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Vitamin D

Vitamin D: group of closely related compounds that possess antirachitic activity:

- via diet
- irradiation of body

Two major natural sources (provitamins):

- cholecalciferol (D_3 in animals)
- ergocalciferol (D_2, predominantly in plants)
- no vitamin D antirachitic acitivity until β-ring opened between 9 and 10 positions by irradiation and a double bond is formed between carbons 10 and 19 to form vitamin D
- ergocalciferol has 1/10 activity of cholecalciferol in chicks

Over-irradiation

- Over-irradiation of precursors produces numerous irradiation products:
- partial vitamin D activity
- toxicity
- potent antagonists of vitamin D

11-45 minutes sunshine daily is sufficient to prevent rickets in growing chicks

Vitamin D deficiency

Upper mandible of chick fails to develop
Chicks cannot crack shell > mortality
D_3 and 25-OHD_3 readily passed to egg so problem if hen's diet deficient

Carnivorous Mammals

Dogs and cats have nutritional requirement for vitamin D even when sufficient sunlight available:

- D_3 not produced in skin through the action of UV sufficient to prevent rickets

- skin precursor 7-dehydrochol concentrations are low and inadequately converted to vitamin D
- implications for carnivorous birds?

Sunlight

Sunlight through ordinary window glass is inefficient in the production of vitamin D in the skin

Vitamin D is converted at UVB (290-320nm)

Sunlight provides most of its antirachitic powers during the 4 hours around noon

Neodymium lights that are marked as 'true daylight' do not provide full spectrum light

Black lights emit UVA and UVB but also UVC that can be harmful

Vitamin D Deficiency

Distinguished from vitamin A deficiency:
- alert rather than droopy
- walk with a lame rather than a staggering gait (ataxia)

First sign:
- thinning of egg shells
- decreased egg production
- thin or no shell
- eggshell strength can decrease as hens age
- decreased hatchability
- embryonic death, especially at 18-19 days

Health impacts:
- liver malfunction: limits production of active forms
- intestinal disorders reduce absorbance
- kidney failure: can't synthesise 1,25-$(OH)_2$D

Vitamin D Toxicity

Widespread calcification of soft tissue:
- inflammation, cellular degeneration, calcification
- kidney insufficiency
- bone thinning from demineralisation
- leg problems due to calcium loss

General depression in performance in hens

Toxic levels can be transferred to the embryo

Long plasma T_{50} of vitamin D (5-7) days and 25-OHD (20-30) days.

Dietary Requirement

Chicken 200 IU/kg
Japanese Quail 1,200 IU/kg
Turkey 900 IU/kg

Most commercial products are in excess of poultry requirements (except HBD) and in excess of turkey (except Roudybush maintenance).

Calcium

Calcium Availability

Calcium availability influenced by solubility

- improved uptake in acidic environment
- foods high in oxalic acid form calcium oxalates (insoluble)
- phytates bind phosphorus and decrease its availability
- fats can form calcium soaps (insoluble)
- faulty fat metabolism (can interfere with vitamin D uptake)

Calcium and Carnivores

Particle size of calcium can influence availability
Careful interpretation of calcium requirements of carnivores that egest pellets
Falconiforms better than strigiforms at digesting

- greater proventricular acidification

Oxalic Acid

Tubers: high in cassava and carrot
Greens: high in beet leaves and spinach

Calcium and Nuts

Calcium content is low in nuts, particularly macadamia and peanut
Ca:P lowest in peanut

Supplementing Meat

Approximately 20% of the vertebrate body consists of bone

If feeding muscle meat, need to supplement with 20% bone

Supplementation of meat-based diets:

- 10g/kg $CaCO_3$ fresh meat
- 10g/kg fresh liver (for vitamins) or cod liver oil/fish oil 1g/kg meat

Calcium Content of Whole Prey

No supplementation requirement as adequate calcium and Ca:P ratios

Stork chicks:

- beak and bone deformities when fed whole chicks (2% Ca)
- studies of wild feeding ecology > frogs
- frogs have twice as much Ca as chickens

Calcium Content of Invertebrates

Insufficient Ca:P ratio

Gutloading increases Ca:P ratio and combination of gutloading and dusting = highest.

Calcium in pinhead crickets is higher than adults

Some insects have high calcium content

- calcium content can vary depending on part of body eaten

Supplementing Invertebrates

80% poultry mash and 20% Calcium carbonate
Water provided *ad lib* from produce or free water
Die-off from constipation:

- add water (apples)
- gutload less than 48 hours before feeding

Have three colonies:

- poultry mash
- gutloading (48 hours prior to feeding)
- dusting of gutloaded (less than 30 minutes prior to feeding)

Calcium in Wild Foods

Seeds of Orange-bellied Parrot:

- all less than 0.7%

Calcium in Commercial Foods

Research indicates that > 0.7% can be toxic

Many greater than 0.7%

- exceptions are Roudybush (maintenance) and HBD

Source	Radiation
Sun	UVB (290-320 nm) UVA (320-400 nm) Visible (400-700 nm) Infrared (>700 nm)
Incandescent	Visible, infrared
Fluorescent	Visible
Black lights	UVA (320-400 nm)
Sun Lamps	UVB (290-320 nm)
High Intensity Discharge	Visible, infrared, UVA/B shielded