A SURVEY OF THE NUTRIENT CONTENT OF FOODS CONSUMED BY FREE RANGING AND CAPTIVE ANEGADA IGUANAS (*CYCLURA PINGUIS*)

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Abstract

Nutrient concentrations were determined in foods consumed by both free ranging and captive Anegada iguanas (*Cyclura pinguis*). Twenty-two species of plants, known to be consumed by free ranging iguanas during the dry season, were collected and analyzed. The plant parts were separated and categorized for analysis as flowers, fruits, or leaves. Mean nutrient concentrations and standard errors (SEM), on a dry matter basis (DMB), included protein (CP) 9.61% ± 0.84, acid detergent fiber (ADF) 29.17% ± 2.29, neutral detergent fiber (NDF) 37.48% ± 3.06, and crude fat (FAT) 4.87% ± 0.81. Nutrient concentrations were analyzed in diets offered and consumed by captive iguanas held for re-introduction at a headstart facility on Anegada, British Virgin Islands. Captive diets were comprised of mixed greens (cabbage, romaine), natural leaves (buttonwood and parrotwood), fruits (banana, honeydew melon), vegetables (red pepper, carrot, cucumber, mushroom), and a commercial complete feed (Zoo Med Juvenile Iguana Diet). Diets consumed by hatchlings and juveniles were 17.36 – 21.97% CP, 18.24 – 34.95% ADF, 18.57 – 36.08% NDF, and 2.11 – 4.36% FAT. All captive Anegada iguanas consumed higher protein levels than those levels available in plants during the dry season. These captive consumption levels were similar to those consumed by headstarted Jamaican iguanas (*Cyclura collei*), as well as levels in plants collected during the dry season in Jamaica. The CP range consumed by Anegada iguanas was at the low end of CP levels supporting growth in green iguanas.

Introduction

The Anegada iguana (*Cyclura pinguis*), with a total wild population of less than 200 individuals, is ranked as critically endangered by the IUCN/SSC Iguana Specialist Group. Major causes of decline are: competitive grazing pressure from free-ranging livestock, predation by feral dogs, and predation of juveniles by feral cats. As a result, captive breeding programs have been established in Anegada and in the United States (US), at the San Diego Zoo (CRES). Hatchling iguanas in Anegada have been removed from the wild to be raised in captivity at a headstart facility until they have reached a size sufficient to avoid predation.

Currently, no nutritional data, nutrient content of wild diet and nutrient levels required to maintain animals in captivity, exist for the Anegada iguana. However, some data do exist on Jamaican iguanas (*Cyclura collei*). Data for this species on plants consumed in the wild during the dry season, and on nutrient levels consumed by captive animals in a headstart program and in zoos has been published.[10,11] The most in-depth information in current literature on iguana diets is for the green iguana (*Iguana iguana*).[2] The purpose of this study was to begin an evaluation of the nutrient content of foods consumed by free-ranging animals, as well as to assess the nutrient content of the headstart diet, in order to promote good health and appropriate growth.

Methods

Twenty-two species of plants known to be consumed by free-ranging iguanas in Anegada, during the dry season, were collected. Plants were separated and categorized for analyses as flowers, fruits, or leaves. Seeds appeared to pass through the gastrointestinal tract undigested as evidenced by their appearance in scat samples. Consequently, seeds were removed from most fruits before analysis. In some plants, seeds were so small and abundant that their removal would have resulted in too little fruit for analysis. For those fruits, seeds are included in the analysis.

Twenty-three iguanas, divided into 3 outdoor enclosures were subjected to a 4-day intake study. The intake study was a quantification of current feeding practices. Number of animals per enclosure ranged from 4 to 13 animals. Animals within an enclosure were of similar age. Age groups ranged from less than 1 year old to 5 years old ($\leq$ 1yr = hatchlings, 1-5 yr = juveniles for the purposes of this study). Iguanas were fed a mixed salad diet. Buttonwood leaves (*Conocarpus erectus*), cabbage, red pepper and carrots were offered daily in the mix. A commercially available iguana diet was added on days 1 and 4 (Zoo Med Juvenile Iguana Pellets, 3100 McMillan Rd., San Luis Obispo, CA 93401 USA). Additional produce items added each day varied and included: green peppers, peeled banana, mushrooms, parrotwood leaves (common name only, scientific identity not yet determined), cauliflower, romaine, honeydew, cucumber, and tomato. A subsample of the mixed diet was collected daily. The amount of diet offered to each enclosure was weighed and recorded. After a 24-hour period, food remaining in each enclosure was removed and contamination from dirt and sand was wiped or rinsed off. Samples were immediately ground, subsampled and dried prior to analysis. Plant parts, samples of diets offered, and orts remaining were analyzed for dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and crude fat (FAT) by wet chemistry methods through a commercial laboratory (DHI Forage Testing Laboratory, 730 Warren Rd., Ithaca, NY 14850).

Results and Discussion

Plant Analysis

Table 1 designates the mean DM and nutrient content of plants consumed by free-ranging Anegada iguanas in comparison with data from Jamaican iguanas and green iguanas. Means represent all plant parts consumed. CP levels consumed by Anegada iguanas were similar to those consumed by free-ranging Jamaican iguanas and levels in plants *not* chosen by free-ranging green iguanas. Plants consumed by free-ranging green iguanas were considerably higher in CP content. ADF levels consumed were similar to those consumed by free-ranging Jamaican and green iguanas but lower than in plants *not* consumed by green iguanas. NDF levels were also similar to those consumed by free-ranging Jamaican and green iguanas, but lower than in plants not consumed by green iguanas. FAT levels consumed by Anegada iguanas were similar to those consumed by green iguanas and given the large SEM there was no apparent difference from FAT levels in plants not consumed by green iguanas.

Competition from free-ranging livestock may limit Anegada iguanas to less than optimal diets or protein levels, similar to low protein plants not chosen by free-ranging green iguanas.[3] The average analyzed CP content of plants was less than the CP levels (13%-14%) that resulted in poor growth in captive green iguanas.[7,8] Consumption of animal matter by green iguanas is only documented by isolated observations, or incidentally, as summarized by Baer.[5] The Caicos ground iguana (*Cyclura carinata*) ingests animal material deliberately, though at a very low level (4% of diet), as estimated from examination of stomach contents.[4] Similarly, the Anegada iguana may use limited consumption of animal material, either deliberately or incidentally, as a method of supplementing an herbivorous, low protein diet. Although nutrient levels were similar to Jamaican plants, those iguanas, as well, may not consume optimal diets during the dry season. While data are lacking, it is possible a better plane of nutrition may be achieved during the wet season. Reproduction appears to be limited to the wet season, further indicating the possibility that dry season nutrient levels are limited.

Fiber levels (ADF and NDF) indicated that Anegada iguanas are not forced to consume diets higher in fiber than in plants not consumed by the green iguana. Differences were not apparent in FAT levels consumed by Anegada iguanas when compared to plants either chosen or not chosen for consumption by green iguanas. SEM For all nutrients was high with many values overlapping making comparisons difficult.

Headstart Facility Intake Study

Six month old hatchlings in enclosure 8 (ENC 8) were smaller in body weight, 0.09 ± 0.005 kg, to captive hatch iguanas at the San Diego Zoo/CRES, 0.12 ± 7.4 kg (Table 2).[9] The difference in size may be a result of less optimal nutrition for the headstart animals for the initial months of their free-ranging lives. Animals in enclosures six and nine, while analyzed separately were similar in age, approximately 4 – 5 years old. Body weights were similar to or exceeded those for headstarted Jamaican iguanas, which ranged in age from 2-5 years (mean = 3.83 years) and had a mean body weight 0.63 kg.[11]

Incomplete removal of contamination of dirt and sand, used as a substrate, resulted in eliminating one to two days of measures for some enclosures. Dry matter intake (DMI) in per day per kilogram body mass (DMI g/d/kg BM), DMI as a percent of body mass per day (DMI %BM/d), and nutrient intakes (g/d/kg BM) for CP, ADF, NDF, and FAT are presented in Table 2. The youngest animals had the greatest DMI, as well as nutrient intakes, while the oldest animals had the lowest. Food always remained following the feeding period, however, long expose to heat, humidity and rain, may have affected palatability. One group of juveniles (ENC 9), had considerably higher intakes of all nutrients compared to the other group of juveniles (ENC 6). Competition among individuals may have affected intakes in each of these groups. Although the diet in each enclosure was split among several feeding stations, ENC 6 contained more animals of larger body mass. All intakes were more comparable to headstarted Jamaican iguanas[11] than adult Jamaican iguanas in US zoos[10] fed salad type diets and to juvenile green iguanas fed a meal diet of similar nutrient content.[6]

Diets consumed by captive Anegada iguanas differed from those offered, an indication the animals were selecting specific food items (Table 3). Consumed diets were higher in CP, similar

to or lower in ADF and NDF, and had no clear trend with regard to FAT as compared to diets offered. The diets offered were lower in CP (13.20–16.43%) as compared to diets that resulted in adequate growth for green iguanas (22%)[2,7], while diets actually consumed were more similar to this level (17.36 – 21.97%). The CP content of the diet consumed supported growth rates ranging from 0.95 g/day to 1.35 g/day for Anegada juveniles. Growth rates were calculated from data recorded 6 months prior to the intake study, during which the diet offered was similar to that measured during the intake study. These rates exceed those for hatchling Anegada iguanas at CRES (0.63 g/day),[9] and hatchling green iguanas (0.30 – 0.40 g/day)[1,7] offered diets similar in CP content. These growth rates are comparable, however, to those measured in juvenile green iguanas fed a higher protein diet, similar in fiber content.[6] Fresh leaves known to be consumed by free-ranging Anegada iguanas were mixed into the daily salad diet for the captive animals and contributed a significant level of fiber (19.5-26.1% ADF, 22.0-33.4% NDF). These leaves were the most frequently left diet ingredient based on observation of orts, resulting in the lower fiber content of the consumed diet verses the offered diet.

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Table 1. Comparison of mean nutrient concentrations of plants consumed by free-ranging Anegada iguanas (*Cyclura pinguis*) and Jamaican iguanas (*Cyclura collei*) with plants consumed and plants not chosen by free-ranging green iguanas (*Iguana iguana*) on a DMB[a].

	Anegada iguanas	Jamaican iguanas	Green iguanas	
Nutrient	Plants consumed	Plants consumed[b]	Plants consumed[c]	Plants not chosen[c]
DM %	40.85 ± 3.15%	44.78 ± 6.71%	16.50 ± 1.98%	33.53 ± 4.71%
CP %	9.61 ± 0.85%	10.68 ± 1.66%	22.63 ± 5.61%	11.65 ± 2.75%
ADF %	29.17 ± 2.30%	34.27 ± 5.70%	26.95 ± 5.83%	40.28 ± 7.25%
NDF %	37.48 ± 3.07%	37.48 ± 5.10%	45.15 ± 4.92%	52.55 ± 4.79%
FAT %	4.87 ± 0.81%	na	5.35 ± 1.39%	8.83 ± 3.55%

[a]Means of all plant parts consumed or not consumed, values expressed as mean ± SEM.
[b]Values from Ward et al. 1999.
[c]Values from Allen et al. 1989.

Table 2. Body measurements, dry matter intakes (DMI) and nutrient intakes (means ± SEM) for 3 groups of captive, Anegada iguanas (*Cyclura pinguis*).

Measurement	Hatchlings Enclosure 8	Juveniles Enclosure 9	Juveniles Enclosure 6
Number of animals	13	4	6
Age (years)	0.50 ± 0.00[a]	4.25 ± 0.25	4.83 ± 0.41
BM (kg)	0.09 ± 0.005	0.64 ± 0.03	1.00 ± 0.05
DMI (g/d/kg BM)	41.82 ± 25.51	32.57 ± 15.88	13.25 ± 4.84
DMI (%BM/d)	4.18 ± 2.55	3.26 ± 1.59	1.32 ± 0.48
CP (g/d/kg BM)	6.40 ± 0.85	4.40 ± 1.84	2.13 ± 0.56
ADF (g/d/kg BM)	9.63 ± 5.55	7.06 ± 3.15	2.81 ± 1.61
NDF (g/d/kg BM)	10.07 ± 4.92	7.29 ± 3.55	2.88 ± 1.68
FAT (g/d/kg BM)	1.47 ± 0.24	0.87 ± 0.64	0.27 ± 0.16

[a]Exact age for hatchlings was unknown as they were collected in the wild after hatching and date of collection was not recorded. All animals had been captive for 0.5 yrs.

Table 3. Mean nutrient concentration of diets offered and consumed by captive Anegada iguanas (*Cyclura pinguis*) on DMB.[a,b]

	Hatchlings Enclosure 8		Juveniles Enclosure 9		Juveniles Enclosure 6	
Nutrient	Diet Offered	Diet Consumed	Diet Offered	Diet Consumed	Diet Offered	Diet Consumed
CP %	13.50 ± 4.95	19.58 ± 13.97	16.43 ± 4.37	21.97 ± 8.69	13.20 ± 2.51	17.36 ±3.59
ADF %	26.55 ± 3.75	23.32 ± 0.96	31.73 ± 6.63	34.95 ± 14.64	25.63 ± 2.19	18.24 ± 9.79
NDF %	27.25 ± 4.60	25.17± 3.59	32.79 ± 7.18	36.08 ± 16.57	26.43 ± 2.51	18.57 ± 10.66
FAT %	3.15 ± 0.64	4.10 ± 1.93	4.10 ± 1.21	4.36 ± 3.05	3.23 ± 0.34	2.11 ± 1.18

[a]Values expressed as mean ± SEM.

[b]Mean dry matter (DM) content of diets offered in each enclosure were: 19.50 ± 0.01% enclosure 8 and 16.30 ± 0.04% enclosures 9 and 6.