Nutrition requirements

Selection and formulation of appropriate diets for companion and aviary birds is based on wild feeding ecology, digestive anatomy and physiology, and nutritional requirements of related species. Research indicates that requirements of some key nutrients for psittacines vary from those of poultry.

Evolution of nutrition for psittacine birds

1st stage
- Early diets were based upon food habits of wild birds

2nd stage
- Nutrient requirements that were scientifically determined for poultry were adopted, at least in part, as standards for diets of captive psittacine birds

3rd stage
- Research populations of easily propagated species, such as budgerigars (Melopsittacus undulatus) and cockatiels (Nymphicus hollandicus), are being used to investigate dietary preferences, nutrient requirements, and metabolic capabilities

Water intake

<table>
<thead>
<tr>
<th></th>
<th>Body Weight (g)</th>
<th>Water Intake Per Day (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budgerigar</td>
<td>30 – 35</td>
<td>4</td>
</tr>
<tr>
<td>Canary</td>
<td>18 – 24</td>
<td>4</td>
</tr>
<tr>
<td>Lovebird</td>
<td>55</td>
<td>10</td>
</tr>
<tr>
<td>Cockatiel</td>
<td>100</td>
<td>13.6</td>
</tr>
<tr>
<td>Cockatoo</td>
<td>300 – 900</td>
<td>15</td>
</tr>
<tr>
<td>Amazon/Grey</td>
<td>350 – 600</td>
<td>17 - 35</td>
</tr>
</tbody>
</table>

Desert – adapted birds require less water intake than tropical birds. Changes in diet or environmental temperatures can alter water intake.
**Carbohydrates**

Carbohydrates are used to produce energy in the form of adenosin triphosphate (ATP) from glycolysis and the tricarboxylic acid cycle, and produce heat from oxidation of glucose to CO2 and H2O. They are also used to produce precursors of the nutrients, synthesize glycogen or fat from glucose, decrease luminal pH through production of short – chain fatty acids, and increase the population of anaerobic flora. The antibacterial properties of short – chain fatty acids may decrease pathogenic intestinal bacteria. The central nervous system, erythrocytes and muscles require glucose for energy. Muscles can utilize substrates such as fatty acids.

Sucrose, one of the predominant disaccharides of fruit sugars is easily digestible. However, some insectivorous passerines that feed on diets high in protein/fat and low in carbohydrate, lack of sucrase enzyme necessary for the digestion of these simple sugars. Avoid feeding this birds fruits high in disaccharides such as mango, apricot, nectarine and peach.

Postgastric microbial fermentation of polysaccharides occurs in nectarivorous, frugivorous and florivorous species.

**Protein**

Proteins are composed of amino acids. The protein chain can contain up to 22 different amino acids. Of these 10 cannot be manufactured by the body, so they must be routinely provided by the diet. The are

- lysin
- arginin
- histidin
- methionine
- tryptophan
- threonin
- leucine
- isoleucine
- valine
- phenylalanine

Lysin, arginin, histidin, methionine, tryptophan, threonin, leucine, isoleucine, valine, and phenylalanine are the 10 essential amino acids.
### Feeding strategies and common diet ingredients

<table>
<thead>
<tr>
<th>Species name</th>
<th>Feeding strategy</th>
<th>Common diet ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue and gold macaw</td>
<td>florivore</td>
<td>seeds, fruits, nuts</td>
</tr>
<tr>
<td>Military macaw</td>
<td>florivore</td>
<td>seeds, nuts, berries, fruits</td>
</tr>
<tr>
<td>Blue-throated macaw</td>
<td>frugivore</td>
<td>palm fruit, nuts, milk</td>
</tr>
<tr>
<td>Budgerigar</td>
<td>granivore</td>
<td>seeds</td>
</tr>
<tr>
<td>Cockatiel</td>
<td>granivore</td>
<td>seeds (prefers soft, young over mature, hard seeds)</td>
</tr>
<tr>
<td>Rose-ringed parakeet</td>
<td>granivore</td>
<td>seeds</td>
</tr>
<tr>
<td>Rainbow lorikeet</td>
<td>nectarivore</td>
<td>primary nectar, pollen, fruits, seeds</td>
</tr>
<tr>
<td>Sulphur-crested cockatoo</td>
<td>omnivore</td>
<td>seeds (primary sunflower), grubs, rhizomes</td>
</tr>
<tr>
<td>Red-tailed amazon</td>
<td>omnivore</td>
<td>seed, fruits, flowers, leaves, nectar, insects</td>
</tr>
</tbody>
</table>

### Functional Digestive Anatomy

- Digestive anatomy of an animal generally reflects the type of diet it consumes, and the feeding strategies of psittacine species (granivory, frugivory, nectarivory, and omnivory)
- Acquisition of food is enabled by the beak, tongue, and oral cavity.
- Beak shape and size are often adapted to accommodate preferred foods

### Crop

- In most birds, the esophagus is divided by the crop or ingluvies (some birds do not have a crop) into a cervical and a thoracic component.
- In Galliformes and Falconiformes, the crop forms a ventral enlargement of the esophagus at the thoracic inlet.
- In Psittaciformes, the crop is stretched transversely across the neck.
- In canaries and ducks, the crop is absent, but there is a spindleshaped swelling of the esophagus at the thoracic inlet.
- In pigeons, the ventral diverticulum of the esophagus that forms the crop is divided into two large lateral sacs.

Some crop shapes include:
- a) Great Cormorant
- b) peafowl
- c) budgerigar
- d) domestic pigeon
- e-h) Various shapes noted in a cockatoo.
Cecal characteristics

- large – chicken, turkeys, grouse, quail
- large to medium – ducks, geese, swans
- vestigial – larks, finches, jays, wrens
- vestigial to absent – pigeons, doves
- absent – parrots, lories, macaws

Paired cecum (a) connected with ileum (b) and rectum (c).

Cloaca

- The cloaca serves as a storage site for urine and feces.
- In many avian species, retrograde movement of urine from the cloaca to the rectum allows for resorption of protein, salts, and water.
- This phenomenon likely occurs in psittacine birds as well.
Mean retention time

- **mean retention time** - the average length of time that food is retained in the GI tract
- Depends upon
  - food characteristics,
  - feeding strategy,
  - digestive anatomy,
  - and body size

- Larger birds have longer GI tracts and retention times.
- **avian nectarivores**, typical mean retention time is approximately 30–50 minutes (but it is 80 minutes in rainbow lorikeets).
- **granivores** retention times are approximately 40–100 minutes.
- **frugivores** retention times are approximately 15–60 minutes.
- The mean retention time is typically an order of magnitude shorter than the time required for complete evacuation of the GI tract.
- Complete evacuation of a single meal from the crop of a budgerigar takes 11.75 hours, whereas complete evacuation of the entire tract takes 26 hours.

Anatomy of specific species

- **Shape of beak**
- **Tongue**

Nutritional strategy

**Food specialization**

- **Red-tailed Black-Cockatoo** – seed of eukalyptus
- **Glossy Black-Cockatoo** – seed Casuarina
- **Pesquet’s Parrot** – fruit from 2 of 38 species of fig
- **Thick-billed Parrot** - pine
- **Red-spectacled Parrot** - araucaria
- **Tucuman Parrot** – genus Alnus - Alder
Budgerigar
*Melopsittacus undulatus*
Australia outback

Mainly arid area. Intake of seed of 39 species of plant. Not detected intake of green part of plant or insects. Size of seeds in range 0.5 – 2.5 mm. In captivity – millet.

Eastern Rosella
*Platycercus eximius*
Australia outback

Intake mainly of fruits and seed, too green parts of grass, bush and tree. In total using 87 species of plants. Marked intake of insects, mainly in time of flower of eucalyptus. Animal parts of diets can made to 50 %.

Yellow-tailed Black-cockatoo
*Calyptorhynchus funereus*
outh-east of Australia

Intake of seeds and green part of 30 species of plants. Marked intake of larva of insects parasitical on the plants, using especially for feeding of young.

Cuban Parrot
*Amazona leucocephala*
Latin America

Rain forest with humid clima and high average temperature. Intake of seed and green parts of 16 species of plants, mainly palm.
Pets
- Commercial quasi “complete” mixture with vitamins. Generally nice coloured packing, composition many times suitable, but not correct way of storage. Intake of human food (sweet, salt and fat).

Birds in breeds
- Original mixture of every breeder, variable offering of fruits and vegetable, sprouting of seeds, tendency imitated naturally variability of feed source.

Seed mixture inhalt protein, sacheride and lipid in correct quantity, but are poor to essential fatty acids aminoacids vitamins minerals and biologically effective substance.

Pelets of different producer inhalt proteins, sacherids and lipid in correct quantity and quality. Depended on the producer inhalt too essential fatty acids, aminoacids, vitamins and minerals. Are poor to biologically effective substance.

Offered vegetable and fruits inhalt great mounts of vitamins, minerals and biologically active compound, but in the spectrum which is suitable for individual normally existing in this clima and enviroment.
What Not to Feed

• Avocado
  – poisoning
• Raw milk or raw milk products
  – microbes, lactose
• Chocolate
  – Theobromine is toxic for bird

Vitamin Supplementation

• Dry powder
  – Sprinkle over fruit, vegetables, and other table food or commercial kibble
  – NOT on seeds
• Liquid
  – Put in water
  – Replace after each water change
  – Thoroughly clean waterer once or twice a day

Nutrition of exotic birds

• Nutrition is the single most important aspect of bird husbandry. Nutrition impacts the health, longevity, appearance and behavior of birds in captivity.
• The complex biochemistry and interactions between levels of nutrients coupled with the paucity of research in companion birds make choosing an appropriate diet very difficult.

Feeding of parrots

• Feed your parrot a balanced diet of fruit, vegetables, cooked meats and grains. Go ahead and share whatever healthful food you’re eating with your parrot.
• Determine the proper amount by feeding your parrot small portions of several foods. If there’s food left over, decrease the amount the next time. Continue doing so until your parrot eats all of the food. Remember this portion size.
• Offer your parrot a variety of small servings of different foods, not a lot of one food.
• Keep your parrot’s food fresh, as bacteria and mold can grow on food left in the cage and make her sick.
• Give your parrot fresh water daily.
• Feed your parrot treats like seeds and nuts sparingly since these foods have few nutrients for parrots.
• Avoid chocolate, caffeine, alcohol, kidney beans, lima beans and avocados. These foods are dangerous for parrots!
Nutrient

- Watter
- Nutrient carrying energy
  - Carbohydrates
  - Sucrase and fruit sugar
  - Polysacharides
- Protein
- Lipids
- Vitamins
- Minerals

Clay
Importance of clay

- Source of macroelements
- Source of trace elements for blood formation and component of enzymatic systems
- Source of sodium for growing chicks
- Binding of toxic alkaloids from feed
- Buffer of pH intestinal contents
Offering excessive amounts of unbalanced foods allows the bird to choose its diet and nutritional disorders result. The amount of food shown was offered twice a day. The immature corn (sweet corn), baby beans, zucchini, and squash are of little nutritional value. The broccoli, kale and carrots are difficult to digest. While no sunflower seeds are offered, safflower is just as imbalanced, being even higher in fat than sunflower seeds. Peanuts are also high in fat, and when fed without the shell, often become rancid. Peanuts are a common source of mycotoxins. If they are fed at all, a human-grade of peanuts certified free of mycotoxins should be used.

An aviculture diet used commonly in the 1980’s. Birds on sunflower seeds, apples, oranges, grapes, pound cake and bread rapidly developed nutritional disorders, especially the breeding females. Nutritionally deprived parent birds were unable to raise their young. Incubation of the eggs and hand-feeding from hatching had to be employed. The associated developmental problems in the young disappeared when a formulated diet was instituted.

Critical factors in the selection of a diet

1. **Consideration of any species** — specific dietary requirements or sensitivities.
2. **Avoidance of excessive amounts of nutrients**, as well as assuring adequate mineral levels.
3. **Analysis of the components** and availability of the listed manufacturers, “crude” protein, fat, calcium, etc., and knowledge of what method is used to measure these levels.
4. **Awareness**, as in human, dog and cat nutrition of the potential dangers inherent in preservatives and additives.
5. **Recognition of the discrepancy** between wild natural food sources and substitutions made by many commercial manufacturers.
Diets of female must be rich to aminoacids, energy, essential fatty acids, vitamins and minerals. If is some deficiency can be presented early embryonal death.

Egg of blue and gold macaw

Past hatching 1. – 3. days of life is reservoir of energy yolk sac. In next period is really important especially for macaw correct mount of aminoacids, linoleic acid, vitamins and minerals. Critical period is time of growing of first feathers - 10% of total body weight and 90% of all accessible proteins.

Egg of blue and gold macaw

Growth of chicks

Past hatching 1. – 3. days of life is reservoir of energy yolk sac. In next period is really important especially for macaw correct mount of aminoacids, linoleic acid, vitamins and minerals. Critical period is time of growing of first feathers - 10% of total body weight and 90% of all accessible proteins.

Egg of blue and gold macaw

Egg of blue and gold macaw

Lower requirement that period of growing. Adequate intake of energy for maintaining body temperature and metabolic functions. Proteins depend on the body weight and species 10% - 20%. Lysin 0.8%, fat 4% - 10%. Sufficient of vitamins and minerals.

Egg of blue and gold macaw

Adulthood

Breeding seasons

Increased intake of proteins, mainly sulphurous aminoacids and lysin. Increased needs of calcium – protection from osteoporosis. Increased intake of vitamin A, cobalamin (B_{12}), riboflavin (B_{2}) and zincum. Mild increasing of cholecalciferol (D_{3}).

For increasing of hatchability is needed tocopherols (vit. E), riboflavin (B_{2}), pantothenic acid (B_{5}), biotin (B_{7}), folid acids (B_{9}), pyrrodoxin (B_{6}) and zincum (zinc), ferrum (iron), cuprum (copper) and manganese (Mn).

Egg of blue and gold macaw

Breeding seasons
Seniors

Feed must be easily digestible, lower contents of proteins, phosphorus and sodium. Sufficiency of minerals and vitamins. Increased amount of vitamins A, E, cobalamine (B12), thiamine (B1), pyridoxin (B6), zinc, linoleic acid and lysine.

Disease

Mobilisation of glucose as easily available source of energy. Glycide store are used during first 24 hour, than are used body proteins and fat. Starting of lose weight as sequence of lose skeletal muscle, which is source of energy for maintaining of live function.

Decreasing of level vitamine A and C, calcium, zinc, iron, copper and magnesium.

Red-fronted Macaw
Ara rubrogenys

Nutritional Disorders

Mobilisation of glucose as easily available source of energy. Glycide store are used during first 24 hour, than are used body proteins and fat. Starting of lose weight as sequence of lose skeletal muscle, which is source of energy for maintaining of live function.

Decreasing of level vitamine A and C, calcium, zinc, iron, copper and magnesium.

Nutrient deficiencies of seeds

The seeds most commonly fed birds, such as oats, corn, sunflower, safflower and millet, are generally missing 32 ingredients (from eight groups) needed to keep birds healthy. These include:

- **Vitamins** - choline, niacin, pantothenic acid, riboflavin (B2), yanocobalamine (B12), biotin (H), D3, E, K, and folic acid (M)
- **Minerals** - calcium, phosphorous (70% tied up as nondigestible phytates in plant products, such as grains), sodium
- **Trace minerals** - selenium, iron, copper, zinc, manganese, iodine, chromium, vanadium, bismuth, tin, boron
- **Pigments** - chlorophyll, canthaxanthin
- **Protein** - (amino acids) lysine, methionine
- **Fiber** - (mucopolysaccharide) both soluble and insoluble
- **Vitamin precursors** - ß-carotene, converted to vitamine A in liver
- **Omega 3 Fatty Acids**
Hypocalcemia

- Hypocalcemia – caused by poor Ca/P balance in seed mixture.
- Danger increases in case high of fat content, lack of vitamine D, lack of UV light.
- In young bird rickets – growth plate fractures, curved legs, S curved breast, muscle weakness.
- In adult bird if egg laying – skeletal decalcification, spontaneous fractures, poor egg shell, egg binding.
- Hypocalcemic tetany – only in African greys muscle scramps, convulsion, uncoordinated fluttering of the wings.

5-week-old African grey parrot with severe nutritional osteodystrophy. There was radiographic evidence of pathological fractures in both tibiotarsi and humeri with severe spinal malformation. The bird was euthanized. Histopathology of the parathyroid glands confirmed vacuolated hypertrophic chief cells suggestive of nutritional secondary hyperparathyroidism. The bird had been parent-reared by adults fed an unsupplemented seed mix.

An adult African grey with osteodystrophy. The bird has characteristic bending in the tibiotarsi. The condition was successfully corrected by osteotomy and fixation of both legs.

Rachitis in amazona chicks
Rachitis in amazona chicks

Hypovitaminosis A

- Seeds contain insufficient vitamin A, vitamin A is decomposed during storage.
- Symptoms – chronic respiratory problems, keratosis of the mucous membranes of the respiratory systems, cheesy deposit in the sinuses, increases susceptibility to other diseases (aspergillosis)

Hypovitaminosis E

- Male – degeneration of testes
- Hen – infertility
- Embryonic mortality
- Dying when hatching
- Fatty liver disease

Vitamin A deficiency: nostril distortion and rhinolith due to squamous metaplasia in an African grey parrot. (Photo of S. Divers.)
Fatty liver in a Mexican red-headed Amazon. The bird died while being restrained for grooming. The serum was lipemic. The veterinarian never realized long nails and beak were a sign of a problem.

Enzymatic Changes in Fatty Liver Affected Birds.

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>FLHS-affected birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylcholinesterase</td>
<td>↑ activity</td>
</tr>
<tr>
<td>Aspartate aminotransferase</td>
<td>↑ activity</td>
</tr>
<tr>
<td>Aspartate transaminase</td>
<td>↑ activity</td>
</tr>
<tr>
<td>Glutaminase</td>
<td>↓ activity</td>
</tr>
<tr>
<td>Glucose oxidase</td>
<td>↓ activity</td>
</tr>
<tr>
<td>Lactate dehydrogenase</td>
<td>↑ activity</td>
</tr>
<tr>
<td>Phosphofructokinase</td>
<td>↓ activity</td>
</tr>
<tr>
<td>Sorbitol dehydrogenase</td>
<td>↓ activity</td>
</tr>
</tbody>
</table>

A blue and gold macaw that was fed a diet of pasta, crackers, cookies, pellets and vegetables. The feathers are tattered and lack symmetry. The blue feathers contain a black pigment. Under the contour body feathers, the bird had an excessive number of pinfeathers.

This blue and gold macaw hen died after laying a clutch of 5 infertile eggs. Note the pinfeathers after all the body and extremity feathers were removed. Also note the black pigment in the normally blue feathers. The bird had been fed a seed and table food diet.
Iron storage disease results from the accumulation of iron in various tissues, with the liver most frequently involved.

**Iron storage disease**

**Stress marks**
Segmental discoloration, black lines or transparent areas across the vane of a feather are called stress marks and indicate a dysfunction of the epidermal collar at the time the feather was developing.

**Lipoma**: Lipomas are benign proliferations of well-differentiated adipocytes (lipocytes) that may exhibit slow-to-rapid, progressive growth over time.

Lipomas are the most frequently observed neoplasms of companion birds, with a reported incidence of 10% to 40% in budgerigars. Besides budgerigars, lipomas may be observed frequently in Rose-breasted Cockatoos, galahs, and Amazon parrots. Obesity, advancing age, species of bird, and high-energy diets appear to be predisposing factors for tumor development.

Based upon clinical observations, a genetic predisposition to lipoma development may exist in budgerigars.
Gout reportedly may be caused by reduced excretion of urates or by increased dietary protein.

Possible supplements with high active compound:
- Palm oil
- Oil from common evening primrose
- Macadamia nut oil
- Common sea-buckthorn
- Safflower
- Oyster mushroom
- Clay

Oil palm (Elaeis qineensis)

Significantly viscous, red colour (high contents of carotenoids)
Composition: saturated fatty acids, similar to animal fat (lard, butter)
carotenoids 15x more as carrots
50x more as tomatoes
high contents of vitamin E

tocotrienols !!!

Effects: source of betacarotene (vitamin A), vitamin E and tocotrienols protect against oxidation with free radicals (exudative diатesis – common problem of chicks)
**Common evening primrose**
*Oenothera biennis*

Oil from the seeds contains a great amount of unsaturated fatty acids:
- Linoleic acid $C_{18}H_{32}O_2$
- Gamma-linolenic acid $C_{18}H_{30}O_2$

Positive effect in the development of feathers in all young chickens, mainly in the macaw.
Effective too in cases of feather picking.
Dose: 10 drops/head/day for 3 weeks.

**Common sea-buckthorn**
*(Hippophae rhamnoides)*

Fruits, or oil:
- Vitamin E, C, A, K
- Omega unsaturated fatty acids
- Bactericidal effect
- Generally healing effect
- Contents of serotonin

**Macadamia nut**
*(Macadamia terniflora)*

Contents: fatty acids very similar to the skin fat vitamin A, B, E
Effects: suitable in the formation and regeneration of skin and skins derivatives (feathers, beaks, claws)
Oyster mushroom *(Pleurotus ostreatus)*

**Contents:** vitamins group B, amino acids, makroelements, mikroelements (Fe, K, P, Na, Se, Co, Cu, B, I)

**Effect:**
- Decreasing of cholesterol level
- Antitumorous activity
- Immunostimulation (incontrovertibly in PBFD)

β-glucan

(1,3/1,6) β-glucan

Safflower *(Carthamus tinctorium)*

In seeds is to 80% linoleic acid
Euterpa oleracea - acaí

Clay and kaolin

• Formation weathering ingenious rock often typical red color (rich on the mineral substance )
• Capability absorb bacteria and toxins
• Excellent source of calcium and others macroelements.
• Sometimes sole source of microelements (as coenzyme essential for good healthy status, limitation of reproductive function and vitability of chickens)

Thank to you attention !!