Chameleons and Vitamin A

The function of and need for vitamin A in chameleons has been a controversial topic for many years, with misinformation being perpetuated in the lay literature and even by some veterinarians. Hopefully this roundtable will help to disseminate further information, separate fact from fiction, and help us all realize how much more is yet to be learned about both vitamins and chameleon care.

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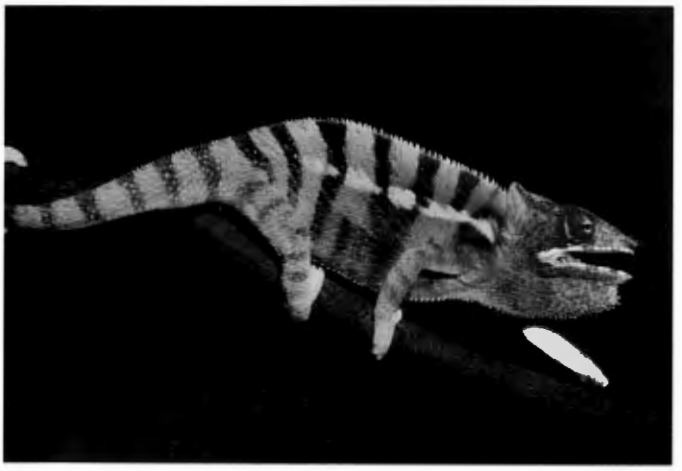
Ardith L. Abate, director of the Chameleon Information Network (website address in references) responded to a request to be on this panel with the following letter which may give members more background on this issue.

"I sincerely hope that the ARAV finds a way to address this issue effectively, as it was the former editor of the CIN, John Annis, who disseminated two poorly researched articles in the early 1990s suggesting that pre-formed vitamin A should not be administered to chameleons. I assumed editorship of the CIN in 1994 and wrote an article on vitamin A in 1997 providing the opinions of Drs. Mader, Boyer, Ferguson, Donoghue and others on the importance of vitamin A for chameleons, however the previous articles by Annis remain entrenched in the popular literature, the minds of hobbyists, and even some veterinarians today. I believe that hypovitaminosis A is prevalent amongst captive chameleons as a result, however this is just one of many factors comprising the poor, imbalanced, and unnatural nutrition provided to the overwhelming majority of captive chameleons. I have lectured on this topic, written manuals on feeder prey, and published a series of detailed articles on chameleon nutrition to little avail. Housing and caring for a wide variety of insects requires knowledge and is expensive and time-consuming, consequently few chameleon owners are willing to go to these lengths. To exacerbate the problem, individuals engaged in commercializing and promoting chameleon ownership often minimize care requirements to attract buyers, or promote nutritional supplementation products that are deficient or over-sufficient in many nutritional elements, resulting in imbalanced or deficient nutrition. I do not believe this widespread problem can ever be corrected.



Chameleons frequently become ill for many reasons in captivity, but mostly they become ill BECAUSE of captivity. Husbandry failures are the underlying cause and these occur commonly in many areas beside nutrition such as temperature, humidity, quantity and quality of drinking water and how it is delivered, hygiene, caging, lighting and provision of UV-B irradiation and sunlight. In the unlikely event these life-sustaining necessities are met adequately, then the other significant factor in captive chameleon morbidity and mortality is stress from being confined, handled, or just from being in visual contact with humans. Chronic stress depresses the immune system and increases susceptibility to disease, usually culminating in death if the stress is not relieved, and captive-born chameleons are as susceptible to captivity-related stress as wild-caught chameleons. In most cases, only freedom in nature will suffice.

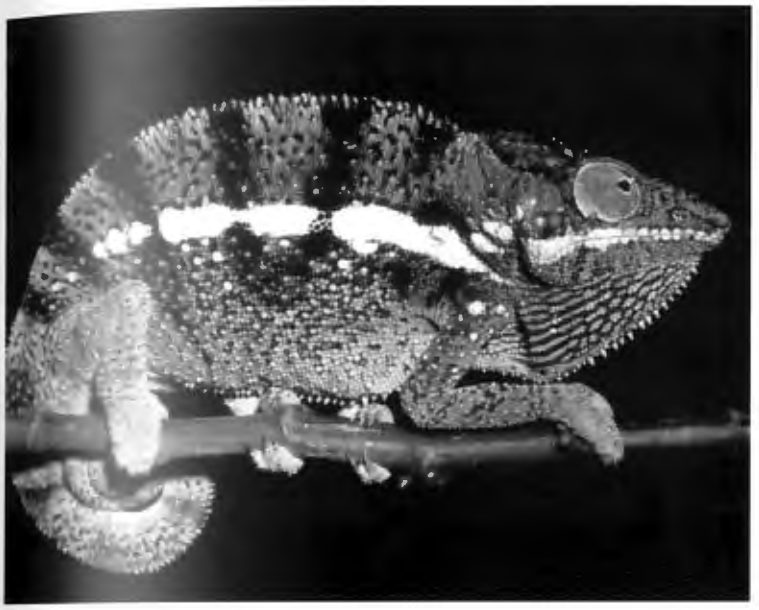
Captive chameleons require very specific care that is both labor intensive and expensive, and very few owners will have the necessary resources and knowledge to keep a chameleon alive a significant portion of their potential life span. There is ample evidence to illustrate that chameleons are far better suited to life in the wild and should not be considered a domesticated animal. The commercial pet trade has consumed more than one million chameleons in just under a decade by very conservative estimates, leaving many wild populations decimated and much closer to extinction. My research into what affects the welfare of captive and wild chameleons since 1991 has culminated in the only humane and ethical solution possible, which is to devote my time and effort to supporting any and all initiatives to end the importation or exportation of chameleons for the commercial trade, to reduce the availability of chameleons as pets, and to discourage chameleon breeding and ownership. I no longer believe that educating the public on captive husbandry will significantly reduce the exorbitant levels of morbidity and mortality in captive chameleons.

I will continue to counsel chameleon owners who contact me to take their ill and injured chameleons to veterinarians, and my first suggestion is always that they consult the directory for the ARAV."

1. What is Vitamin A?

Coke: Vitamin A is a fat-soluble organic substance that is used in the formation and maintenance of healthy skin, mucous membranes, the retina, teeth, skeletal muscles and soft tissues. Carotenoids, such as beta, alpha, and gamma carotene, are precursors to vitamin A.

Ferguson: (The following is paraphrased from Ross, 1999) Vitamin A includes a family of essential, fat-soluble dietary compounds related to the lipid alcohol retinol. It is required in the vertebrate body for vision, growth, reproduction, cell proliferation, cell differentiation and integrity of the immune system. Formally, vitamin A includes those provitamin A carotenoids that serve as precursors of retinol. Carotenoids, or provitamin A, are synthesized by plants and converted to retinol or its metabolites in the gut of animals (vertebrates?). Useful vitamin A activity can be obtained by ingestion of either provitamin A, or the various metabolites of retinol. Excess vitamin A is stored primarily in the liver as retinyl esters, mainly retinyl palmitate. Retinoid binding proteins provide solubility to retinol and its metabolites and serve as chaperones during transport by the cardiovascular system and metabolism in tissue eells.



Reavill: Vitamin A is a fat-soluble vitamin. It is part of a group of related chemicals with hormone-like activities. The following are the best-defined functions.

1. Maintenance of specialized epithelia, mainly mucus-secreting cells
2. A component of the visual pigment
3. Enhancing immunity to infections
4. Some forms have antioxidant properties

2. What chameleon species do you see most commonly affected by vitamin A abnormalities?

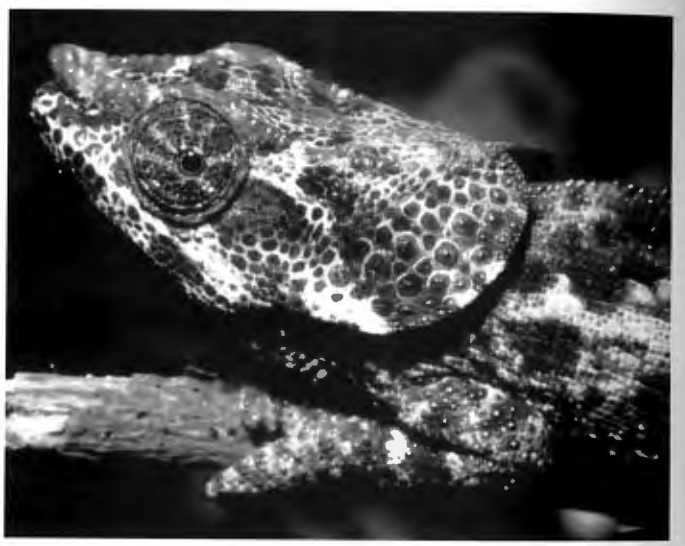
Coke: Without a correlating blood assay, the true extent and species susceptibility of Vitamin A abnormalities is difficult to establish. A series of articles, by Annis in the Chameleon Information Network Newsletter, suggested that Jackson's chameleons, *Chamaeleo (Trioceros) jacksonii*, mountain chameleons, *Chamaeleo (Trioceros) montium*, and Johnston's chameleons, *Chamaeleo (Trioceros) johnstoni*, were more susceptible to hypervitaminosis A. This informa-

tion was based on unpublished data at the time (Annis, 1992 and 1993). These articles sparked alarm in the herpetocultural field, many chameleon enthusiasts, and many herpetoculturalists discontinued preformed vitamin A supplementation in the diet. Instead as a "safer" method, herpetoculturalists used reptile vitamin supplements that contained only vitamin A precursors such as beta-carotene. This may have led to the emergence of many cases of vitamin A deficiency.

Later Dr. Ferguson, *et al*, performed a formal research study using panther chameleons, *Furcifer pardalis*, and showed the results of different vitamin A and D levels with their relationship to ultraviolet light (Ferguson, 1996). Recently, the relationship between carotenoids and vitamin A during the egg development of panther chameleons was determined (Dierenfeld, 2002).

Ferguson: My experience has been primarily with panther chameleons, which have been the subject of numerous research projects in my laboratory at Texas Christian University since 1988. The main abnormalities have been symptoms of hypovitaminosis in captive-born individuals whose diets did not include sufficient preformed vitamin A (retinol or retinyl esters). Oddly, despite the dogma outlined in question #1 above, high amounts of beta carotene provided by gut loading crickets with carrots and an accompanying grain diet low in preformed vitamin A did not prevent the onset of symptoms of hypovitaminosis A. These symptoms could be relieved with oral doses of over-the-counter "vitamin A" supplements (probably retinyl palmitate) suspended in vegetable oil. Whether and under what conditions panther chameleons can "do the vertebrate thing" and convert carotenoids to useable vitamin A in their gut needs to be investigated experimentally.

Reavill: We see suspected nutritionally related lesions in Jackson's, panther, and veiled chameleons, *Chamaeleo (Trioceros) calyptratus*; however, these are the most common species submitted to us.



3). What is different in the diet of wild chameleons versus captive-raised chameleons that leads to vitamin A problems?

Coke: Many clients purchase insects from pet stores or vendors and immediately feed them to their chameleons. Unfortunately, many of these insects have not been properly fed at the pet store, thus not possessing the proper quantities of nutrients. In many instances many of the feeder insects are not fed at all and have defecated their entire gut contents and what nutrients are present within the rest of the body are consumed by a catabolic state.

Once captive prey insects have been properly fed a proper diet, i.e. "gut-loaded," then they may be equal or even superior to wild prey insects. The main nutrition of a prey insect is the gastrointestinal contents. Gut-loading is accomplished by feeding the food insects a combination diet of sweet potatoes, fresh greens, carrots, rolled oats, apples, ground legumes, oranges, corn meal, etc. Another food source for the food insects is commercial insect food preparations, grain mixes, or chicken feed found in co-ops and feed stores. These food mixes must be free from any additive chemicals or medications.

Ferguson: Virtually nothing is known about the vitamin A content of wild insects. The few data suggest that values are low. Conversely, plant-eating insects, as one would expect,

contain considerable carotenoids or provitamin A. Adult panther chameleons do eat small lizards and baby mice in captivity, although most keepers feed exclusively insects to them. In a recent study we showed that eggs from wild-caught gravid females contain high concentrations of vitamin A. In one of our earlier studies using first-generation hatchling captive panther chameleons, we showed that with vitamin A-deficient diets beginning at hatching hypovitaminosis A symptoms appear at an age of 6 months. At this age in the field the chameleons would be large enough to eat small geckos or hatchling birds of small species, which probably contain high vitamin A concentrations. If panther chameleons are unable to enzymatically convert provitamin A to vitamin A in their guts, and let me hasten to add the jury is still out on this pending further study, the egg supply of vitamin A might carry the neonates until they can obtain their own from the diet. Adult females might regularly feed on small vertebrates during the breeding season to provision their eggs with vitamin A.

4. What should the private veterinary practitioner recommend for clients to feed their chameleons (most common species – Jackson's, veiled, panther, Parson's, others you feel are being seen more), including specific supplements and regimens of those supplements?

Coke: Chameleons are insectivores. They can eat a varied diet consisting of crickets, mealworms, wax worms, grasshoppers, roaches, flies, bees, beetles, butterflies, caterpillars, stick insects, arachnids, snails, moths, etc. The larger species of chameleons [Parson's chameleon, *Calumma parsonii*, Oustalet's chameleon, *Furcifer oustaleti*, panther chameleon, etc.] may also eat small birds, small mammals, and even small lizards.

In captivity, these meal patterns are difficult to provide; therefore a basic diet may consist of crickets, *Acheta domesticus*, mealworms, *Tenebrio molitor*, superworms, *Zoophobias morio*, and wax worms, *Galleria mellonella*. Other insect prey can be added to this staple diet as available. To prevent "food burnout," periodic feeding of wild insects such as grasshoppers, butterflies, etc. can be very beneficial. One needs to be careful in the collection process to avoid collecting insects in areas where chemicals and/or insecticides might have been used. Chameleons can be hand fed individual insects which can be placed in an opaque container, which is short enough for the chameleon to crawl out on, but tall

enough the insects cannot jump out. The container must be cleaned daily to prevent microbial contamination.

Veiled chameleons may supplement their water and food intake by eating plant material. They may accept a small dish of leafy greens and vegetables (the same types of food sources that may be fed to an herbivore such as an iguana, *Iguana iguana*) or snack on the tree leaves in the cage. Other species of chameleons such as panther and Jackson's chameleons may also ingest plant or soil material.

If the food items are gut-loaded properly, artificial supplementation may be used sparingly or even not at all. Rate and amount of supplementation should be determined for each chameleon breeder and then each species. One example is supplementing once a week for adult chameleon males, once to twice a week for adult females, and every to every other feeding for juveniles. Most adult chameleons should be fed three to four times weekly, and juvenile chameleons need to be fed once or twice daily.

Ferguson: Based on my response in question #3, I think that vets should recommend a dietary vitamin A supplement for adult panther chameleon females that are in breeding condition of at least 1 – 2 IU/g/week. Gut loading crickets with a grain diet containing 50 – 100 IU/g of vitamin A should work but this introduces intermediate links in the delivery system and less reliability than direct oral administration of an oil solution of known vitamin A concentration, using a small syringe or comparable instrument.

5. What are the clinical signs of hypovitaminosis A and hypervitaminosis A in chameleons?

Coke: The clinical signs of hypovitaminosis A include but are not limited to ocular inflammation, decreased eyesight, squamous metaplasia of the mucous membranes, increased infections, increased reproductive disorders, hemipenile plug impaction, skin disorders, anorexia, and developmental disorders. Hypovitaminosis A is considered as a major differential disease for disorders of the ocular, dermatologic, and respiratory systems.

The clinical signs of hypervitaminosis A include but are not limited to anorexia, hepatomegaly, osteomalacia, soft tissue mineralization, cutaneous fissuring, and the controversial "gular edema." History and husbandry in cases of metabolic bone disease may help determine if the problem is related to a vitamin D_3 deficiency or vitamin A excess in the diet.

Ferguson: Based on our study we have documented the symptoms of hypovitaminosis A in some detail (Ferguson, 1996):

1) reduced growth rate
2) increased mortality
3) some or all of the following signs of morbidity:
   a) tail tip necrosis
   b) swollen lips
   c) gular or cervical edema
   d) vertebral kinking
   e) eyelid closure and oozing
   f) loss of posture control or muscular grip
   g) hemipenile impaction of newly matured males
4) metabolic bone disease
   a) easily cut bones

b) poorly formed irregular cement lines

c) significantly higher ash content of bones with no reduction in bone calcium content

5) reduced reproduction and egg viability

Reavill: I am unaware of published studies documenting cases of either deficient or excessive vitamin A states in old world chameleons. There are few reports in any reptiles, so the following observations are based on assumptions. With vitamin A deficiency, turtles (sliders and box turtles) classically are listless and anorexic. They will have ocular and nasal discharge, conjunctivitis, blepharitis, and otitis media. In a recent report, the lesions of focally thickened lips, ulcerative cheilitis, swollen eyes, lethargy, depression, and weight loss were recognized as signs of vitamin A deficiency in green anoles, *Anolis carolinensis*, (Miller, 2001). Empirical reports link periocular swelling in Old World chameleons to vitamin A deficiency. The clinical signs provided by our clients in chameleons with general malnutrition have included swollen lips, upper respiratory infections, and "abscesses" of the periocular tissues and tongue.

The clinical signs of hypervitaminosis A are even more difficult to guess at. The best-known signs of hypervitaminosis A in reptiles are recognized in box turtles. Those of us who practiced in the early years of reptile medicine might remember using injectable Injacom-100 to treat cases of hypovitaminosis A. The turtles would develop skin blisters on their legs within two to three weeks. The epidermis would then appear to slough at four weeks, leaving a moist, reddened non-keratinized thin skin. These were cases of iatrogenic hypervitaminosis A.

6. How do you diagnose hypovitaminosis A and hypervitaminosis A in chameleons?

Coke: The measurement of vitamin A (retinol) levels in the blood or tissues (liver) may lead to a diagnosis of a vitamin A deficiency or excess. On radiographs, areas of the bones may show osteomalacia of the skull or hyperostosis of the long bones when vitamin A is in excess. Histopathology of the diseased tissues can also reveal a vitamin A abnormality.

Ferguson: Using the symptoms above and if possible serum analysis.

Reavill: The definitive diagnosis would require measuring tissue or serum levels of vitamin A. Of course, knowing the normal levels would be helpful. Without this information, a good history, some relevant clinical signs, and response to therapy might lead to a presumptive diagnosis. Histology may be helpful in a collection of lizards with non-specific problems.

7. What pathological changes occur in chameleons with hypovitaminosis A and hypervitaminosis A respectively?

Coke: I will defer to the pathologist's discussion.

Ferguson: See question #5

Reavill: Again, I am unaware of any studies that have defined the lesions of vitamin A deficiencies and excesses specifically in chameleons. In turtles with hypovitaminosis A, there is epithelial metaplasia and excessive keratosis of the nasal sinuses and conjunctiva of the eye, as well as a bilateral otitis media (Holliday, 2001). Squamous metaplasia has also been described of the pancreatic ducts and renal collecting ducts. In anoles the squamous metaplasia was present of oral mucus glands, palpebral conjunctiva, and respiratory mucus membranes in nasal cavity (Miller, 2001). While oral and nasal squamous metaplasia has been considered pathognomonic for hypovitaminosis A in chickens and psittacines, there are other diseases that can produce this lesion. A chronic bacterial infection of mucosal surfaces, chronic irritation (toxic or chemical), endocrine disorders, and the sequelae of viral infections can all result in squamous metaplasia.

In other animals, we know vitamin A excess suppresses keratinization. More chronic hypervitaminosis A can lead to hyperostosis. Excessive vitamin A apparently interferes with vitamin D metabolism and exaggerates bone remodeling.

8. Are those pathological changes reversible, and if so, what are the expected duration and parameters that can be use to monitor improvement?

Coke: In mild to moderate cases, dietary modification alone has the potential to restore proper vitamin A levels *in vivo*. The resolution of the pathological changes may take weeks to months. Secondary effects such as severe ocular deformity or infection may complicate normal resolution and lead to a graver prognosis, however, with proper diet modification and nursing care the chameleon may survive but may not be able to see, reproduce, etc.

Ferguson: For early symptoms of hypovitaminosis A, such as eye closure or tail tip necrosis, they can be reversed fairly rapidly (one to two weeks).

Reavill: In all species examined to date, it takes several months for the clinical signs of hypovitaminosis A to develop. With supportive care and attention to secondary infections, I would expect the condition to be reversible.

9. What are your recommended treatments for hypovitaminosis A and hypervitaminosis A in chameleons respectively?

Coke: Treatment for hypovitaminosis A includes supplementation of the diet or parenteral administration with vitamin A. Proper "gut-loading" of the insect prey with natural vegetables or commercial insect diet is often enough to correct mild to moderate cases. Severe cases of hypovitaminosis A often possess a guarded prognosis and may require parenteral and oral vitamin A supplementation. Secondary infections should be treated with topical and/or parenteral antibiotics.

Treatment for hypervitaminosis A deals with the discontinuing of artificial vitamin A supplementation. Specific maladies like liver toxicity, etc may require intensive nursing care (fluid administration and tube feeding). Dermal abnormalities may require topical wound management.

Ferguson: We just give the contents of a soft gel vitamin A capsule containing 400 or more IU of retinol or retinyl esters orally to a large juvenile or adult panther chameleon with early symptoms of hypovitaminosis A. Usually one treatment is effective. Adjustment of the chronic intake to higher levels is usually necessary to prevent return of symptoms. We don't have a lot of experience nor have we done any rigorous research on this. It only occurs occasionally in our colony.

10. Is spirulina (blue-green algae) a recommended source of vitamin A, and if so, what regimen should be followed in its administration?

Coke: Spirulina is a microscopic fresh water plant that is a highly absorbable source of protein, essential amino acids, gamma linolenic acid, vitamins B-12 and E, beta carotene, and vitamin A. It has been used for years as a natural herbal dietary supplement for humans as well as in the avicultural community. Spirulina may be used as a supplement for chameleons and reptiles but its true effects on dietary requirements has not been researched and is therefore unknown.

Ferguson: No experience here.

11. Can parenteral vitamin A be given orally, and if so, what regimen should be followed?

Coke: The injectable vitamin A may be given orally.

A normal eye of a young Jackson's chameleon, *Chamaeleo (Trioceros) jacksonii xantholophus*. Photo courtesy of Rob Coke, DVM.

Periocular edema in a Jackson's chameleon, *Chamaeleo (Trioceros) jacksonii xantholophus*. Photo courtesy of Rob Coke, DVM.

A normal eye of an older Jackson's chameleon, *Chamaeleo (Trioceros) jacksonii xantholophus*. Photo courtesy of Rob Coke, DVM.

A normal eye of a young Jackson's chameleon, *Chamaeleo (Trioceros) jacksonii xantholophus*. Photo courtesy of Rob Coke, DVM.

Parenteral vitamin A as supplied by commercial distributors has an unfortunately large concentration of vitamin A. Some of the current veterinary products supply around 100,000 to 500,000 IU of vitamin A/ml, which is extremely large as compared to the diminutive chameleon. Also, many of these compounds contain other vitamins (vitamin D and E) that may be over dosed when injected mixed with the vitamin A. Less concentrated forms of only vitamin A can be compounded through a specialized pharmacy; alternatively, Aquasol A® (Astra® USA, Inc., Westborough, MA 01581) is a parenteral water-miscible form of vitamin A palmitate, which is a human labeled product that contains 50,000 IU vitamin A palmitate/ml. Treatment should be initiated conservatively. Panther chameleons should require about 1 – 2 IU/g given as a weekly oral dose or fed weekly diets of gut-loaded crickets that contain 50 – 100 IU/g of preformed vitamin A (Ferguson, 1996). The above "more sensitive species" such as Jackson's chameleons, Mountain chameleons and Johnston's chameleons may require half that amount.

Ferguson: See question #9.

A young Jackson's chameleon, *Chamaeleo (Trioceros) jacksonii xantholophus*. Photo courtesy of Rob Coke, DVM.

A veiled chameleon, *Chamaeleo calyptratus*, with blepharospasm from conjunctivitis with concurrent gular edema from stomatitis. Photo courtesy of Rob Coke, DVM.

All photos courtesy of John H. Tashjian, unless noted otherwise.

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