation of the nutrient content of diets consumed by captive Jamaican iguanas held in U.S. zoos.

MATERIALS AND METHODS

Sixteen iguanas, housed indoors at four zoos, were subjects in a diet intake study. The intake study was a quantification of current feeding practices at each zoo. Number of iguanas per enclosure ranged from 1 to 3 animals. Animals within an enclosure were of similar age ranging from 7 to 10 years old. Enclosure dimensions varied. The data collection period varied for each zoo based on feeding practices and ranged from 4 to 7 days. Each zoo was sent a preliminary questionnaire to determine the current feeding practices as well as the diet fed. Using this information, instructions were customized to each zoo in an effort to standardize data collection for this study.

Iguanas at all four zoos were fed mixed salad diets with the addition of commercially made feeds and/or supplements. On each day animals were fed, a duplicate diet was prepared and immediately frozen for analysis of the diet offered for each enclosure or group. The total amount of diet offered per day to each enclosure was weighed and recorded. On the following day, food remaining in each enclosure was removed, weighed and frozen for analysis. All samples were shipped on dry ice to the Fort Worth Zoo once data collection was finished.

Samples of the diets offered and food remaining were analyzed for dry matter (DM), crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) by a commercial laboratory (DHI Forage Testing Laboratory, 730 Warren Road, Ithaca, NY 14850). Calcium (Ca) and phosphorus (P) levels were analyzed at the Fort Worth Zoo Nutritional Services Laboratory [AOAC, 1997]. All animals were weighed and measured prior to intake data collection.

RESULTS

Group sizes were uneven making between age group comparisons difficult (Table 1). Data is discussed using the mean of each group. Body mass (BM) ranged from 0.77 kg to 2.61 kg. Snout vent length (SVL) ranged from 27 cm to 38.4 cm. Daily dry matter intake (DMI) in grams per day per kilogram body mass (DMI g•kg BM^{-1}) ranged from 3.98 to 8.05. Daily DMI as percent of body mass ranged from 0.41 to 0.81%. Daily nutrient intakes (g•kg BM^{-1}) ranged as follows: 0.91 to 1.86 CP, 0.76 to 2.26 ADF, 0.79 to 2.90 NDF, 0.09 to 0.41 fat, 0.03 to 0.34 Ca, and 0.02 to 0.04 P.

Nutrient content of the diets offered and consumed on a dry matter basis (DMB) are presented in Table 2. Dry matter content of the diets offered ranged from 11.78 to 19.49%. Crude protein content in the diets offered ranged from 16.26 to 26.95% and in the diets consumed ranged from 11.24 to 19.94%. Acid detergent fiber content in the diets offered ranged from 13.13 to 24.29% and in the diets consumed from 5.90 to 30.40%. Neutral detergent fiber content in the diets offered ranged from 16.20 to 28.90% and in the diets consumed from 7.97 to 35.33%. Fat content in the diets offered ranged from 2.23 to 3.83% and in the diets consumed from 1.52 to 4.04%. Calcium content in the diets offered ranged from 1.15 to 2.44% and in the diets consumed from 0.38 to 3.56%. Phosphorus content in the diets offered ranged from 0.38 to 0.60% and in the diets consumed from 0.0.25 to 0.45%. Contribution of individual ingredients to dietary nutrient content was not determined.

DISCUSSION

Body mass and SVL appear lower for Jamaican iguanas in this study compared to published data available on green iguanas. Two and a half year old green iguanas hatched and raised as part of a breeding program in Panama had a mean BM of 0.58 kg [Baer et al., 1993]. From hatch, these animals were raised for fast growth and at 3+ years of age had a mean final BM of 0.79 kg. Free ranging green iguanas in Costa Rica captured at 1 year of age already weighed 0.25 kg with a SVL of 14.5-18.5 cm [Van Devender, 1982]. These differences may be attributed to differences in the nutrient content of the diets consumed as well as species variation. Restricted feed intake in the current study and may have resulted in slower growth. Snout-vent length was comparable to that of Jamaican iguanas of similar age (7 and 8 years) at the Hope Zoo, Kingston, Jamaica that had a mean SVL of 30.79 $\pm$ 1.97 cm and ranged from 26.0 to 37.3 cm [Ward, et al., 1999].

In general, the animals in this study had DMI (as %BW/d) that were similar to green iguanas offered a pelleted diet [Baer et al., 1993]. Differences in intake may be attributed the lower nutrient density of the zoo diets and possibly an increased palatability of this salad type diet. Comparative data on CP, fat, Ca, and P intake do not exist. However, daily NDF and ADF intake (g•kg BM^{-1}) tended to be lower than those reported for green iguanas even though the diets

in this study appeared to have higher fiber levels [Baer et al., 1993]. This may indicate that the Jamaican iguanas in the present study were preferentially consuming lower fiber items in the mixed salad diets. The Jamaican iguana reportedly consumes more fruit than the more folivorous green iguana in the wild. It is not clear if fiber intakes in this study reflect the preference of this species for lower fiber, less nutrient dense fruits.

Dry matter and fat levels for the diets offered and consumed were lower than nutritionally complete pelleted diets fed to green iguanas in previous studies [Baer et al., 1993]. However, in general, ADF and NDF levels in offered and consumed diets were comparable to pelleted feeds and to recommended nutrient levels for green iguanas which supported growth [Allen and Oftedal, 2002; Allen et al., 1982; Baer et al., 1993]. Crude protein of the diet offered (16.26 –26.95%) was lower than salad diets fed in a previous study (31% CP) but comparable to nutritionally complete pelleted diets (22% CP) and to recommendations [Allen and Oftedal, 2002; Allen et al., 1989; Baer et al., 1993; Donoghue, 1994]. Three of the four CP levels of the diets consumed (11.24%, 14.26%, and 14.60%) appeared to be below suggested levels for reproducing adults. Calcium levels in diets offered met or exceeded recommended levels [Allen and Oftedal, 2002]. Generally, Ca levels in the diets consumed met recommended levels though a large amount of variation existed between institutions. Phosphorus levels in diets offered and consumed were below suggested levels to maintain iguanas in all life stages [Allen and Oftedal, 2002].

The length of data collection periods in this study were variable, averaging 4 days, and may not have been representative of normal intake. In addition, the variability in values for the diets consumed may be reflective of problems with sample collection.

CONCLUSIONS

1. Currently, none of the Jamaican iguanas in captivity have successfully reproduced and this may be related to nutrient intakes.
2. Long term data collection using homogenous, nutritionally complete diets, is needed to determine appropriate dietary nutrient levels for the Jamaican iguana over all physiological states.

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TABLE 1. Mean body measurements, mean daily dry matter intake (DMI) and daily nutrient intakes for several groups of captive, Jamaican iguanas (*Cyclura collei*)

Measurement	Indianapolis Zoo	Fort Worth Zoo	Sedgwick County Zoo	San Diego Zoo /CRES
Number of animals	3	4	3	6
Age (years)	9.0	9.75 ± 0.50 [a]	8.0	7.0
BM (kg)	2.15 ± 0.91	2.61 ± 0.89	0.88 ± 0.14	0.77 ± 0.26
SVL (cm)	36.6 ± 4.91	38.4 ± 3.77	27.0 ± 1.32	27.8 ± 3.51
DMI ($g \cdot kg\ BM^{-1}$)	4.39 ± 1.97	3.98 ± 2.13	10.73 ± 3.77	8.06 ± 3.26
DMI (%BM/d)	0.44	0.40	1.22	0.81
CP ($g \cdot kg\ BM^{-1}$)	0.91 ± 0.41	0.88 ± 0.55	1.64 ± 0.59	1.86 ± 0.94
ADF ($g \cdot kg\ BM^{-1}$)	0.93 ± 0.28	0.76 ± 0.33	2.26 ± 1.30	0.86 ± 0.28
NDF ($g \cdot kg\ BM^{-1}$)	1.12 ± 0.29	0.79 ± 0.44	2.90 ± 1.33	1.17 ± 0.32
Fat ($g \cdot kg\ BM^{-1}$)	0.14 ± 0.09	0.09 ± 0.04	0.38 ± 0.15	0.41 ± 0.32
Ca ($g \cdot kg\ BM^{-1}$)	0.10 ± 0.07	0.03 ± 0.02	0.34 ± 0.18	0.16 ± 0.08
P ($g \cdot kg\ BM^{-1}$)	0.02 ± 0.01	0.02 ± 0.02	0.04 ± 0.03	0.04 ± 0.02

[a]Values are means ± SEM.

TABLE 2. Mean nutrient concentration of diets offered and consumed by captive, Jamaican iguanas (*Cyclura collei*) on a dry matter basis[a,b]

	Indianapolis Zoo		Fort Worth Zoo		Sedgwick County Zoo		San Diego Zoo /CRES	
Nutrient	**Diet Offered**	Diet Consumed	**Diet Offered**	Diet Consumed	**Diet Offered**	Diet Consumed	**Diet Offered**	Diet Consumed
CP %	23.66 ± 4.41	19.94 ± 7.32	23.85 ± 1.56	14.60 ± 8.91	16.26 ± 1.19	14.26 ± 5.35	26.95 ± 1.22	11.24 ± 2.00
ADF %	24.29 ± 6.58	30.40 ± 28.57	17.58 ± 2.31	13.03 ± 7.28	19.95 ± 2.56	20.82 ± 7.44	13.13 ± 1.50	5.90 ± 1.91
NDF %	28.90 ± 8.55	35.33 ± 29.49	22.68 ± 3.82	12.06 ± 6.45	26.49 ± 2.52	27.29 ± 12.49	16.20 ± 2.09	7.97 ± 2.40
Fat %	2.51 ± 1.13	3.30 ± 1.53	2.23 ± 0.53	1.52 ± 1.14	3.65 ± 0.57	4.04 ± 2.56	3.83 ± 1.47	2.35 ± 1.41
Ca %	2.09 ± 0.94	2.30 ± 1.30	1.15 ± 0.22	0.38 ± 0.26	2.38 ± 0.33	3.56 ± 2.52	2.44 ± 0.53	0.97 ± 0.39
P %	0.47 ± 0.13	0.45 ± 0.09	0.60 ± 0.15	0.41 ± 0.31	0.38 ± 0.05	0.41 ± 0.38	0.48 ± 0.07	0.25 ± 0.08

[a]Values expressed as mean ± standard deviation.
[b]Mean Dry matter (DM) content of the diets offered at each zoo were: 11.78 ± 2.19 % IZ, 12.47 ±3.05% FWZ, 19.49 ± 2.71 % SCZ, and 12.79 ± 2.07 % SDZ/CRES.