Nutrition of the Green Iguana (Iguana iguana)

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The green iguana, Iguana iguana, lives in the lush tropical forests of Central and South America. These lizards are arboreal and diurnal. Wild green iguanas are herbivorous, consuming a primarily folivorous diet of leaves, blossoms and fruit. Green iguanas have enlarged ceca adapted for hindgut fermentation.

This general information is the basis for dietary management of these lizards when kept in captivity in temperate climates. Green iguanas are the second most traded vertebrate species in world commerce according to the World Conservation Monitoring Center in the UK; in 1992, over 300,000 were imported into the US. Thus they may be the most common reptile seen in veterinary practice.

Specific numbers are lacking, but most iguanas in the US appear to die prematurely, and malnutrition appears to be common. Thus thorough dietary histories should be obtained for iguanas presenting as new patients to your clinic, for diet histories greatly aid the diagnosis of nutritional disorders. Since nutritional requirements and dietary standards are not established for iguanas, the adequacy of commercial and homemade diets should always be questioned.

Diet and husbandry

In captivity — whether in an aquarium, screened cage, or (unfortunately) loose in a house — the green iguana requires specific ranges for temperature and humidity which are essential for optimal health. Generally, green iguanas prefer heat and humidity (as found in tropical forests), but there are upper limits, especially for temperature. Maintenance of an iguana outside of its optimal ranges is a physiological stress that may result in poor intake, digestion, and utilization of food. Iguanas maintained with poor husbandry fail to thrive.

Likewise, the iguana has requirements for habitat size, substrate, furnishings, lighting, and social interaction. Failure to provide iguanas with their environmental needs and with suitable gradients that allow choices within its space can lead to stress, with negative effects on food intake and metabolic status of the patient.

Thus poor husbandry negatively affects nutrition, and a diet — even a superior diet that is complete and balanced — will fail to meet the nutritional needs of the green iguana if the lizard is, for example, too cold to eat, deprived of UV light for vitamin D synthesis, or too dry to maintain kidney function.

Data from my feeding trials suggest that iguanas are more reluctant than most species to accept new foods. This trend seems to be especially notable for adults. Green iguanas offered new foods abruptly (such as a sudden change from mixed salads to commercial pellets) may eat inadequate amounts of food for as long as 10-14 day. Compounding the problem is owners’ perceptions of food intakes. Even if dry matter intakes were identical for an iguana consuming a mixed salad first and then a pelleted diet, the volume of pellets consumed is much lower because of differences in water contents. Owners should be cautioned to make all diet changes gradually, over a ten day period at least, and to recognize differences in volumes of foods consumed due to water contents.

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Diet history

A diet history permits assessment of the animal's intake of energy and nutrients, and provides information relevant to the animal's clinical condition and attitude. A diet history also helps to detect nutritional problems before they become serious clinical disorders. Diet histories may grow complex for iguanas consuming a mix of different diets, including salads and supplements.

For many diet-related diseases, nutritional mismanagement has occurred for a long time before clinical signs appear. Using diet history as a part of the medical work up for iguana patients strengthens a preventive health program.

One goal of a diet history is to obtain a picture – both cross-sectional and longitudinal -- of the foods which are offered and consumed by the patient. Foods may be intentionally offered, such as commercial diets, homemade salads, snacks, treats and supplements. Foods may also be available unintentionally, such as houseplants for iguanas kept in planted terraria.

Attention is given to the quality and wholesomeness (absence of potential pathogens) of the food, cleanliness of feeding utensils, and the skills and reliability of those responsible for feeding. Evaluation of water is included too.

It is best to query those directly responsible for feeding the animal and not to rely on second-hand information. For complicated feeding programs involving a wide variety of foods, owners may complete seven- or ten-day diaries, listing all foods offered and estimates of amounts consumed. For both written or oral diet histories, care must be taken to avoid influencing responses by owners.

For green iguanas, dietary histories should especially concern sources of protein, calcium, and fiber. Other concerns are the use of commercial diets which are inadequate and the dilution of nutrients from excessive additions of fruit to commercial diets. For iguanas fed mixed salads, look for sources of protein (romaine, legumes), calcium (such as calcium carbonate), fiber (crumbled hay cubes or fresh grasses). For commercial diets, check labels.

Examination of foods

*Produce:* Estimates of produce consumption may be problematic. Often, information is obtained in volumes (one cupful of chopped greens, for example) that must be converted to weight (35 g of chopped greens). Weight for volumes of produce vary and depend in part on the moisture in and upon the produce and the exuberance with which the produce is packed into cups.

The domestic fruits and vegetables available from groceries are lower in nutritional value (especially protein and fiber) than some of the fruits and plants in the wild consumed by reptiles. Among domestic produce, higher protein levels are found in greens (such as romaine and spinach), alfalfa and mung-bean sprouts, mushrooms, and bamboo shoots. However, domestic produce rarely provides enough protein, calcium, and fiber, or adequate levels of trace minerals and vitamins to support growth or reproduction, so produce needs supplementation.

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Calorie and nutrient contents of foods commonly fed to green iguanas. Data presented here are estimates only; actual contents vary.

<table>
<thead>
<tr>
<th>FOOD ITEM</th>
<th>WEIGHT</th>
<th>WATER</th>
<th>ENERGY (calories/gram)</th>
<th>PRO&lt;sup&gt;a&lt;/sup&gt;</th>
<th>FAT</th>
<th>CARB&lt;sup&gt;b&lt;/sup&gt;</th>
<th>FIBER</th>
<th>Ca</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lettuce, Romaine</td>
<td>100</td>
<td>94</td>
<td>0.18 3.0</td>
<td>36</td>
<td>7</td>
<td>50</td>
<td>11</td>
<td>1.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Lettuce, Iceberg</td>
<td>100</td>
<td>96</td>
<td>0.13 3.2</td>
<td>25</td>
<td>0</td>
<td>59</td>
<td>11</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Spinach, raw</td>
<td>100</td>
<td>91</td>
<td>0.26 2.9</td>
<td>36</td>
<td>3</td>
<td>48</td>
<td>7</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Mung Bean sprouts, raw</td>
<td>100</td>
<td>89</td>
<td>0.35 3.2</td>
<td>31</td>
<td>2</td>
<td>54</td>
<td>6</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Vegetables, mixed, frozen</td>
<td>100</td>
<td>83</td>
<td>0.47 2.8</td>
<td>16</td>
<td>2</td>
<td>68</td>
<td>7</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>Summer squash, 1/2 cup</td>
<td>100</td>
<td>94</td>
<td>0.18 3.0</td>
<td>17</td>
<td>2</td>
<td>65</td>
<td>9</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Blueberries, 1 cup</td>
<td>145</td>
<td>85</td>
<td>0.51 3.4</td>
<td>4</td>
<td>2</td>
<td>80</td>
<td>12</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Banana, 1 medium</td>
<td>114</td>
<td>74</td>
<td>0.82 3.2</td>
<td>4</td>
<td>2</td>
<td>86</td>
<td>2</td>
<td>tr</td>
<td>tr</td>
</tr>
</tbody>
</table>

<sup>a</sup> Pro = protein  
<sup>b</sup> Carb = carbohydrate  
<sup>c</sup> AF = as fed basis  
<sup>d</sup> DM = dry matter basis  
<sup>e</sup> tr = trace amounts

Quality of produce depends on its freshness, handling during harvest and transport, and storage conditions. Although older texts disparaged (correctly) frozen produce, today's technology is such that frozen vegetables usually meet and sometimes exceed the nutritional quality of fresh vegetables. Wholesomeness of commercial and home-grown produce depends on exposure to fertilizers, herbicides, and pesticides.
Fruits are often consumed by iguanas, probably because of their bright colors, sweet taste, and moist texture. However, fruits contain mostly water, fructose, and a little fiber. Additions of small amounts of fruit markedly dilute the calories, nutrients, and fiber provided by greens. For example:

<table>
<thead>
<tr>
<th>WEIGHT</th>
<th>DM</th>
<th>ENERGY</th>
<th>PROTEIN</th>
<th>Ca</th>
<th>P</th>
<th>FIBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>g</td>
<td>g</td>
<td>kcal</td>
<td>%dm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Romaine, chopped, 1 cup</td>
<td>56</td>
<td>3</td>
<td>8</td>
<td>36</td>
<td>1.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Plus 1 cup Strawberries</td>
<td>205</td>
<td>15</td>
<td>50</td>
<td>11</td>
<td>0.3</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Adding one cup strawberries to one cup romaine reduces the concentrations of protein and calcium by two-thirds.

Free-ranging green iguanas tend to select plants that contain not only high protein but also relatively high fiber, yet very high fiber diets suppress growth of juvenile green iguanas. In a recent study of iguana growth and commercial diets, best growth was observed in the diet containing not only the highest protein (31%) but also the highest fiber (13%). Digestibilities in green iguanas decreased with increasing dietary lignin and cutin, and transit times ranged from 4 to 9 days. With increasing environmental temperature (from 30-36 °C) transit time decreased from 10 to 3 days, with no change in digestibility. These data add further evidence that iguanas do best when maintained at warm temperatures on relatively high fiber diets.

Portion sizes should be checked, for appropriate items may be offered in inappropriate sizes. Juvenile green iguanas may be offered large chunks of produce which they cannot swallow. Because of inability to eat such items, these patients may show signs of under feeding, such as weight loss or failure to grow, listlessness, and increased susceptibility to infectious and parasitic diseases.

**Commercial diets**

Producers of commercial iguana diets should provide, upon request, proximate analyses of their product, which details the contents of essential nutrients and fibers. Products should have been tested in the laboratory and in the animal, by means of feeding trials. If manufacturers are unwilling to provide such information, use of their products is not recommended.

Iguanas have been fed commercial diets formulated for other species and those formulated specifically for iguanas. Diets formulated for dogs or cats are not appropriate for iguanas because the relatively high fat, low fiber diets made for carnivores often produce maldigestion in a hindgut fermenter such as the green iguana.

Dog and cat foods may contain a label claim of "complete and balanced" because there are independent standards for nutritional adequacy of these products. In contrast, commercial diets for iguanas cannot justifiably make such claims because there is no body of scientific data upon which an independent authority could establish a standard for nutritional adequacy.
**Guaranteed analyses:** A pet food label must state guarantees for minimum percentages of crude protein and crude fat, and maximum percentages of crude fiber and moisture. The term "crude" refers to a specific method of analysis, not to quality. The percentages are presented on an as-fed basis. Occasionally other guarantees are provided voluntarily. The guaranteed analysis on the label is subject to testing by feed control officials to ensure it conforms to the food inside the package.

Discrepancies between the guaranteed analysis and laboratory analyses are not uncommon in petfoods, where testing is more routine. Testing by states is rare for reptile diets. However, in one study evaluating commercial diets fed to juvenile green iguanas, a product tested twice in an independent laboratory was found to contain only 55% of the protein reported on the label guaranteed analysis.

**Ingredient lists:** Ingredients are required to be listed in order of predominance by weight. The weights are determined as they are added in the formulation, including water. So a moist ingredient, such as peas (90% water) may be listed ahead of a dry ingredient, such as soybean meal (10% water), yet the soy actually contributes more solids to the diet.

For green iguanas, ensure that animal proteins are not in ingredient lists. These include poultry and meat meals. In my feeding trials, dried (low fat) egg protein has been used successfully with plant proteins to improve protein quality. Look for plant proteins (such as soybean meal and corn gluten meal) on label ingredient lists.

**Supplements**

Commercial vitamin-mineral supplements offer a wide variety in nutrient content and quantity. Differences in quality control of ingredients, manufacture, and storage are likely, too, but are difficult to document.

Supplements marketed for humans generally contain more of the nutrients known and assumed to be essential for herps in better balanced quantities. However, not all products marketed for humans contain vitamin D₃.

Although supplements are necessary for green iguanas fed diets of mixed salads, there is great potential for over dosage and intake of toxic amounts of vitamins and trace minerals. Commercial diets should require no supplementation, and use of vitamin-mineral products are likely to imbalance the diet.

Calcium may be provided as limestone (38% calcium) or as calcium salts — carbonate (40% calcium), lactate (18%), gluconate (9%). Calcium and phosphorus are supplied in bone meal (24% calcium, 12% phosphorus) and dicalcium phosphate (18-24% calcium, 18% phosphorus).

**Clinical nutrition**

Poor diet and feeding management often lead to disease in captive reptiles and, conversely, medical and surgical disorders may adversely effect nutritional status. Diet related disease varies with species and feeding management. Common problems in green iguanas include calcium deficiency from unsupplemented produce, protein deficiency from diets containing much fruit, and multiple deficiencies from unsupplemented produce.
Those animals subjected to zealous supplementation risk potentially toxic intakes of vitamins A and D, phosphorus, selenium, iodine and other trace minerals. Less clearly defined for reptiles and amphibians but likely to occur are interactions between nutrients. For example, excess dietary calcium interferes with the absorption of zinc and copper and the thyroidal uptake of iodine in endotherms and, presumably, ectotherms.

**Calcium and vitamin D₃ deficiencies**

In green iguanas, calcium deficiency arises from consumption of unsupplemented salads or insufficient legumes. Also, calcium absorption may be impaired by diets containing phytates (soy ingredients), oxalates (spinach), high fat (performance pet foods), or acid (certain commercial cat foods) and by diets deficient in vitamin D. Data are lacking for ectotherms, but generally, in endotherms — excepting diets deficient in vitamin D — diets must be borderline in calcium content before these latter conditions become significant.

Iguanas with calcium deficiency present with multiple and spontaneous bone fractures, muscle tremors, skeletal deformities (especially mandible), and inadequately calcified eggs. Treatment of calcium deficiency consists of hydration and calcium therapy. Intravenous calcium is recommended for patients with hypocalcemia, muscle tremors, or paresis. Subcutaneous or intramuscular calcium gluconate is administered to less critical patients (0.5 ml/kg b.i.d.). An effective treatment protocol (from Dr. Mader) includes Neo-calglucon (23 mg/ml) at 1 ml/kg p.o. b.i.d., Injacom 100 (10,000 IU/ml) at 100 IU/kg s.c. q 7 day and synthetic salmon-derived calcitonin (100 IU/ml) at 50 IU/kg i.m., repeat in 7 day.

Vitamin D₃ is problematic. Limited research data, anecdotal evidence and clinical impressions suggest that perhaps dermal synthesis of 1,25-dihydroxycholecalciferol may be more efficient than gastrointestinal absorption of dietary vitamin D₃. This presumption promotes the use of "full-spectrum" lighting, which appears adequate for D₃ synthesis in some species but perhaps not others that require sunlight. Interactions between vitamin D, calcium and phosphorus, and secondary interactions with vitamin A and several trace minerals complicates an already confused picture. For now, general recommendations include consistent but not excessive supplementation of mixed salads with both calcium and vitamin D₃, exposure to full-spectrum lights and, whenever possible, time spent outdoors with exposure to sunlight.

Calcium and vitamin D₃ requirements are unknown for reptiles, but, from data in endotherms and practical experience with iguanas, dietary calcium should be about 1.0 up to perhaps 1.5 or even 2.0% (DM basis), phosphorus 0.5 to about 0.8%, and vitamin D₃ 500 to 1000 IU/kg DM. For many species, maximum tolerances are about 2.5% for calcium, 1.6% for phosphorus, and perhaps more than 5000 IU/kg for vitamin D.

**Gout**

Deposition of urates on visceral and articular surfaces is termed gout. It is associated clinically with other disorders, especially those affecting water balance. Etiopathologic theories include inappropriate dietary nitrogen levels and dehydration. Most likely, any disturbance in renal excretion of uric acid in uricotelic species predisposes an individual to precipitation of urate crystals.
Dietary management of gout has been tried in endotherms with disordered purine metabolism, but support and drugs are usually found to be more effective than changes in diet. However, dietary management may be warranted when patients are at risk for gout, or when a case is diagnosed early in its course. For dietary management, rations are formulated with ingredients that are low in purines and that promote acidification:

<table>
<thead>
<tr>
<th>HIGH PURINE FOODS</th>
<th>LOW PURINE FOODS</th>
<th>POTENTIALLY ACID FOODS</th>
<th>POTENTIALLY ALKALINE FOODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus</td>
<td>Breads</td>
<td>Brazil nuts</td>
<td>Beets</td>
</tr>
<tr>
<td>Mushrooms</td>
<td>Brains</td>
<td>Walnuts</td>
<td>Beet greens</td>
</tr>
<tr>
<td>Liver</td>
<td>Kidney</td>
<td>Corn</td>
<td>Chard</td>
</tr>
<tr>
<td></td>
<td>Mincemeats</td>
<td>Lentils</td>
<td>Dandelion</td>
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<td></td>
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<td></td>
<td>Kale</td>
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Care should be taken not to restrict protein unnecessarily in efforts to prevent gout. Nitrogen requirements appear to be substantial for herbivorous reptiles. Our feeding trials in green iguanas suggest that dietary protein of about 28% (DM basis) is needed for optimal growth in young iguanas. Requirements are likely to be lower in adults. Restriction of protein in attempts to prevent gout may lead to poor growth and malnutrition. Rather, attention may be given to maintenance of hydration in green iguanas and provision of adequate humidity levels in the reptile's environment.

Protein contents of plants selected by iguanas in the wild may have higher protein contents (13-33%) than those rejected (7-17%). In a study of juvenile green iguanas in Costa Rica, body weights of
those fed diets containing 28% crude protein (DM basis) were 30% and 300% greater than body weights for iguanas fed 20 and 15% protein, respectively. In another study comparing growth in juvenile green iguanas fed diets ranging from 13 to 31% protein (DM basis), growth rates for greatest for the 31% protein diet (26). Protein requirements are likely to decrease as growth slows, perhaps by 24 mo of age.

SUGGESTED READING