Reptile and Amphibian Nutrition
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General considerations in reptile & amphibian nutrition
In general, information about an animal’s origin and natural history is often the basis for recommendations concerning dietary management of these animals in captivity. In captivity, whether in an aquarium, screened cage, or (inappropriately) loose in the house – reptiles and amphibians have specific ranges for temperature, humidity, and ventilation which are essential for optimal health. Maintenance of an animal outside of its optimal range is a physiological stress that often results in poor intake, digestion/absorption, and utilization of food. Animals not properly maintained will fail to thrive and often die. Also, reptiles and amphibians have specific requirements for habitat size, substrate, cage accessories, lighting, and social interaction. The failure to provide them with their environmental needs, and with suitable gradients that allow choices within this space, can lead to stress, with negative effects on food intake and metabolism. Thus, poor husbandry can have a significantly negative affect on an animal’s nutritional status, so that even a superior diet that is "complete and balanced” will fail to meet the nutritional needs of the animal.

The field of veterinary nutrition is a continually evolving science, and this could not be truer for reptile and amphibian nutrition. The science of reptile nutrition is growing every year, but is still hampered by trying to determine normal baseline diets for many species. With over 10,000+ species of reptiles and amphibians, there is relatively little data on what most of these animals actually eat, not to mention the nutritional composition of these diets. With this being said there still are a number of basic nutritional guidelines for which to follow with reptiles and amphibians. In addition to the basics there are a number of new products and ideas which are discussed in context of their nutritional appropriateness for reptiles and amphibians.

Specific numbers are not available, but many reptiles and amphibians die prematurely; malnutrition is often a factor in this early demise. Therefore, a thorough dietary history should be obtained each time a reptile (and/or amphibian) presents as a patient; current and complete diet histories greatly aid the diagnosis of nutritional disorders. Because the exact nutritional requirements and dietary standards have not been established for most reptiles or amphibians, the adequacy of commercial pre-formed and homemade diets should always be questioned. A diet history permits assessment of the animal’s intake of energy (calories) 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. 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 strengthens a preventative health program.

For example, the green iguana, *Iguana iguana*, the second most traded vertebrate species in the world - inhabits the tropical regions of Central and South America. These lizards are known to be arboreal and diurnal. Green iguanas are herbivorous, in the wild consuming a primarily folivorous diet of leaves, blossoms, and fruit. Green iguanas, as is the case with other herbivorous reptiles, have enlarged ceca that make them well adapted for hindgut fermentation. It has been determined that free-ranging green iguanas tend to select plants that contain not only high protein but also relatively high fiber, though very high fiber diets have been found to suppress growth in juvenile green iguanas. It appears that a green iguana diet of greater then 13% crude fiber is desirable. Producers of commercial green iguana diets should provide proximate analysis of their product, which details the contents of essential nutrients and fiber. Products ideally should have been tested in the laboratory and in the animals via feeding trials. Dog and cat foods may contain a label claim of "Complete and Balanced" because there are specific independent standards for nutritional adequacy of these diets. In contrast, commercially produced diets for green 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.

There are a plethora of nutritional supplements available, with each offering a wide variety in nutrient quantity and quality. Most clients are surprised to discover that they are not providing a completely balanced diet for their captive reptiles and amphibians; supplements are often recommended. However it is often difficult to make specific recommendations because there may be significant differences in quality control of ingredients, manufacturing, and storage of nutritional supplements for reptiles, though these differences are difficult to document.

Calcium deficiency in green iguanas can also arise because of a number of different dietary reasons i.e. - consumption of unsupplemented salads or insufficient legumes. Also calcium absorption may be impaired by diets containing phytates (soy ingredients), oxalates (spinach etc...), high fat (performance pet foods), or acid (certain commercial cat foods) and by diets deficient in vitamin D. Vitamin D3 supplementation is problematic. Limited research data, anecdotal evidence and clinical impressions suggest that dermal synthesis of 1,25-dihydroxycholecalciferol may be more efficient than gastrointestinal absorption of dietary vitamin D3. This impression promotes the use of "full spectrum" lighting - which appears adequate for vitamin D3 synthesis in some species but perhaps not in others. The already confused picture is only further complicated by the interactions between vitamin D, calcium, phosphorous, and secondary interactions with vitamin A and several trace minerals.
Anamnesis/history of the diet

- What is the Diet = what food is being offered versus what is actually being eaten?
- How frequently are the animals fed and How long is food left in the enclosure?
- Are any supplements being offered: Vitamins/Minerals – names and ages?
- If “Insect Eating” Species – are Insects “Gut-Loaded”? Are insects dusted before being fed?
- Other prey items – offered Live or Dead, (Freshly killed or Frozen/Thawed: How Long Frozen)?
- How long are prey items kept in with animal? Is feeding supervised?
- When did the animal(s) last eat? Did it eat well? Did it eat readily?
- How is water provided? In what manner, and how often is it cleaned? …

Thus, most nutritional problems in reptiles arise from improper care combined with poor feeding management, including inappropriate or unpalatable foods, which cause undernutrition and from imbalanced diets, which cause malnutrition.

Significance of and techniques for delivering nutritional support

As mentioned many reptiles presenting to us in our clinics are malnourished either because of dietary deficiencies or improper husbandry having an adverse effect on the animals metabolism. It is generally recommended that nutritional support be provided to any patient that has acutely lost 10% of chronically 20% of its body weight. Nutritional support can be provided by a number of means including syringe/force feeding, orogastric tube feeding, and pharyngostomy feeding tube placement. Though at times the greatest challenge is often opening the mouth - once it is open – in many species, the glottis, which is typically closed at rest, is located at the base of the tongue in the rostral oral cavity making it easy to avoid during orogastric intubation.

When continued nutritional support is required for reptiles with mouths that are difficult to open, placement of a pharyngostomy tube is recommended. For herbivorous and omnivorous reptiles, Isocal and Sustacal (Mead Johnson Nutrionals, Evansville, IN), Ensure and Osmolite (Ross Labs, Columbus, OH), are appropriate liquid diets. For carnivorous reptiles Traumacal ead Johnson Nutrionals), Pulmocare (Ross Labs), and Feline and canine Clini care Liquid (Pet-AG, Elgin, IL) are appropriate liquid diets. Care must be exercised in patients suffering chronic starvation. "Refeeding syndrome", a condition referring to hypophosphatemia and hypokalemia, is seen in patients fed large amounts of calorie rich foods and it can be potentially fatal. The phosphorus and potassium move into the cells with glucose and thereby deplete circulating levels - resulting in rapid weakness and often coma - leading ultimately/often to death. It is therefore recommended that reptiles that have been chronically starved be fed 50% of their need calculated based on their real, not ideal weight. This would be continued for several days, until the patient's condition improves. The amount of calories supplemented is then increased in increments of 10 - 20 % until the recommended level of caloric supplementation for that sized animal is reached.

For an excellent current reference on feeding carnivorous, omnivorous and herbivorous reptiles please refer to Dr. Scott Stahl’s Proceedings notes and his references for the 2000 meeting of the Association of Reptilian and Amphibian Veterinarians (ARAV), Reno, NV. [pages: 177 – 182].

Snakes

Most snakes are carnivorous. Most of the commonly seen snakes in practice including boas and pythons (the boids), rat, corn, bull and pine snakes eat warm-blooded prey. The most common food items offered to these snakes are mice and rats; other prey offered include gerbils, rabbits and young chicks. All food items should be killed prior to feeding. The prey items can be freshly killed or can be stored in a frozen state then thawed and warmed up prior to be offered to the snake. Feeding of killed prey eliminates the possibility of injury to the snake from the prey item. Prey animals should be healthy and fed a high quality complete ration prior to feeding them to the snake. Generally, supplementation is not necessary when feeding whole vertebrate prey.

Some snakes feed on ectotherms such as amphibians, fish, crayfish and other reptiles. Snake species that eat this diet include king snakes, indigo snakes, water snakes, garter snakes and hognosed snakes. Many of the young of rodent eating snakes will begin life eating ectotherms. Most of the above snakes can be transitioned over to a diet of appropriately sized rodent prey by using various techniques including scenting of the rodent with a more familiar prey item. Freezing ectotherm prey items for a minimum of three days may reduce exposure to some parasites such as nematodes but will not eliminate exposure to protozoa or bacteria.

Insect and invertebrate eating snakes may also be seen in practice. These include green snakes, worm snakes and ring-necked snakes. A variety of insects such as crickets, mealworms, earthworms, grasshoppers and wax-moth larvae can be offered as food. Prey items need to be fed a high quality diet before offering them to the snakes and the prey should be eaten fairly rapidly (within a few hours) before it empties the contents of the gut and becomes nutritionally inferior.

Lizards

Carnivorous lizards include monitor lizards, tegus, Gila monsters and beaded lizards. Like snakes these lizards eat whole prey items such as mice, rats, gerbils and young chicks. These prey items should be offered freshly killed or frozen/thawed and should be fed a high quality complete ration prior to feeding to the lizards. Supplementation needs are minimal or absent in animals eating whole
vertebrate prey. These lizards will also accept cooked meat, eggs and commercial pet foods (canned dog food and canned lizard food). Supplementation may be needed when animals are fed a predominantly commercial diet.

Insectivorous lizards include geckos, Old World chameleons, water dragons, anoles, skinks, small monitors (as well as the young of the larger monitors). These lizards should be offered a variety of insects including crickets, mealworms, cockroaches, fruit flies, earthworms, grasshoppers and wax-moth larvae. These insects should be fed a complete diet to “gut load” them prior to feeding them to the lizards and should be dusted with both a calcium and vitamin and mineral supplement. Generally, calcium supplementation can be provided daily for juvenile lizards and two to three times a week for adults. Multivitamin supplements should be used less frequently—generally once a week for juveniles and every other week in mature animals.

Omnivorous lizards include bearded dragons, blue-tongued skinks, water dragons and plated lizards. These lizards often eat insects or small rodents as well as vegetable protein. Meat protein sources as similar to those described above as well as low fat dog food and monkey biscuits; blue-tongued skinks should be supplemented with some canned cat food. Vegetable protein sources include fresh leafy greens (see herbivorous reptiles below), carrots, green beans, yellow squash and many of the bean and alfalfa sprouts. A small amount of fruit such as melon, various berries, bananas and oranges can be offered.

Herbivorous lizards include green iguanas, the island iguanas, prehensile tailed skinks and spiny tailed lizards. The basic diet consists of a staple of dark green leafy vegetables such as collard, mustard and turnip greens, romaine and leaf lettuce, dandelion greens and flowers and Swiss chard. Greens that contain oxalates such as spinach or goitrogens such as kale should be fed sparingly as should fruit which is high in water content and fructose. Commercial diets for herbivorous lizards are relatively new and thus should not make up greater than 50% of the diet. Herbivorous diets may need to be supplemented with calcium and vitamins and minerals (multivitamin powders) to provide a balanced diet (see insectivorous lizards above).

Chelonians
Carnivorous turtles are generally aquatic and include common and alligator snapping turtles and the mata mata. Most aquatic turtles will often only feed in the water. These turtles will take a variety of food such as commercial turtle or fish food (floating turtle sticks, trout chow, catfish chow), feeder fish from the pet shop or bait shop, amphibians and even rodent prey. Frozen oily fish such as smelt or mackerel should be fed in limited amounts to avoid vitamin deficiencies and steatites. Insects such as earthworms, crickets, mealworms and grasshoppers can also be fed. Vitamin and mineral supplementation is not usually necessary if commercial foods are being fed as part of the diet.

Omnivorous aquatic turtles that are seen in practice can include red-eared sliders, painted turtles, map turtles, cooters and box turtles. These turtles are generally carnivorous as juveniles but begin to accept more vegetable matter as they mature. The diet for juveniles is similar to that described for carnivorous turtles above and will make up the majority of the diet while adults will eat about 30-50% vegetable matter. Vegetable that float such as collard greens and romaine lettuce, endive and kale can be offered. Supplementation with vitamins and minerals is not needed if the diet includes commercial turtle or fish foods.

Box turtles are primarily omnivorous terrestrial turtles and include the eastern, ornate, three-toed and Asian species of box turtles. Some box turtles such as the Asian and three-toed tend to be more carnivorous. Juvenile box turtles also tend to be carnivorous and accept mor plant material as they mature. The carnivorous portion of the diet is similar to that described for carnivorous aquatic turtles and can include commercial box turtle diet, low-fat dog food and trout chow. Cooked meat as well as earthworms and “gut loaded” and dusted insects can be offered. Vegetables and fruit can be offered to both juveniles and adults and can include greens and fruits as described above for omnivorous lizards. Box turtles readily accept red, yellow and orange colored foods such as tomatoes, strawberries, raspberries, squash and oranges and these can be used to entice them to eat other foods.

Herbivorous chelonians include the land tortoises. The diet is similar to that described above for herbivorous lizards. To complete the diet the grass hays such as timothy or coastal or fresh grass clippings should be added to the diet. Alfalfa hay or pellets should be fed in lesser quantities do high quality and tendency for weight gain. Supplementation is as described for herbivorous lizards and turtles and may not be needed if a commercial diet makes up 30-50% of the diet.

Reptile nutrition: herbivorous species
As mentioned, the correct balance of protein, carbohydrates, fats, fiber, vitamins and minerals is essential for the proper nutrition to be provided to our Reptiles & Amphibians. A diet consisting of primarily one ingredient is not/never sufficient. Lettuce, celery, and carrots are human “diet” food and are low in calories. Never feed large quantities of them. Meat & meat by-products are grossly unbalanced & never appropriate for herbivorous species = it is recommended to never feed them. Feeding herbivorous animals such as tortoises and green iguanas may be confusing as there are a multitude of food choices. In general, these types of reptiles use fermentative digestion in the lower bowel to obtain energy. This often results in extended gastrointestinal (GI) transit times (up to weeks in large tortoises). The main energy source is carbohydrate yielded from the breakdown of fiber. Fermentation yields the short-chain fatty acids that are utilized for energy. Diets low in fiber result in loose feces. Fiber intake should be about 10% to 40% of dry matter (DM) with 18% to 28% being optimal. Other fuel sources such as fat and protein should be limited to <10% and 15% to 35%,
respectively. Starches are not a normal part of herbivorous reptiles' diet and should be avoided. So what does this mean? Feeding should mainly consist of high fiber (grasses/pellets/hay) with limited green leafy vegetables, fruits, and pellets. An example of a herbivorous diet is 70% greens, 10% high-fiber pellet, 15% veggies and 5% fruit, and unlimited fresh grass/grass hay.

A properly balanced diet can be formulated using the following.

I. PLANT MATERIAL
   a. Uncooked frozen mixed vegetables (Thaw/warm & serve)
   b. Collard, mustard, beet, & turnip greens + Carrot tops
   c. Swiss chard, romaine/green/red leaf lettuce, escarole
   d. Cabbage, broccoli, kale, cauliflower, brussel sprouts
   e. (members of this family should not be fed in volume, as they can lead to the formation of goiter).
   f. Green peas (including pods), fresh corn, cucumbers, string beans
   g. Dandelions (both greens & flowers), clover [Red & White]
   h. Various squashes, pumpkins, sweet potatoes, other tubors
   i. Fruit: i.e. berries, melons, apples, pears, bananas, peaches, plums
   j. Breads and dry cereals

II. PROTEIN
   a. Species Specific Pelleted Rations = Complete/balanced nutrition for plant eating species. They are typically made for specific groups of herbivorous animals {i.e. Tortoises/Iguanas (Juvenile/Adult)}. Reptiles can do well with this as part of their diet {i.e. +/- 25%}. Soak in water until soft or feed dry/or mix w/other foods i.e. in salad.
   b. High quality “Vegetarian” dog food. No more than 25% of the diet.
   c. Never use cat food. Cat food is over-supplemented and can cause/lead to mineralization of tissues in the reptile.

Complete vitamin/mineral supplements
Growing iguanas and turtles have especially high requirements for Calcium. Turtles have a specific need for Vitamin A.

There are several reptile specific vitamin & mineral supplements available – best to evaluate the labels for content and compare with known species specific requirements. When multiple items make up a diet it is always a good idea to supplement with a mineral supplement. The author suggests using Rep-Cal phosphorous-free calcium supplement once a week. This supplement should be stored in the freezer to reduce the effects of oxidation, especially if the supplement contains any vitamins. In addition, product life is about 6 months if kept in the freezer to maintain optimal quality.

Proper food preparation
A. Wash all fresh vegetables and fruits before cutting.
B. Cut food into small bite-sized pieces and toss like a salad to prevent finicky eaters that prefer specific items, i.e. based on color, from picking them out.
C. Use a low dish so the reptile can easily see & eat the food.
D. Feed individually to avoid competition & to monitor eating.
E. If reluctant to eat, pile/place the food directly on the cage floor.
F. Feed young animals at least daily, larger ones can be fed less often.

Special requirements
Tortoises require a large amount of fiber in their diet. As much as 50% of their diet should be cubed or pelleted hay: Alfalfa Legume hay is richer than Orchard/Brome/or Timothy grass hay. Grass clippings (making sure no chemicals have been used on lawn) can also be used. In the summer it is a great idea to allow your tortoises, and other reptiles, supervised time out of doors – perhaps to graze on untreated lawns as well as to receive direct exposure to natural sunlight. This is what they do in the “wild” and “in captivity” we can do no better.

One word about Pelleted Diets: These diets for tortoises have become popular in the last few years. Analysis shows that certain brands have high levels of dietary starches, up to 24%, in addition to low levels of dietary fiber. This level of starch is probably inappropriate for herbivores. Fiber is found mainly in grasses and NOT in leafy green or fruits. Commercially available high-fiber pellets designed for hoof stock and primates are available and are a much better pellet to feed. Commercial tortoise pellets can be used (<5% of diet) as a supplement or a treat.
Reptile nutrition: carnivorous species
Most reptiles that are strictly carnivores have short, simple digestive tracts, like cats and dogs. Their main nutrient sources come in the form of fat (25-60%), protein (30-60%), minimal carbohydrate, and negligible fiber content. This group of reptiles is often one of the simple groups to feed as they accept whole prey items. Some examples of reptiles and amphibians in this group are snakes, monitor lizards, tegus, crocodilians, and aquatic turtles. The main issue with the nutrition of this group of animals is obtaining high quality food items and storage of these items.

Food items
These include mice, rats, rabbits, Guinea pigs, hamsters, fish, chickens and chicks.

Live vs. dead
This is a topic of continual debate among reptile owners. In the author’s opinion freshly killed or defrosted frozen prey items (< 3 months frozen) are the safest option for feeding. Vitamin E may break down after 3 months of freezing resulting in nutritional deficiencies. Vitamin E can be supplemented at 200 IU/kg of food. In many cases live prey items (rats and mice) can inflict severe trauma to a snake during a struggle or if left alone unattended with snake. If the snake is not in the mood for eating it may not move and allow the rodent to chew, resulting in severe trauma. This behavior is not clearly understood.

Fish prey items
Whole live fish or gold fish are often fed. These prey items should be in good body condition and fed a good diet prior to being fed to the reptile. Frozen fish, especially herring and mackerel (high fat content), over time may have a breakdown of fatty stores, resulting in the production of thiaminase and hypovitaminosis E. It is recommended that frozen fish (or any frozen prey item) be stored for only 3 months. Supplementation with vitamin E (200 IU/kg of food) and thiamine (50 mg/kg of food) may be necessary if this is the only food source.

Adult vs. young prey
Independent analysis has shown that frozen pinkie mice have a 0.79:1 calcium:phosphorus (Ca:P) ratio while adult mice have a 1.4:1 Ca:P ratio. Some people say that if you feed pinkie mice just after they have fed on milk that the calcium level increases. This appears to be logical; however, there are no published data to support this. The author advises that if you are feeding a number of pinkies that you supplement with a commercial calcium product.

Pelleted diets
Pelleted diets are now available for both aquatic turtles and crocodilians. Aquatic turtle diets are plentiful and may vary in their protein content, with most ranging around 40% protein. These diets are recommended as they are nutritionally balanced and very palatable. Crocodilian pellets are available from Mazuri and come in a variety of sizes from 0.5-cm to 4- to 5-cm pellets. These are also a good choice for crocodilians and large aquatic turtles; however, they must be fed in a ratio of 1/3 by weight of the whole prey item. This is because these pellets are 95% dry matter (DM) compared with 35% DM in whole prey items.

Carnivore sausages
In the recent trade journals there have been advertisements for prepared sausage-like food items for snakes. These items are currently available for dogs and cats and could be used for carnivorous reptiles as well.

Reptile nutrition: insectivorous species
Insect-eating reptiles can be considered carnivores and have short, simple digestive tracts. Their main nutrient sources come in the form of fat (25-60%), protein (30-60%), minimal carbohydrate, and negligible fiber content. The main problem facing insectivorous reptiles and amphibians is the low diversity of food items offered to the pet. In many cases people become dependent on one or two food sources such as crickets or mealworms and the health of their pet deteriorates. Most wild insectivorous lizards consume dozens if not hundreds of species of insects. In the last few years a number of different insect species have been offered for sale including crickets, meal worms, super worms, wax worms, butter worms, phoenix worms, night crawlers, silk worms, goliath worms, fruit flies, and fly maggots. Of these, the butter worms and phoenix worms have the best Ca:P levels with a ratio of 2:1 where as crickets, meal worms and super worms have inverse Ca:P levels. In addition, wild insects can also be used as supplement feed. Care must be taken to collect in areas that are free of insecticide spray. In addition, some insects such as lightning bugs have been proven to be toxic to bearded dragons.

Canned diets
Some companies are now offering canned invertebrate diets such as crickets in a can, caterpillars and snails in a can. Nutritional analysis has shown that these diets have the same nutritional content as live insect, however there palatability is in question. The canned snails have the highest Ca: P ratio of 12:1. Some species like Caiman lizard would probably do well on the canned snail diet.

Supplementation
Supplementation of all insects and canned diets with a calcium supplement is necessary. The most effective approach is to house feeder insects in a clean, appropriate enclosure with a low stocking density. The highest food quality should be offered, as the food you feed the insects directly translates into the nutrition that your reptile is acquiring. Commercial pelleted diets for crickets are available and this along with fresh water and some fresh vegetables will provide a good diet. Gut loading of insects has some merit.
Certain diets high in calcium have caused gut impaction with crickets. Once again a well-balanced insect diet combined with dusting just prior to feeding to the reptile is the best option. New gelled water products appear to be a good way of feeding crickets water without the mess of an open water container. Some of these products have extra calcium; the nutritional verdict is still out on these products.

**Reptile nutrition: omnivorous species**

Omnivores can be fed a variety of items from the carnivorous and herbivorous diets. The ratio should be about 75% herbivorous and 25% carnivorous. Some of these species, such as bearded dragons, are carnivorous as juveniles and herbivorous as adults. It is the author’s opinion that these animals should be acclimatized to herbivorous food at an early age so the lizard becomes accustom to eating greens.

**Gelled diets**

Many commercially prepared gel diets are available. The advantage of these diets is that they can be altered and medication can be added with ease. These can also be custom-made at home; however, when making these gel diets you must be careful to design a nutritionally balanced diet.

**Calcium & phosphorus content of selected foods**

The following charts show the total amount of calcium and phosphorus in 1-cup portions of selected foods. One needs to look not only at the total milligram (mg) amount of calcium, but also the Calcium to Phosphorus ratio. This ratio should be close to 1 to 0.5 for the best calcium absorption. The higher the phosphorus amount is compared to the calcium, the poorer the absorption of calcium in the body.

This information was extrapolated from a variety of sources including *Practical Guide for Feeding Captive Reptiles*, by Dr. Fred L. Frye, Krieger Publishing Company, Malibar, Fl. 1991.

**Good calcium sources**

<table>
<thead>
<tr>
<th>1 Cup Portion</th>
<th>Calcium</th>
<th>Phosphorus</th>
<th>Ca:Phos Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnip Greens</td>
<td>694 mg</td>
<td>98 mg</td>
<td>1:0.14</td>
</tr>
<tr>
<td>Cabbage (outside green leaves)</td>
<td>429 mg</td>
<td>72 mg</td>
<td>1:0.17</td>
</tr>
<tr>
<td>Chinese Cabbage</td>
<td>400 mg</td>
<td>72 mg</td>
<td>1:0.2</td>
</tr>
<tr>
<td>Broccoli Leaves</td>
<td>349 mg</td>
<td>89 mg</td>
<td>1:0.26</td>
</tr>
<tr>
<td>Watermelon</td>
<td>33 mg</td>
<td>9 mg</td>
<td>1:0.27</td>
</tr>
<tr>
<td>Mustard Greens</td>
<td>582 mg</td>
<td>168 mg</td>
<td>1:0.29</td>
</tr>
<tr>
<td>Kohlrabi</td>
<td>390 mg</td>
<td>120 mg</td>
<td>1:0.3</td>
</tr>
<tr>
<td>Watercress</td>
<td>53 mg</td>
<td>15 mg</td>
<td>1:0.3</td>
</tr>
<tr>
<td>Chard</td>
<td>300 mg</td>
<td>100 mg</td>
<td>1:0.33</td>
</tr>
<tr>
<td>Collards (Cooked)</td>
<td>414 mg</td>
<td>150 mg</td>
<td>1:0.4</td>
</tr>
<tr>
<td>Kale</td>
<td>390 mg</td>
<td>134 mg</td>
<td>1:0.4</td>
</tr>
<tr>
<td>Dandelion Greens</td>
<td>168 mg</td>
<td>70 mg</td>
<td>1:0.4</td>
</tr>
<tr>
<td>Endive</td>
<td>104 mg</td>
<td>39 mg</td>
<td>1:0.4</td>
</tr>
<tr>
<td>Broccoli Stem</td>
<td>111 mg</td>
<td>47 mg</td>
<td>1:0.4</td>
</tr>
<tr>
<td>Beet greens</td>
<td>188 mg</td>
<td>80 mg</td>
<td>1:0.4</td>
</tr>
<tr>
<td>Orange or Tangerine</td>
<td>48 mg</td>
<td>18 mg</td>
<td>1:0.4</td>
</tr>
<tr>
<td>Cauliflower (greens)</td>
<td>162 mg</td>
<td>80 mg</td>
<td>1:0.5</td>
</tr>
<tr>
<td>Dark Green Leaf lettuce</td>
<td>25 mg</td>
<td>14 mg</td>
<td>1:0.56</td>
</tr>
<tr>
<td>Parsley</td>
<td>46 mg</td>
<td>30 mg</td>
<td>1:0.65</td>
</tr>
<tr>
<td>Spinach</td>
<td>156 mg</td>
<td>30 mg</td>
<td>1:0.65</td>
</tr>
<tr>
<td>Yellow Wax Beans</td>
<td>63 mg</td>
<td>46 mg</td>
<td>1:0.7</td>
</tr>
<tr>
<td>Celery</td>
<td>44 mg</td>
<td>32 mg</td>
<td>1:0.7</td>
</tr>
</tbody>
</table>

**Moderate calcium sources**

<table>
<thead>
<tr>
<th>1 Cup Portion</th>
<th>Calcium</th>
<th>Phosphorus</th>
<th>Ca:Phos Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage (inside white leaves)</td>
<td>46 mg</td>
<td>34 mg</td>
<td>1:0.74</td>
</tr>
<tr>
<td>Rutabaga</td>
<td>99 mg</td>
<td>75 mg</td>
<td>1:0.75</td>
</tr>
<tr>
<td>Blueberries</td>
<td>33 mg</td>
<td>26 mg</td>
<td>1:0.8</td>
</tr>
<tr>
<td>Strawberries</td>
<td>68 mg</td>
<td>56 mg</td>
<td>1:0.8</td>
</tr>
<tr>
<td>Squash</td>
<td>36 mg</td>
<td>30 mg</td>
<td>1:0.8</td>
</tr>
<tr>
<td>Turnips</td>
<td>112 mg</td>
<td>94 mg</td>
<td>1:0.84</td>
</tr>
<tr>
<td>Okra</td>
<td>144 mg</td>
<td>124 mg</td>
<td>1:0.86</td>
</tr>
<tr>
<td>Carrots</td>
<td>90 mg</td>
<td>82 mg</td>
<td>1:0.9</td>
</tr>
<tr>
<td>Raspberries</td>
<td>82 mg</td>
<td>76 mg</td>
<td>1:0.93</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>64 mg</td>
<td>60 mg</td>
<td>1:0.9</td>
</tr>
</tbody>
</table>
Green Beans 55 mg 50 mg 1:1
Blackberries 43 mg 43 mg 1:1
Yams 44 mg 50 mg 1:1
Guavas 15 mg 16 mg 1:1
Apples 10 mg 10 mg 1:1
Pears 15 mg 18 mg 1:1.2

**Poor calcium sources**

Parsnips 120 mg 152 mg 1:1.3
Radish 21 mg 29 mg 1:1.4
Apricots 15 mg 21 mg 1:1.4
Plums 20 mg 27 mg 1:1.4
Beets 56 mg 84 mg 1:1.5
Cherries (pitted) 19 mg 35 mg 1:1.6
Cauliflower (florets) 28 mg 46 mg 1:1.6
Broccoli (florets) 85 mg 140 mg 1:1.65
Grapes 19 mg 35 mg 1:1.8
Peaches 10 mg 19 mg 1:1.9
Cucumber 10 mg 21 mg 1:2.1
Pumpkin 46 mg 100 mg 1:2.2
Sweet Potato 19 mg 45 mg 1:2.4
Lettuce (head, iceberg) 17 mg 40 mg 1:2.4
Asparagus 28 mg 70 mg 1:2.5
Tomato 11 mg 29 mg 1:2.6
Eggplant 22 mg 62 mg 1:2.3
Pineapple 12 mg 35 mg 1:2.9
Bananas 7 mg 22 mg 1:3.1
Peas 56 mg 254 mg 1:4.5
Brussels Sprouts 36 mg 161 mg 1:4.18
Mushrooms 19 mg 131 mg 1:6.9
Corn 16 mg 206 mg 1:12.9

**If you are feeding a pet that needs a good calcium source (such as iguanas and other herbivorous lizards), feed daily several foods in the good calcium source table as the basic diet. Feed small amounts of the moderate calcium source group, and rarely feed from the poor calcium source group.**

***If you are instructed to feed your pet a diet that is low in calcium, then concentrate on foods in the poor calcium sources group with supplementation from the moderate calcium source group. Consult us for amounts, because some of these foods may be high in calories, if your pet is also on a restricted calorie diet.***

"MEAT"/protein (for carnivorous species)

<table>
<thead>
<tr>
<th>1 Cup Portion</th>
<th>Calcium</th>
<th>Phosphorus</th>
<th>Ca:Phos Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinkie Mice</td>
<td>1.6 %</td>
<td>1.8%</td>
<td>1:1.1</td>
</tr>
<tr>
<td>Earthworms</td>
<td>.95 %</td>
<td>.95%</td>
<td>1:1</td>
</tr>
<tr>
<td>Crickets</td>
<td>.16%</td>
<td>.87%</td>
<td>1:5.4</td>
</tr>
<tr>
<td>Crickets (fortified)*</td>
<td>.77%</td>
<td>.88%</td>
<td>1:1.1</td>
</tr>
<tr>
<td>Mealworms</td>
<td>.038%</td>
<td>.57%</td>
<td>1:1.5</td>
</tr>
<tr>
<td>Canned Dog Food**</td>
<td>.3%</td>
<td>.2%</td>
<td>1:0.6</td>
</tr>
</tbody>
</table>

**Fortified “Gut Loaded” crickets = crickets that are fed a high calcium diet prior to using them for prey.**

**We do not recommend Canned Dog food as a source for Calcium or Phosphorous.**

***Prey items listed above should be dusted with a balanced vitamin-mineral supplement as well as “Gut Loaded” [Fed a proper balanced diet] prior to feeding to your pet.