Nutritional Considerations Section II

Nutritional Disorders

GREG J. HARRISON, DVM, Dipl ABVP-Avian, Dipl ECAMS
DEBRA McDONALD, PhD, BSc (HONS I)

Nutritional disorders can result from malabsorption, a deficient diet, over-supplementation and/or overeating. Deficiencies and excesses of nutrients can both be harmful to birds.

Companion birds have been maintained for decades on diets that, while nutritionally inadequate, support limited breeding in a few species. While there are numerous publications regarding nutritional requirements of agricultural species, captive passerine energetics and feeding ecology, there are few controlled scientific studies on aviary and companion birds or their wild conspecifics. Variations in lifestyle and breeding ecology result in differing nutritional requirements. Clinically, many health problems are correlated with nutritional disorders. This chapter will provide an overview of these conditions observed in companion birds, with reference to anecdotal observations in a clinical context and summaries of nutrient implications that have been predominantly studied in agricultural species. Specific studies of companion and wild birds will be discussed. Parallels may exist between the following description of the improper diet cascade and the metabolic syndrome of humans and rats.[1,2]

The Improper Diet Cascade (IDC)

The 'improper diet cascade' (IDC) (Table 4.2.1) has been postulated by the author (GJH) from decades of clinical experience, reports from pathologists and nutritionists, as well as consultations with companies that produce commercially formulated diets. The IDC expresses itself in a highly individualistic fashion. The most common thread is the history of a basic seed and table food diet. Generally, at presentation of a "sick" bird, the IDC patient exhibits pansystemic clinical signs that often include various behavioral problems. Typically though, the earliest clinical signs are reflected in the integument, followed closely by the digestive system. Often birds are not presented for evaluation until the reproductive or respiratory system is affected. Behavioral problems can be the proximal cause of veterinary presentation when other clinical signs have been missed or ignored.

The IDC can be initiated from a nutrient imbalanced diet as well as from influences, such as improper husbandry, diet handling and storage or over-supplementation of nutrients in formulated diets. Therefore, when evaluating nutritional disorders, consider the composition of the diet eaten, as well as the stability or availability of nutrients in that diet. Pathological influences such as parasite infestation, metal toxicoses, malabsorption syndromes, pancreatitis and gastroenteritis produce clinical signs similar to those seen in IDC, and therefore need to be ruled out (Table 4.2.2a).

The IDC is the result of improper nutrient utilization, usually from malnutrition that weakens the body immunologically and structurally. This can allow invasion of low level pathogens or commensals of viral, bacterial, or fungal origin.

Recent research by Dr. M. Beck, University of North Carolina[3], showed that when the host is affected by a nutritional deficiency, the invading pathogen is affected as well. By sequencing the viral isolates recovered from selenium-deficient mice, she demonstrated mutations in the viral genome associated with increased pathogenesis of the virus affected by nutrient deficiency. Bhaskaram

Nutritional Section II Considerations

Nutritional Disorders

GREG J. HARRISON, DVM, Dipl ABVP-Avian, Dipl ECAMS DEBRA McDONALD, PhD, BSc (HONS I)

Nutritional disorders can result from malabsorption, a deficient diet, over-supplementation and/or overeating. Deficiencies and excesses of nutrients can both be harm- ful to birds.

Companion birds have been maintained for decades on diets that, while nutritionally inadequate, support lim- ited breeding in a few species. While there are numer- ous publications regarding nutritional requirements of agricultural species, captive passerine energetics and feeding ecology, there are few controlled scientific stud- ies on aviary and companion birds or their wild con- specifics. Variations in lifestyle and breeding ecology result in differing nutritional requirements. Clinically, many health problems are correlated with nutritional disorders. This chapter will provide an overview of these conditions observed in companion birds, with reference to anecdotal observations in a clinical context and sum- maries of nutrient implications that have been predomi- nantly studied in agricultural species. Specific studies of companion and wild birds will be discussed. Parallels may exist between the following description of the improper diet cascade and the metabolic syndrome of humans and rats.90b

The Cascade Improper (IDC)

Diet

The ‘improper diet cascade’ (IDC) (Table 4.2.1) has been postulated by the author (GJH) from decades of clinical experience, reports from pathologists and nutritionists, as well as consultations with companies that produce commercially formulated diets. The IDC expresses itself in a highly individualistic fashion. The most common

thread is the history of a basic seed and table food diet. Generally, at presentation of a “sick” bird, the IDC patient exhibits pansystemic clinical signs that often include various behavioral problems. Typically though, the earliest clinical signs are reflected in the integument, followed closely by the digestive system. Often birds are not presented for evaluation until the reproductive or respiratory system is affected. Behavioral problems can be the proximal cause of veterinary presentation when other clinical signs have been missed or ignored.

The IDC can be initiated from a nutrient imbalanced diet as well as from influences, such as improper hus- bandry, diet handling and storage or over-supplementa- tion of nutrients in formulated diets. Therefore, when evaluating nutritional disorders, consider the composi- tion of the diet eaten, as well as the stability or availabil- ity of nutrients in that diet. Pathological influences such as parasite infestation, metal toxicoses, malabsorption syndromes, pancreatitis and gastroenteritis produce clinical signs similar to those seen in IDC, and therefore need to be ruled out (Table 4.2.2a).

The IDC is the result of improper nutrient utilization, usually from malnutrition that weakens the body immunologically

and structurally. This can allow inva- sion of low level pathogens or commensals of viral, bac- terial, or fungal origin.

Recent research by Dr. M. Beck, University of North Carolina15, showed that when the host is affected by a nutritional deficiency, the invading pathogen is affected as well. By sequencing the viral isolates recovered from selenium-deficient mice, she demonstrated mutations in the viral genome associated with increased pathogenesis of the virus affected by nutrient deficiency. Bhaskaram

Table 4.2.1 | Improper Diet Cascade (IDC)

Nutritional Imbalance			
⇩			
MULTISYSTEMIC ABNORMALITIES			
Cellular	**Structural**	**Functional**	**Immunologic**
Impaired metabolism	Metaplasia of columnar epithelium	Goblet cells mucin production impaired	Commensal organisms normally bound to mucus are not excreted
Altered cell wall permeability	Increased mucous viscosity	Loss of cleansing ability of mucous	Relationship with commensal organisms disrupted
Cellular autointoxication Change in GI pH (less acidic)	Loss of normal collagen elasticity	Normal glandular production of various systems suppressed	Bone marrow suppression Decreased IgA, decreased lymphocytes
Chronic: eg, • Hepatic lipidosis, fibrosis, cirrhosis • Iron storage disease • Irreversible degradation of retinal cones leading to blindness	Chronic: eg, • Abnormal cilia • Renal tubular nephrosis • Follicular atresia • Cataract formation • Bone/muscle abnormalities	Chronic: eg, • Diabetes mellitus • Deposits of high density lipids in vasculature • Exocrine pancreatic insufficiency • Infertility, decreased hatchability of chicks • Secondary hyperparathyroidism	Chronic: eg, • Secondary microbial infections • Increased susceptibility to neoplasia
⇩			

ABNORMALITIES OF SPECIFIC SYSTEMS						
Integument	**Gastrointestinal**	**Respiratory**	**Renal**	**Endocrine**	**Reproductive**	**Cardiovascular**
• Skin • Feathers • Beak • Nails • Fat deposits	• Oropharyngeal • Pancreatic • Hepatic • Intestinal	• Nares • Infraorbital sinus • Syrinx • Air sacs	• Glomeruli • Renal tubules • Ureters • Urodeum	• Pancreatic • Thyroid • Parathyroids • Intestinal • Gonadal	• Ovarian • Uterovaginal • Testicular • Cloacal • Egg abnormalities	• Vasculature • Myocardium • Air capillaries • Pericardium

Biochemical	Hematological	Behavioral
• AST, ALT • Bile acid • Glucose • HDL, LDL, Triglycerides • Cytokines	• Increased WBC • Altered total WBC	(see subsequent section)

Table 4.2.2a | Commonly Encountered Etiologies of Improper Nutrient Intake or Utilization

Congenital Developmental	Individual	Complicating Factors	Rule outs that impair digestion and/or absorption
Improper parental diet	Provision of improper diet	Little or no sunlight	Pancreatitis or organ failure
Improper handfeeding diet	Consumption of improper diet	Lack of bathing	Malabsorption syndromes
Weaned to improper diet	Improper diet supplementation	Lack of exercise	Viral, bacterial, fungal, or parasitic gastroenteritis
Diet constituents interfere with nutrient utilization	Improper food packaging/handling or storage		Metal toxicosis

Table 4.2.1| Improper Diet Cascade (IDC)

Nutritional Imbalance

MULTISYSTEMIC ABNORMALITIES

Cellular Structural Functional Immunologic

Impaired metabolism Metaplasia of columnar epithelium Goblet cells mucin production

impaired

Commensal organisms normally bound to mucus are not excreted

Altered cell wall permeability Increased mucous viscosity Loss of cleansing ability of mucous Relationship with commensal

organisms disrupted

Cellular autointoxication Change in GI pH (less acidic)

Loss of normal collagen elasticity Normal glandular production of vari-

ous systems suppressed

Bone marrow suppression Decreased IgA, decreased lymphocytes

Chronic: eg,

• Hepatic lipidosis, fibrosis, cirrhosis

• Iron storage disease

• Irreversible degradation of retinal cones leading to blindness

Chronic: eg,

• Abnormal cilia

• Renal tubular nephrosis

• Follicular atresia

• Cataract formation

• Bone/muscle abnormalities

Chronic: eg,

• Diabetes mellitus

• Deposits of high density lipids in vasculature

• Exocrine pancreatic insufficiency

• Infertility, decreased hatchability of chicks

• Secondary hyperparathyroidism

Chronic: eg,

• Secondary microbial infections

• Increased susceptibility to neoplasia

ABNORMALITIES OF SPECIFIC SYSTEMS

Integument Gastrointestinal Respiratory Renal Endocrine Reproductive Cardiovascular

• Skin

• Feathers

- Beak
- Nails
- Fat deposits
- Oropharyngeal
- Pancreatic
- Hepatic
- Intestinal
- Nares
- Infraorbital sinus
- Syrinx
- Air sacs
- Glomeruli
- Renal tubules
- Ureters
- Urodeum
- Pancreatic
- Thyroid
- Parathyroids
- Intestinal
- Gonadal
- Ovarian
- Uterovaginal
- Testicular
- Cloacal
- Egg abnormalities
- Vasculature
- Myocardium
- Air capillaries
- Pericardium

Biochemical Hematological Behavioral

- AST, ALT
- Bile acid
- Glucose
- HDL, LDL, Triglycerides
- Cytokines

Table 4.2.2a | Commonly Encountered Etiologies of Improper Nutrient Intake or Utilization

Congenital Developmental

• Increased WBC

• Altered total WBC

(see subsequent section)

Individual Complicating Factors Rule outs that impair digestion and/or absorption

Improper parental diet Provision of improper diet Little or no sunlight Pancreatitis or organ failure

Improper handfeeding diet Consumption of improper diet

Lack of bathing Malabsorption syndromes

Weaned to improper diet Improper diet supplementation

Lack of exercise Viral, bacterial, fungal, or parasitic gastroenteritis

Diet constituents interfere with nutrient utilization

Improper food packaging/handling or storage

Metal toxicosis

expanded this theory by showing that several micronutrients such as vitamin A, ß-carotene, folic acid, vitamin B_{12}, vitamin C, riboflavin, iron and selenium could be involved in such a scenario in humans.[57] These micronutrient-compromised viruses can lead to the emergence of new infections.[57] This hypothesis was further advanced by Lavender[61], who showed that, at least for RNA viruses, host nutrient deficiencies and excesses can influence the genetic make-up of the pathogen. The majority of viruses are RNA viruses.[64]

The importation of wild caught psittacines has traditionally involved weeks to months of stress including severe nutrient imbalance. Such birds imported into the USA in the 1970s and 1980s were a part of a pandemic of new viral diseases. Psittacine beak and feather disease, proventricular dilatation disease and papillomatosis are three that still plague us. The research community has not adequately addressed the role of malnutrition in viral pathogenesis. It is interesting to ponder this hypothesis in light of the new expressions of these same viruses occurring in the European Union countries that still import wild-caught birds.

IMPROPER DIET FORMULATION

There is a general perception that 'fresh' is best. However, presenting a bird with an array of fresh produce, seeds and nuts does not necessarily provide a nutritionally balanced diet. Commonly fed seeds are deficient in a number of nutrients (Table 4.2.2b). Much of the produce is sold in its immature state of growth, and even when mature, it does not have the equivalent nutrient profiles of wild food items. Thus such produce is unable to improve the nutrient profile of the diet.

It is imperative that bird owners be informed of the nutritional inadequacies of such diets. In the wild, psittacines usually balance their diets by feeding on a variety of seeds and other plant parts. Primary issues of concern with captive diets are vitamin levels (vitamins A, D, E, and K and the water-soluble vitamins—biotin and B_{12}) and minerals. Seeds do not contain vitamin A and are generally low in the vitamin A precursor ß-carotene. Hypovitaminosis A is particularly prevalent in birds on all-seed diets. Mineral levels of seeds can vary among plant species as well as geographically, depending on the composition of the parent soil. Calcium is deficient in most seeds and, while adequate phosphorous may appear to be present, up to 70% may exist in phytate form that is generally indigestible. Fatty acid composition will also vary among seed species and an imbalance can be an important cause of a number of health issues. Many seeds provide adequate total protein but do not contain the complete set of essential amino acids. A diet of predominantly millet seed will result in a lysine deficiency not seen on other seed-based diets. The composition of commercially raised seeds differs dramatically from wild seeds (see Section I of this Chapter).

Table 4.2.2b | 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 (B_2), cyanocobalamine (B_{12}), biotin (H), D_3, E, K, and folic acid (M)
- Minerals - calcium, phosphorous (70% tied up as non-digestible 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 vitamin A in liver
- Omega 3 Fatty Acids

Birds do not exhibit nutritional wisdom when selecting dietary ingredients; they show a preference for high-energy, lipid-rich seeds, high carbohydrate seeds and fruits. The advent of formulated foods has diminished the incidence of nutritional disorders in the author's (GJH) practice. Yet not all formulated diets are created equal (Tables 4.2.2c-e). For example, products that offer the opportunity for selecting favored food items are poorly formulated and can be just as imbalanced as a seed-based diet in the end.

The Association of Avian Veterinarians (AAV) formed a committee of nutrition experts who developed a list of recommendations to assist veterinarians and owners in feeding pet birds (Table 4.2.2f).

While some essential nutrients are higher in organically certified plant products, a diet composed solely of organic seeds will present as many nutritional problems as a diet solely composed of non-organic seeds.

There are also the issues of diminished availability of some nutrients by interference from other nutrients and potential breakdown of key nutrients.

OVER-SUPPLEMENTATION

Vitamin toxicity is an aspect of dietary management that is frequently overlooked, but can be responsible for a number of clinical signs of a disease. Many commercially formulated products contain excessive levels of the fat-soluble vitamins A and D. The addition of vitamin supplements with high concentrations of these two vitamins compounds that excess. The generally low levels of

A, ß-carotene, folic acid, vitamin B

12

, vitamin C, riboflavin, iron and selenium could be involved in such a scenario in humans.17 These micronu- trient-compromised viruses can lead to the emergence of new infections.17 This hypothesis was further advanced by Lavender61, who showed that, at least for RNA viruses, host nutrient deficiencies and excesses can influence the genetic make-up of the pathogen. The majority of viruses are RNA viruses.61

The importation of wild caught psittacines has tradition- ally involved weeks to months of stress including severe nutrient imbalance. Such birds imported into the USA in the 1970s and 1980s were a part of a pandemic of new viral diseases. Psittacine beak and feather disease, proventricular dilatation disease and papillomatosis are three that still plague us. The research community has not adequately addressed the role of malnutrition in viral pathogenesis. It is interesting to ponder this hypothesis in light of the new expressions of these same viruses occurring in the European Union countries that still import wild-caught birds.

IMPROPER DIET FORMULATION

There is a general perception that 'fresh' is best. However, presenting a bird with an array of fresh pro- duce, seeds and nuts does not necessarily provide a nutritionally balanced diet. Commonly fed seeds are deficient in a number of nutrients (Table 4.2.2b). Much of the produce is sold in its immature state of growth, and even when mature, it does not have the equivalent nutrient profiles of wild food items. Thus such produce is unable to improve the nutrient profile of the diet.

It is imperative that bird owners be informed of the nutritional inadequacies of such diets. In the wild, psittacines usually balance their diets by feeding on a variety of seeds and other plant parts. Primary issues of concern with captive diets are vitamin levels (vitamins A, D, E, and K and the water-soluble vitamins—biotin and B

12

) and minerals. Seeds do not contain vitamin A and are generally low in the vitamin A precursor ß-carotene. Hypovitaminosis A is particularly prevalent in birds on all-seed diets. Mineral levels of seeds can vary among plant species as well as geographically, depending on the composition of the parent soil. Calcium is deficient in most seeds and, while adequate phosphorous may appear to be present, up to 70% may exist in phytate form that is generally indigestible. Fatty acid composi- tion will also vary among seed species and an imbalance can be an important cause of a number of health issues. Many seeds provide adequate total protein but do not contain the complete set of essential amino acids. A diet of predominantly millet seed will result in a lysine defi-

Table 4.2.2b | 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 (B

2

), cyanocobalamine (B

12

), biotin (H), D

3

, E, K, and folic acid (M)

• Minerals - calcium, phosphorous (70% tied up as non- digestible phytates in plant products, such as grains), sodium

• Trace minerals - selenium, iron, copper, zinc, man- ganese, 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 vitamin A in liver

• Omega 3 Fatty Acids

ciency not seen on other seed-based diets. The composi- tion of commercially raised seeds differs dramatically from wild seeds (see Section I of this Chapter).

Birds do not exhibit nutritional wisdom when selecting dietary ingredients; they show a preference for high- energy, lipid-rich seeds, high carbohydrate seeds and fruits. The advent of formulated foods has diminished the incidence of nutritional disorders in the author's (GJH) practice. Yet not all formulated diets are created equal (Tables 4.2.2c-e). For example, products that offer the opportunity for selecting favored food items are poorly formulated and can be just as imbalanced as a seed-based diet in the end.

The Association of Avian Veterinarians (AAV) formed a committee of nutrition experts who developed a list of recommendations to assist veterinarians and owners in feeding pet birds (Table 4.2.2f).

While some essential nutrients are higher in organically certified plant products, a diet composed solely of organic seeds will present as many nutritional problems as a diet solely composed of non-organic seeds.

There are also the issues of diminished availability of some nutrients by interference from other nutrients and potential breakdown of key nutrients.

OVER-SUPPLEMENTATION

Vitamin toxicity is an aspect of dietary management that is frequently overlooked, but can be responsible for a number of clinical signs of a disease. Many commercially formulated products contain excessive levels of the fat-soluble vitamins A and D. The addition of vitamin sup- plements with high concentrations of these two vitamins compounds that excess. The generally low levels of

Table 4.2.2c | Provision of Improper Diet – Common Presentations

Excessive quantity of seeds or nuts provided (minimal vitamin A precursors, lysine deficient, decreased vitamin E absorption, inverted Ca:P ratio, excessive calories)	Excessive percentage of fruits and vegetables (deficient in essential amino acids and essential fatty acids, contain excessive sucrose) *Nutritional deficiencies vary widely between fruits and vegetables - see Figs 4.1.2, 4.1.3 and Tables 4.1.8, 4.1.9 in section 1)	Excessive quantity of "table foods" such as the carbohydrate rich pastas and breads (in addition to the aforementioned deficiencies, these provide a medium for yeast overgrowth in susceptible individuals)	Improper/excessive vitamin-mineral supplementation	
			Potential toxicities eg, vitamin A,D_3, iron, selenium	Competitive nutrient absorption, eg, excessive fatty acids, phytates, and fat soluble vitamins

Table 4.2.2d | Consumption of Improper Diet – Common Presentations

Formulated diet over-supplemented with vitamins (vitamin A) or minerals (iron). Deficiencies: lysine, L-carnitine	Diet provided requires bird to consume all components to achieve balance	Supplements needed to balance diet are provided as a coating on food that is not entirely consumed

Table 4.2.2e | Preparation, Packaging and Storage Problems of Formulated Diets

Problems in Preparation	Packaging Concerns	Improper Storage
Inclusion of raw soybeans, oats or brown rice. Cooking soybeans improves the availability of methionine & cystine[1-3] & destroys trypsin inhibitors. Oats & brown rice are high in lipase [break down fats to free fatty acids & lipoxygenase (oxidizes fatty acids to hydroperoxides)][4,5]	Use of oxygen-permeable packaging Oxidation → Rancidity	Continued mycotoxin production
Inclusion of mycotoxin producing agents	Exposure to light	
Poor quality control	Insect contamination	
Over cooking → degradation of nutrients and conversion of cis to trans fatty acids	Pesticide contamination	Insect infestation (eg, transmission of Sarcocystosis)
Addition of artificial coloring/dyes long term effects unknown	Soft plastics may act as phytoestrogens	Degradation of nutrients
Preservatives (such as ethoxyquin) may be toxic or teratogenic. However, in the absence of preservatives, proper packaging and storage are imperative to maintain quality and prevent rancidity.		

vitamin E in both commercial diets and vitamin supplements may exacerbate toxicity. Dietary supplementation should be undertaken only if there is an extensive knowledge of the nutrient composition of both the diet and the supplement. The common clinical practice of injecting vitamins into sick birds may not be defensible, especially if the bird has been on a formulated and/or supplemented diet. See Section 1, Nutrition and Dietary Supplementation for a more in-depth discussion.

RANCIDITY

Altering tissue structure mechanically (hulling, grinding, and crushing in the case of vegetable matter or maceration in the case of animal tissue) releases lipases.

Grains damaged at harvest also allow this lipase release to occur. Similarly, micro-organisms (fungal contaminants) contain lipases that cause hydrolysis of fats.[5b] So quality control of source products is essential. The exposure to oxygen, moisture and heat act with the catalysts naturally present in grains (iron, copper) to accelerate the deterioration process at all stages of grain handling and product manufacturing.

These lipolytic enzymes act on lipids to release free fatty acids and triglycerides. In the presence of oxygen, heat and moisture, these fatty acids and triglycerides are auto-oxidized or acted upon by enzymes (primarily stored in the germ) called lipoxygenases. Polyunsaturated fatty acids (oleic, linoleic, and linolenic) are the most likely to be oxidized, and they are usually the most abundant fatty acids in nuts and seeds.[5b] This oxidation process produces free radicals in a dark environment. A similar but slightly different reaction occurs when exposed to light. Both reactions end with the production of lipid hydroperoxides which further break down, causing rancidity. This process is often self perpetuating, starting

Table 4.2.2c | Provision of Improper Diet - Common Presentations

Excessive quantity of seeds or nuts

Improper/excessive vitamin-mineral provided (minimal vitamin A precur-

supplementation sors, lysine deficient, decreased vita- min E absorption, inverted Ca:P ratio, excessive calories)

Table 4.2.2d | Consumption of Improper Diet - Common Presentations

Formulated diet over-supplemented with vitamins (vitamin A) or minerals (iron). Deficiencies: lysine, L-carnitine

Problems in Preparation Packaging Concerns Improper Storage

Inclusion of raw soybeans, oats or brown rice. Cooking soybeans improves the availability of methion- ine & cystine14b & destroys trypsin inhibitors. Oats & brown rice are high in lipase [break down fats to free fatty acids & lipoxygenase (oxi- dizes fatty acids to hydroperoxides)]43b

Excessive percentage of fruits and vegetables (deficient in essential amino acids and essential fatty acids, contain excessive sucrose) *Nutritional deficiencies vary widely

Potential toxicities eg, vitamin A,D

3

between fruits and vegetables - see Figs 4.1.2, 4.1.3 and Tables 4.1.8, 4.1.9 in section 1)

Excessive quantity of "table foods" such as the carbohydrate rich pastas and breads (in addition to the afore- mentioned deficiencies, these pro- vide a medium for yeast overgrowth in susceptible individuals)

Competitive nutrient absorp- tion, eg, exces- sive fatty acids, phytates, and fat soluble vitamins

Table 4.2.2e | Preparation, Packaging and Storage Problems of Formulated Diets

vitamin E in both commercial diets and vitamin supple- ments may exacerbate toxicity. Dietary supplementation should be undertaken only if there is an extensive knowledge of the nutrient composition of both the diet and the supplement. The common clinical practice of injecting vitamins into sick birds may not be defensible, especially if the bird has been on a formulated and/or supplemented diet. See Section 1, Nutrition and Dietary Supplementation for a more in-depth discussion.

RANCIDITY

Altering tissue structure mechanically (hulling, grinding, and crushing in the case of vegetable matter or macera- tion in the case of animal tissue) releases lipases.

Grains damaged at harvest also allow this lipase release to occur. Similarly, micro-organisms (fungal contami- nants) contain lipases that cause hydrolysis of fats.43b So

, iron, selenium

Diet provided requires bird to con- sume all components to achieve bal- ance

Supplements needed to balance diet are provided as a coating on food that is not entirely consumed

Continued mycotoxin production

Inclusion of mycotoxin producing agents

Use of oxygen- permeable packaging

Oxidation →

Rancidity

Exposure to light

Poor quality control Insect contamination

Over cooking → degradation of nutrients and conversion of cis to trans fatty acids

Pesticide contamination Insect infestation (eg, transmission of

Sarcocystosis)

Addition of artificial coloring/dyes long term effects unknown

Soft plastics may act as

Degradation of nutrients phytoestrogens

Preservatives (such as ethoxyquin) may be toxic or teratogenic. However, in the absence of preservatives, proper packaging and storage are imperative to maintain quality and prevent rancidity.

quality control of source products is essential. The expo- sure to oxygen, moisture and heat act with the catalysts naturally present in grains (iron, copper) to accelerate the deterioration process at all stages of grain handling and product manufacturing.

These lipolytic enzymes act on lipids to release free fatty acids and triglycerides. In the presence of oxygen, heat and moisture, these fatty acids and triglycerides are auto- oxidized or acted upon by enzymes (primarily stored in the germ) called lipoxygenases. Polyunsaturated fatty acids (oleic, linoleic, and linolenic) are the most likely to be oxidized, and they are usually the most abundant fatty acids in nuts and seeds.43b This oxidation process produces free radicals in a dark environment. A similar but slightly different reaction occurs when exposed to light. Both reactions end with the production of lipid hydroperoxides which further break down, causing ran- cidity. This process is often self perpetuating, starting

Table 4.2.2f | AAV Feeding Brochure

Association of Avian Veterinarians
Feeding Recommendations

FEEDING COMPANION BIRDS
Feeding of companion birds has been one of the most challenging aspects of their care, primarily because of limited nutritional research on all species. However, based on studies of poultry and other animals, generalizations can be made on adequate feeding practices for companion birds.

FORMULATED DIETS
Formulated bird food products are available from the pet food industry as a convenience to the owner and to ensure a more nutritionally balanced diet than that offered by seeds alone. The current trend is toward specific formulations addressing age, activity, therapeutic, and stress-related needs of the bird. For example, birds have special nutritional needs during molting, egg laying, or raising young. However, improving a diet in the short term in anticipation of these life stages is not effective; the feeding practices must be optimal year round.
Commercial bird food products may be purchased as pellets, nuggets, crumbles, or hand feeding premixes. Converting a seed-eating bird to a formulated diet must be done with care because new items in the cage may not be immediately recognized as food. Your veterinarian can recommend a commercial formulated bird diet and help you with the conversion process.

ALTERNATIVE HOMEMADE DIETS
Where commercial diets are not available, attempts are made to produce a homemade diet. While not ideal for pet birds, these usually offer an improvement over an exclusive seed diet. Overall, however, homemade diets are often lacking in calcium, iodine, selenium, protein, fatty acid balance, fiber, pigments, and vitamins A, B complex, E, and D_3 while providing an excess of carbohydrates, and phosphorus. Additionally, homemade diets with moist ingredients tend to spoil easily and lose nutrients if not stored properly or if made too far in advance of feeding. The time and effort involved in preparing foods and the difficulty in balancing the nutrients make homemade diets impractical for the pet bird owner. Owners choosing a fresh food plan tend to offer too much variety and quantity of food each day, permitting birds to pick out what they like. Birds will not choose a balanced diet if given free choice. Consult your avian veterinarian for specific recommendations on items and quantities to feed.

FRESH WATER
Fresh water must be provided at all times. Some aviculturists and companion bird owners have had success using pet water bottles for birds, thereby limiting soiling of water.

FEEDING TIPS
- Carefully monitor TOTAL food consumption during any diet change.
- Introduce small amounts of a new food at a time.
- Gradually reduce the total volume of seeds as you increase the volume of more nutritional foods.
- Clean all food and water cups and remove old food from the cage daily.
- Do not provide supplemental vitamins unless recommended by your avian veterinarian.

BEHAVIORAL ENRICHMENT
A consistent daily feeding program contributes to physical and mental health as much as a varied diet. The availability of natural items such as branches, empty nutshells, leather pieces and coconut shells create a stimulating environment.

GRIT
Grit is small non-dissolvable rock. The necessity of grit in the diet is debatable. Some birds, such as pigeons, fowl, canaries and finches, appear to need the availability of grit. In psittacine species, an occasional grit particle is harmless but it is not necessary for healthy maintenance of pet parrots, macaws, parakeets and similar species.

SALT
Salt licks are not necessary for birds.

DEPRAVED EATING HABITS
Birds that routinely eat inappropriate materials (eg, feces, enclosure substrate) should be examined by a veterinarian. This behavior may be associated with disease or nutritionally deficient diets and is often prevented by the feeding of a more balanced formulated food product.

SPECIAL REQUIREMENTS
Lories and lorikeets require specialized diets in captivity. These nectar diets attract insects and result in liquid and messy feces. Your avian veterinarian can recommend a diet for these species. Soft-billed birds, waterfowl, backyard poultry and gamebirds Commercial foods are available for these birds. Some toucans and mynahs may have a special dietary requirement for a low-iron formula. Consult your avian veterinarian for recommendations.

Association of Avian Veterinarians Feeding Recommendations

FEEDING COMPANION BIRDS Feeding of companion birds has been one of the most challenging aspects of their care, primarily because of limited nutritional research on all species. However, based on studies of poultry and other animals, general- izations can be made on adequate feeding practices for companion birds.

FORMULATED DIETS Formulated bird food products are available from the pet food industry as a convenience to the owner and to ensure a more nutritionally balanced diet than that offered by seeds alone. The current trend is toward specific formulations addressing age, activity, therapeu- tic, and stress-related needs of the bird. For example, birds have special nutritional needs during molting, egg laying, or raising young. However, improving a diet in the short term in anticipation of these life stages is not effective; the feeding practices must be optimal year round. Commercial bird food products may be purchased as pellets, nuggets, crumbles, or hand feeding premixes. Converting a seed-eating bird to a formulated diet must be done with care because new items in the cage may not be immediately recognized as food. Your vet- erinarian can recommend a commercial formulated bird diet and help you with the conversion process.

ALTERNATIVE HOMEMADE DIETS Where commercial diets are not available, attempts are made to produce a homemade diet. While not ideal for pet birds, these usually offer an improvement over an exclusive seed diet. Overall, however, homemade diets are often lacking in calcium, iodine, selenium, protein, fatty acid balance, fiber, pigments, and vitamins A, B complex, E, and D

3

FEEDING TIPS·

• Carefully monitor TOTAL food consumption during any diet change.

• Introduce small amounts of a new food at a time.

• Gradually reduce the total volume of seeds as you increase the volume of more nutritional foods.

• Clean all food and water cups and remove old food from the cage daily.

• Do not provide supplemental vitamins unless recom- mended by your avian veterinarian.

BEHAVIORAL ENRICHMENT A consistent daily feeding program contributes to physi- cal and mental health as much as a varied diet. The availability of natural items such as branches, empty nutshells, leather pieces and coconut shells create a stimulating environment.

GRIT Grit is small non-dissolvable rock. The necessity of grit in the diet is debatable. Some birds, such as pigeons, fowl, canaries and finches, appear to need the avail- ability of grit. In psittacine species, an occasional grit particle is harmless but it is not necessary for healthy maintenance of pet parrots, macaws, parakeets and similar species.

SALT Salt licks are not necessary for birds.

DEPRAVED EATING HABITS Birds that routinely eat inappropriate materials (eg, feces, enclosure substrate) should be examined by a veterinarian. This behavior may be associated with dis- ease or nutritionally deficient diets and is often pre- while providing an excess of carbo-

vented by the feeding of a more balanced formulated hydrates, and phosphorus. Additionally, homemade

food product. diets with moist ingredients tend to spoil easily and lose nutrients if not stored properly or if made too far in

SPECIAL REQUIREMENTS advance of feeding. The time and effort involved in

Lories and lorikeets require specialized diets in captivity. preparing foods and the difficulty in balancing the

These nectar diets attract insects and result in liquid

nutrients make homemade diets impractical for the pet owner. Owners choosing a fresh food plan tend to offer too much variety and quantity of food each day, permitting birds to pick out what they like. Birds will not choose a balanced diet if given free choice. Consult avian veterinarian for specific recommendations items and quantities to feed.

FRESH WATER Fresh water must be provided at all times. Some avicul- turists and companion bird owners have had success using pet water bottles for birds, thereby limiting soiling of water.

and messy feces. Your avian veterinarian can recom- bird mend a diet for these species. Soft-billed birds, water- fowl, backyard poultry and gamebirds Commercial foods are available for these birds. Some toucans and mynahs may have a special dietary requirement for a your low-iron formula. Consult your avian veterinarian for on recommendations.

slowly and increasing rapidly as reaction chemicals become available.

Expressing the oil from seeds increases the surface area being exposed to oxygen, which can increase the possibility of rancidity occurring.

The production of lipid hydroperoxides does not appear to alter flavor. Lipid hydroperoxides deteriorate to aldehydes in the presence of oxygen.[47b] These do alter flavor and finally palatability. Alcohols and hydrocarbons are also produced. These latter products have been reported to be mutagenic.[16] Rancid fats can lead to selenium and vitamin E deficiencies implicated in encephalomalacia, pancreatitis, myocardial necrosis, hepatic necrosis and general myopathy. Biochemical analysis of affected birds' blood may show anemia, elevated lactate dehydrogenase (LDH), aspartate aminotransferase (AST), creatinine phosphate (CK) and phosphorous levels. Many of these clinical conditions are not reversible.[82]

Chickens fed diets with increased rancidity parameters (peroxide and aldehyde concentrations) experienced increased mortality from fatty liver syndrome (FLS). Total blood proteins of affected chickens were elevated, as were lipoproteins and total lipids.[23]

HANDLING AND STORAGE

Wild birds naturally feed on an array of fresh foods while their captive counterparts are provided with foods that have been stored for extended periods. Nutritionally imbalanced food supplies are not uncommon in wild situations. Agriculture produces seeds and nuts only at the end of the growing season, usually in the fall. Storage increases the potential for nutrient degradation. Nitrogen flushing and storage under refrigeration are steps that discourage oxidation.

COLD DARK STORAGE HELPS PREVENT RANCIDITY

Storing walnuts in the light at 21° C resulted in profound oxidative changes.[34] However, walnuts stored in the dark at 5° C for 25 weeks, even in 50% oxygen, were without a trace of rancid taste.[34] However, it should be remembered that rancidity, as determined by chemical analysis, precedes taste detection.

Storing corn oil at room temperature for 48 months resulted in rancid oil, whereas storage in the refrigerator did not.[66] A specific strain of mice fed the rancid corn oil showed significantly increased expression of oncogenes in all major organs. The results demonstrated that rancid oils, rich in *n*-6 polyunsaturated fatty acids, could initiate tumors and promote tumor growth.[66]

COOKING

In the preparation of a formulated diet, cooking (roasting, pelletizing or extrusion) is designed to stabilize oils. However, depending on the condition of the products being mixed, some combinations may cause flash rancidity (D. Jones, personal communication 2000). This is due to the presence of enzymes in items like grains and peanuts that cause natural fermentation when exposed to warm moist air. The lipase concentration in some grains is very high. Oats and brown rice are examples.[47b] Dehulling and milling these products causes rapid deterioration (rancidity) unless they are heat stabilized prior to storage or further processing. When these raw products are combined under the heat of processing, this flash rancidity can occur. For this reason, these ingredients need to be roasted or otherwise partially cooked separately, then mixed with the other ingredients prior to final processing.

Raw soybeans contain trypsin inhibitors and can therefore be difficult to digest. This enzyme is a critical part of digestion in monogastric animals. Trypsin inhibitors are inactivated by heat.[34b,70b] Cooking also improves the availability of methionine and cysteine.[34b] Overcooking destroys or makes unavailable certain amino acids (lysine) and greatly reduces natural vitamin precursors such as tocopherols and carotenoids.

MOISTURE CONTENT

Lowering the moisture content of a product also acts as a stabilizer. Moisture plays a vital chemical role in most oxidation processes.[47b] Levels below 5% are often required to deter degradation. The author (GIH) has shown that these low moisture levels cause minor proventricular irritation evidenced by excessive regurgitation and minor weight loss in some pet umbrella cockatoos. Even at these low moisture levels, over time non-free 'water' is all lipases need to act. Non-free water cannot be removed by drying.[47b]

PACKAGING

Many bird foods are packaged in plastic, cellophane, coated paper or cardboard boxes. The latter two prevent exposure to light. Airtight containers (plastic, cellophane) prevent moisture from evaporating, but many do not stop oxygen from crossing into the food. The oxygen then breaks down essential nutrients or changes their biological activity. An advertised vitamin A content of 12,500 IU/kg may be reduced to as few as 1,500 IU/kg by inadequate packaging, with further deterioration once the package is opened. Even if one starts with a nutritionally sound, preservative-free formulated diet, the lack of proper packaging and resulting rancidity can cancel its effectiveness.

slowly and increasing rapidly as reaction chemicals become available.

Expressing the oil from seeds increases the surface area being exposed to oxygen, which can increase the possibility of rancidity occurring.

The production of lipid hydroperoxides does not appear to alter flavor. Lipid hydroperoxides deteriorate to aldehydes in the presence of oxygen.43b These do alter flavor and finally palatability. Alcohols and hydro- carbons are also produced. These latter products have been reported to be mutagenic.16 Rancid fats can lead to selenium and vitamin E deficiencies implicated in encephalomalacia, pancreatitis, myocardial necrosis, hepatic necrosis and general myopathy. Biochemical analysis of affected birds' blood may show anemia, ele- vated lactate dehydrogenase (LDH), aspartate amino- transferase (AST), creatinine phosphate (CK) and phos- phorous levels. Many of these clinical conditions are not reversible.98

Chickens fed diets with increased rancidity parameters (peroxide and aldehyde concentrations) experienced increased mortality from fatty liver syndrome (FLS). Total blood proteins of affected chickens were elevated, as were lipoproteins and total lipids.28

HANDLING AND STORAGE

Wild birds naturally feed on an array of fresh foods while their captive counterparts are provided with foods that have been stored for extended periods. Nutritionally imbalanced food supplies are not uncommon in wild sit- uations. Agriculture produces seeds and nuts only at the end of the growing season, usually in the fall. Storage increases the potential for nutrient degradation. Nitrogen flushing and storage under refrigeration are steps that discourage oxidation.

COLD DARK STORAGE HELPS PREVENT RANCIDITY

Storing walnuts in the light at 21° C resulted in pro- found oxidative changes.51 However, walnuts stored in the dark at 5° C for 25 weeks, even in 50% oxygen, were without a trace of rancid taste.51 However, it should be remembered that rancidity, as determined by chemical analysis, precedes taste detection.

Storing corn oil at room temperature for 48 months resulted in rancid oil, whereas storage in the refrigerator did not.16 A specific strain of mice fed the rancid corn oil showed significantly increased expression of onco- genes in all major organs. The results demonstrated that rancid oils, rich in n-6 polyunsaturated fatty acids, could initiate tumors and promote tumor growth.86

COOKING

In the preparation of a formulated diet, cooking (roast- ing, pelletizing or extrusion) is designed to stabilize oils. However, depending on the condition of the products being mixed, some combinations may cause flash rancid- ity (D. Jones, personal communication 2000). This is due to the presence of enzymes in items like grains and peanuts that cause natural fermentation when exposed to warm moist air. The lipase concentration in some grains is very high. Oats and brown rice are examples.43b Dehulling and milling these products causes rapid dete- rioration (rancidity) unless they are heat stabilized prior to storage or further processing. When these raw prod- ucts are combined under the heat of processing, this flash rancidity can occur. For this reason, these ingredi- ents need to be roasted or other wise partially cooked separately, then mixed with the other ingredients prior to final processing.

Raw soybeans contain trypsin inhibitors and can there- fore be difficult to digest. This enzyme is a critical part of digestion in monogastric animals. Trypsin inhibitors are inactivated by heat.14b,70b Cooking also improves the availability of methionine and cysteine.14b Overcooking destroys or makes unavailable certain amino acids (lysine) and greatly reduces natural vitamin precursors such as tocopherols and carotenoids.

MOISTURE CONTENT

Lowering the moisture content of a product also acts as a stabilizer. Moisture plays a vital chemical role in most oxidation processes.43b Levels below 5% are often required to deter degradation. The author (GIH) has shown that these low moisture levels cause minor proventricular irritation evidenced by excessive regurgi- tation and minor weight loss in some pet umbrella cock- atoos. Even at these low moisture levels, over time non- free 'water' is all

lipases need to act. Non-free water can- not be removed by drying.43b

PACKAGING

Many bird foods are packaged in plastic, cellophane, coated paper or cardboard boxes. The latter two prevent exposure to light. Airtight containers (plastic, cello- phane) prevent moisture from evaporating, but many do not stop oxygen from crossing into the food. The oxy- gen then breaks down essential nutrients or changes their biological activity. An advertised vitamin A content of 12,500 IU/kg may be reduced to as few as 1,500 IU/kg by inadequate packaging, with further deterioration once the package is opened. Even if one starts with a nutritionally sound, preservative-free formulated diet, the lack of proper packaging and resulting rancidity can- cel its effectiveness.

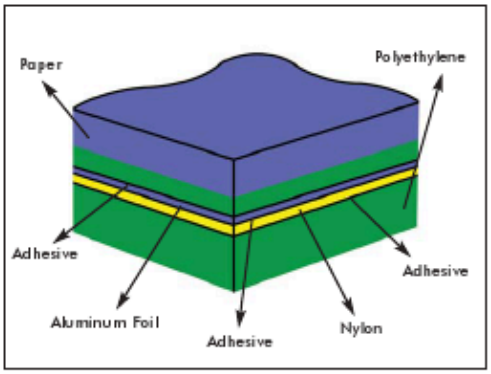

Fig 4.2.1 | Quadruple laminate packaging helps preserve the freshness of formulate diets and prevents rancidity.

Fig 4.2.2 | A red-lored Amazon fed a seed and table food diet has an overgrown maxillary rhamphotheca that has been recently honed down to a more normal shape.

Fig 4.2.3a | A green-winged macaw fed a seed and table food diet. The red feathers are almost pink. Black pigment is co-mingled with green. The beak is hyperkeratotic. The breast and wing feathers are tattered and picked.

Fig 4.2.3b | A yellow-naped Amazon fed a seed and table food diet. The bird is obese, the maxillary rhamphotheca is overgrown and the feathers are abnormally pale green. The rectrices are tattered. Structural abnormalities make the coverts of the wing and body contour feathers lack the homogeneous interlocking appearance of a normal bird.

To avoid oxygen deterioration, chemical preservatives like ethoxyquin (originally used to soften rubber, later as a herbicide) and propylene glycol have been used for decades in dry animal foods. They have not been deemed safe for human foods. Recent public demand for more natural pet foods has led to a variety of newer techniques to avoid rancidity.

Lipid peroxidation can particularly affect products composed of organic ingredients that lack synthetic preservatives but is no less an issue for any products that are inadequately packaged.

For these reasons, all foods need to be smelled when first opened. If they smell like old frying grease or linseed oil they are rancid. A taste test should be observed when first offering a new bag of food to the bird. If the bird acts hungry but rejects the food it might be rancid. Rancid foods should not be fed. Following the manufacturer's directions for handling the food and shelf life will usually prevent rancidity problems.

Polyethylene Paper

Adhesive

Adhesive

Aluminum Foil

Adhesive

Nylon

Fig 4.2.1 | Quadruple laminate packaging helps preserve the freshness of fomulate diets and prevents rancidity.

Fig 4.2.3a | A green-winged macaw fed a seed and table food diet. The red feathers are almost pink. Black pigment is co-mingled with green. The beak is hyperkeratotic. The breast and wing feathers are tattered and picked.

To avoid oxygen deterioration, chemical preservatives like ethoxyquin (originally used to soften rubber, later as a herbicide) and propylene glycol have been used for decades in dry animal foods. They have not been deemed safe for human foods. Recent public demand for more natural pet foods has led to a variety of newer techniques to avoid rancidity.

Lipid peroxidation can particularly affect products com- posed of organic ingredients that lack synthetic preserva- tives but is no less an issue for any products that are

Fig 4.2.2 | A red-lored Amazon fed a seed and table food diet has an overgrown maxillary rhamphotheca that has been recently honed down to a more normal shape.

Fig 4.2.3b | A yellow-naped Amazon fed a seed and table food diet. The bird is obese, the maxillary rhamphotheca is overgrown and the feathers are abnormally pale green. The rectri- ces are tattered. Structural abnormalities make the coverts of the wing and body contour feath- ers lack the homogeneous interlocking appear- ance of a normal bird.

inadequately packaged.

For these reasons, all foods need to be smelled when first opened. If they smell like old frying grease or lin- seed oil they are rancid. A taste test should be observed when first offering a new bag of food to the bird. If the bird acts hungry but rejects the food it might be rancid. Rancid foods should not be fed. Following the manufac- ture’s directions for handling the food and shelf life will usually prevent rancidity problems.

Table 4.2.3 | IDC and the Integument

Nutritional Imbalance

CLINICAL SIGNS

Feathers	Skin	Beak and Nails
• Frequent or incomplete molts • Retained feather sheaths • Abnormal coloration • Irritability due to feather discomfort • Deformities: - Cysts - Loss of elasticity - Barbules not interlocking • Chronic/Severe - Feather destructive behavior - Self-mutilation	• Flaky • Dry • Pruritic • Hyperkeratotic • Loss of elasticity (tears readily) • Plantar surface - loss of pattern • Chronic/Severe - Pododermatitis	• Excessive length • Exaggerated curvature • Friable texture • Splitting • Bruise readily • Chronic/Severe - Marked deformity - Secondary infections

INITIAL TREATMENT

Husbandry	Medical	Procedural	Diet Conversion
• Increase UVB • Increase outdoor exposure: - Humidity - Ventilation - Sunlight - Psychological stimulation • Improve available perches, increased variety of sizes and textures • Increase exercise, both physical and mental • Verify or improve hygiene	• Antipruritics: - Systemic - Topical • Treat secondary infection if present and significant • Psychotropic medications if self-mutilating • Parenteral vitamin supplementation for severe deficiencies • Blood work and other diagnostics if indicated	• Trim overgrown beak • Trim overgrown nails • Remove damaged feathers • Trim rachis of feathers if irritating bird • Mechanical barrier to self-mutilation if needed • Medicated padding and or bandaging for pododermatitis when present	• Evaluate for the following: - Essential amino acids - Balanced fat and CHO - Vitamins at physiologic levels (not excessive or deficient) - Free of dyes and preservatives - Need for supplemental essential fatty acids • Formulated diet is often most convenient and effective • Monitor weight during conversion

EVALUATION OF THERAPY

- Dietary conversion is necessary for long-term treatment and control.
- Anticipate exacerbation of clinical signs for 3-9 months (pruritus, flaking of skin and molting) with integumentary regeneration.
- If clinical signs worsen, perform diagnostic work-up for systemic sequelae to IDC.
- At 9-12 months, marked improvement should be noted in initial clinical signs.

There are few natural oxidative inhibitors. Tocopherols (vitamin E) and rosemary leaves have been tried. In the author's experience, preliminary studies of products containing rosemary had less than ideal acceptance, and the test subjects' had lower than desired body weights.

The natural antioxidants found in whole cereal grains have not been fully exploited.

The development of quadruple laminate bags (Fig 4.2.1), consisting of a layer of poly-coated extruded paper (blocking light), a layer of nylon for puncture resistance, a metal alloy as a barrier to oxygen and a polyethylene layer to resist changes in moisture and retain oils, have increased shelf life of non-synthetically preserved products by up to 14 months. However, once the seal is broken and exposure to oxygen and moisture increases, these products are only viable for up to six weeks before clinical signs produced in birds resemble those of birds maintained on diets depicted in Figs 4.2.2-4.2.3a,b. It is important that clients adhere to the manufacturers'

Table 4.2.3 | IDC and the Integument

Nutritional Imbalance

There are few natural oxidative inhibitors. Tocopherols (vitamin E) and rosemary leaves have been tried. In the author's experience, preliminary studies of products containing rosemary had less than ideal acceptance, and the test subjects' had lower than desired body weights.

The natural antioxidants found in whole cereal grains have not been fully exploited.

The development of quadruple laminate bags (Fig 4.2.1), consisting of a layer of poly-coated extruded paper

CLINICAL SIGNS

Feathers Skin Beak and Nails

• Frequent or incomplete molts

• Retained feather sheaths

• Abnormal coloration

• Irritability due to feather discomfort

• Deformities: - Cysts - Loss of elasticity - Barbules not interlocking

• Chronic/Severe - Feather destructive behavior - Self-mutilation

• Flaky

• Dry

• Pruritic

• Hyperkeratotic

• Loss of elasticity (tears readily)

• Plantar surface - loss of pattern

• Chronic/Severe - Pododermatitis

• Excessive length

• Exaggerated curvature

• Friable texture

• Splitting

• Bruise readily

• Chronic/Severe - Marked deformity - Secondary infections

INITIAL TREATMENT

Husbandry Medical Procedural Diet Conversion

• Increase UVB

• Increase outdoor exposure: - Humidity - Ventilation - Sunlight - Psychological stimulation

• Improve available perches, increased variety of sizes and tex- tures

• Increase exercise, both physical and mental

• Verify or improve hygiene

• Antipruritics: - Systemic - Topical

• Treat secondary infection if present and significant

• Psychotropic medications if self- mutilating

• Parenteral vitamin supplementation for severe deficiencies

• Blood work and other diagnostics if indicated

• Trim overgrown beak

• Trim overgrown nails

• Remove damaged feathers

• Trim rachis of feathers if irritating bird

• Mechanical barrier to self-mutila- tion if needed

• Medicated padding and or band- aging for pododermatitis when present

• Evaluate for the following: - Essential amino acids - Balanced fat and CHO - Vitamins at physiologic levels (not excessive or deficient) - Free of dyes and preservatives - Need for supplemental essential fatty acids

• Formulated diet is often most con- venient and effective

• Monitor weight during conversion

EVALUATION OF THERAPY

• Dietary conversion is necessary for long-term treatment and control.

• Anticipate exacerbation of clinical signs for 3-9 months (pruritus, flaking of skin and molting) with integumentary regeneration.

• If clinical signs worsen, perform diagnostic work-up for systemic sequelae to IDC.

• At 9-12 months, marked improvement should be noted in initial clinical signs.

(blocking light), a layer of nylon for puncture resistance, a metal alloy as a barrier to oxygen and a polyethylene layer to resist changes in moisture and retain oils, have increased shell life of non-synthetically preserved prod- ucts by up to 14 months. However, once the seal is bro- ken and exposure to oxygen and moisture increases, these products are only viable for up to six weeks before clinical signs produced in birds resemble those of birds maintained on diets depicted in Figs 4.2.2-4.2.3a,b. It is important that clients adhere to the manufacturers'

Fig 4.2.4 | 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.

Fig 4.2.5 | 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.

Table 4.2.4 | Using a Formulated Diet

Shelf Life	Use within 4-6 weeks of opening*
Storage	Store in manufacturer's packaging only if adequate**
	Express air to minimize oxidation
Feeding Frequency	Offer fresh food 2-3 times daily dependent on species
Feeding Amount	Ensure bird eats all food offered, including crumbs. Amount fed should maintain normal body weight.
Selective Feeding	Don't allow bird to favor individual particles
Supplementation	Follow manufacturer's instructions as to types and amounts of supplementary foods
Water	Don't allow birds to dunk food in water as this degrades vitamins and pollutes water leading to bacterial and fungal overgrowth

*Diets composed of nonorganic ingredients may have a longer shelf life due to synthetic preservatives.
**Many products are packaged in inferior packaging resulting in breakdown of key nutrients before packaging is even opened. Quadruple laminate packaging preserves nutrients for extended periods of time.

storage directions, as even nutritionally adequate diets have a limited shelf life once opened (see Table 4.2.4).

The IDC from a Systemic Point of View

Although birds seldom present with only one system affected by improper diet cascade, diagnosis, treatment and prevention are best discussed by looking at a single system at a time.

Early recognition by the clinician of the effects of IDC on various systems allows diagnosis and implementation of dietary therapy. This is a key element in avian preventive health care.

INTEGUMENTARY SYSTEM

The integument is the site where clinical signs of dietary inadequacy often appear to be noticed first, but these early stages are so commonly encountered that they may not be perceived as abnormal (Table 4.2.3). The stratified squamous epithelial (SSE) cells characteristic of skin are involved in the production of integumentary components such as the nails, beak, feathers, and feather follicles. In addition to the integument, SSE cells are found in the rhinal cavity, mouth, salivary duct junctions, tear ducts, ear canal, syrinx, air sac junctions to the lungs, bile duct, pancreatic duct, cloaca, renal tubules and vagina. Nutritional imbalance can influence the structure and function of any of these sites. While nutritional inadequacies are most often manifested in the integument, the clinical presentation can be complicated by more serious underlying illnesses. The development of nutritionally balanced formulated diets has dramatically reduced the incidence of dermal disorders, but such diets are far from successful in totally eliminating these problems once they have developed.

The Physical Exam Form outlined in Chapter 6, Maximizing Information from the Physical Examination, is a useful tool for identifying signs and common clinical presentations listed in Table 4.2.3. Minor integumentary signs are often overlooked by the bird care industry. It is important to establish a program of wellness with regular checkups, especially for new birds, to identify problems with nutritional inadequacies at an early stage.

KERATINIZATION

Hyperkeratosis is characterized by failure of the new cells to differentiate beyond the squamous stage.

Fig 4.2.5 | This blue and gold macaw hen died after laying a crackers, cookies, pellets and vegetables. The feathers are tat-

clutch of 5 infertile eggs. Note the pinfeathers after all the body tered and lack symmetry. The blue feathers contain a black pig-

and extremity feathers were removed. Also note the black pig- ment. Under the contour body feathers, the bird had an excessive

ment in the normally blue feathers. The bird had been fed a number of pinfeathers.

seed and table food diet.

Table 4.2.4 | Using a Formulated Diet

Shelf Life Use within 4-6 weeks of opening*

Storage Store in manufacturer's packaging

only if adequate**

Express air to minimize oxidation

Feeding Frequency Offer fresh food 2-3 times daily dependent on

species

Feeding Amount Ensure bird eats all food offered, including crumbs.

Amount fed should maintain normal body weight.

Selective Feeding Don't allow bird to favor individual particles

Supplementation Follow manufacturer's instructions as to types and

amounts of supplementary foods

Water Don't allow birds to dunk food in water as this

degrades vitamins and pollutes water leading to bacterial and fungal overgrowth

*Diets composed of nonorganic ingredients may have a longer shelf life

due to synthetic preservatives. **Many products are packaged in inferior packaging resulting in break- down of key nutrients before packaging is even opened. Quadruple laminate packaging preserves nutrients for extended periods of time.

storage directions, as even nutritionally adequate diets have a limited shelf life once opened (see Table 4.2.4).

The Point IDC of View from a Systemic

Although birds seldom present with only one system affected by improper diet cascade, diagnosis, treatment and prevention are best discussed by looking at a single system at a time.

Early recognition by the clinician of the effects of IDC on various systems allows diagnosis and implementation of dietary therapy. This is a key element in avian preventive health care.

INTEGUMENTARY SYSTEM

The integument is the site where clinical signs of dietary inadequacy often appear to be noticed first, but these early stages are so commonly encountered that they may not be perceived as abnormal (Table 4.2.3). The stratified squamous epithelial (SSE) cells characteristic of skin are involved in the production of integumentary compo- nents

such as the nails, beak, feathers, and feather folli- cles. In addition to the integument, SSE cells are found in the rhinal cavity, mouth, salivary duct junctions, tear ducts, ear canal, syrinx, air sac junctions to the lungs, bile duct, pancreatic duct, cloaca, renal tubules and vagina. Nutritional imbalance can influence the structure and function of any of these sites. While nutritional inad- equacies are most often manifested in the integument, the clinical presentation can be complicated by more serious underlying illnesses. The development of nutri- tionally balanced formulated diets has dramatically reduced the incidence of dermal disorders, but such diets are far from successful in totally eliminating these problems once they have developed.

The Physical Exam Form outlined in Chapter 6, Maximiz- ing Information from the Physical Examination, is a use- ful tool for identifying signs and common clinical pre- sentations listed in Table 4.2.3. Minor integumentary signs are often overlooked by the bird care industry. It is important to establish a program of wellness with regu- lar checkups, especially for new birds, to identify prob- lems with nutritional inadequacies at an early stage.

KERATINIZATION

Hyperkeratosis is characterized by failure of the new cells to differentiate beyond the squamous stage.

Table 4.2.5 | IDC and the Digestive System

Nutritional Imbalance → Pathology of gastrointestinal organs, liver, pancreas			
⇩			
CLINICAL SIGNS			
Body Condition	**Behavior**	**Flora**	**Digestive**
• Obesity • Loss of muscle mass • Bleeding • Chronic - Emaciation - Fatty liver - Cirrhosis - Hemochromatosis	• Regurgitation • Vomiting • Loss of appetite • Listlessness • Aggression	• Total # gram-positives decrease • Lower % gram-positive rods • Gram-negative bacteria increase • Yeast not budding • Chronic - Gram-negatives predominate - Budding yeast - Enterotoxemia (gram-positives explode) - Clostridial overgrowth	• Bilestained urine, urates and stool • Occult blood in stool • Undigested food and fiber in stool = pancreatic failure • Liver shadow increases or decreases • Chronic - Ileus - Diarrhea
TREATMENT			
Diagnostics for Secondary Infections	**Medical Treatment**	**Environmental Concerns**	**Dietary Conversion**
• Endoscopy and organ biopsy • Culture and sensitivity • Radiology • Hematology • Biochemistry • Ultrasound	• Fluids • Systemic treatment of secondary infections • GI stimulants • Bacteria, enzyme replacement • Lactulose • Milk thistle • SAMe • Apple cider vinegar • Chronic - Ultra clear®† - Hepasan®‡	• Heat • Proper humidity	• Same as Table 4.2.3 • Formulated diet is often most convenient and effective

Dysfunctional, excessively keratinized cells replace normal cells. This can result in epithelial lesions and an increased susceptibility to infection. If the imbalance is severe and prolonged, columnar epithelium undergoes metaplasia to SSE. Keratinization can result in a loss of function of the tissues involved, including those of the alimentary, reproductive, respiratory and urinary tracts.

Clinical signs of hyperkeratosis involving the integumentary system can manifest as overgrowth of the beak and nails, which retain their outer covering due to a proliferation of basal cells. The keratinized outer coatings of pinfeathers are thicker, less flexible and retained much longer than normal. Retained coatings prevent pinfeathers from opening and such feathers appear to be painful to the birds if the unopened feathers are manipulated. Clients commonly report that birds with chronically retained pin feathers are irritable and vocalize as if in pain during preening (Figs 4.2.4 and 4.2.5).

While hyperkeratosis is generally associated with dietary deficiencies of vitamin A, excesses of vitamin A are also correlated with hyperkeratosis. The percent of squamous cells present in nasal flushes has been used as an indicator of vitamin A toxicosis.[36] It is important to obtain a full dietary history before prescribing vitamin A supplementation to treat hyperkeratosis. In rodents, oral supplementation with vitamin A failed to raise serum vitamin A levels in the absence of adequate vitamin E.[6] Therefore a mixture of both vitamin E and vitamin A may be required to treat hyperkeratosis due to a vitamin A deficiency. Deficiencies of zinc and biotin have been associated with hyperkeratosis. Biotin deficiencies, which can result from excess of salt, are correlated with hyperkeratosis on the footpad and the plantar surfaces of the toes.[7] Thus the caveat to not treat all hyperkeratosis with vitamin A injections is valid.

GASTROINTESTINAL SYSTEM

Secondary to the dermal system (and some behavioral traits), the avian clinician is likely to observe gastrointestinal tract (GIT) dysfunction next in the unfolding of the IDC (Table 4.2.5). Vitamin A deficiency may interfere with normal growth, rate by influencing functionality of the small intestine by altering the proliferation and maturation of cells of the intestinal mucosa.[106] Hyperproliferation of enterocytes, decreased number of goblet cells, decreased alkaline phosphatase activity, and decreased expression of brush-border enzymes are all correlated with vitamin A deficiencies.[106]

Dysfunctional, excessively keratinized cells replace nor- mal cells. This can result in epithelial lesions and an increased susceptibility to infection. If the imbalance is severe and prolonged, columnar epithelium undergoes

metaplasia to SSE. Keratinization can result in a loss of function of the tissues involved, including those of the alimentary, reproductive, respiratory and urinary tracts.

Clinical signs of hyperkeratosis involving the integumen- tary system can manifest as overgrowth of the beak and nails, which retain their outer covering due to a prolifer- ation of basal cells. The keratinized outer coatings of pinfeathers are thicker, less flexible and retained much longer than normal. Retained coatings prevent pinfeath- ers from opening and such feathers appear to be painful to the birds if the unopened feathers are manipulated. Clients commonly report that birds with chronically retained pin feathers are irritable and vocalize as if in pain during preening (Figs 4.2.4 and 4.2.5).

While hyperkeratosis is generally associated with dietary deficiencies of vitamin A, excesses of vitamin A are also correlated with hyperkeratosis. The percent of squa- mous cells present in nasal flushes has been used as an indicator of vitamin A toxicosis.58 It is important to obtain a full dietary history before prescribing vitamin A

Table 4.2.5 | IDC and the Digestive System

CLINICAL SIGNS

Body Condition Behavior Flora Digestive

• Obesity

• Loss of muscle mass

• Bleeding

• Chronic - Emaciation - Fatty liver - Cirrhosis - Hemochromatosis

Nutritional Imbalance→ Pathology of gastrointestinal organs, liver, pancreas

• Regurgitation

• Vomiting

• Loss of appetite

• Listlessness

• Aggression

• Total # gram-positives decrease

• Lower % gram-positive rods

• Gram-negative bacteria increase

• Yeast not budding

• Chronic - Gram-negatives predominate - Budding yeast - Enterotoxemia (gram-positives explode) - Clostridial overgrowth

• Bilestained urine, urates and stool

• Occult blood in stool

• Undigested food and fiber in stool = pancreatic failure

• Liver shadow increases or decreases

• Chronic - Ileus - Diarrhea

TREATMENT

Diagnostics for Secondary Infections

Medical Treatment

Environmental Concerns

Dietary Conversion

• Endoscopy and organ biopsy

• Culture and sensitivity

• Radiology

• Hematology

• Biochemistry

• Ultrasound

• Fluids

• Systemic treatment of secondary infections

• GI stimulants

• Bacteria, enzyme replacement

• Lactulose

• Milk thistle

• SAMe

• Apple cider vinegar

• Chronic - Ultra clear®f - Hepasan®e

• Heat

• Proper humidity

• Same as Table 4.2.3

• Formulated diet is often most con- venient and effective

supplementation to treat hyperkeratosis. In rodents, oral supplementation with vitamin A failed to raise serum vitamin A levels in the absence of adequate vitamin E.6 Therefore a mixture of both vitamin E and vitamin A may be required to treat hyperkeratosis due to a vitamin A deficiency. Deficiencies of zinc and biotin have been associated with hyperkeratosis. Biotin deficiencies, which can result from excess of salt, are correlated with hyperkeratosis on the footpad and the plantar surfaces of the toes.7 Thus the caveat to not treat all hyperkerato- sis with vitamin A injections is valid.

GASTROINTESTINAL SYSTEM

Secondary to the dermal system (and some behavioral traits), the avian clinician is likely to observe gastroin- testinal tract (GIT) dysfunction next in the unfolding of the IDC (Table 4.2.5). Vitamin A deficiency may interfere with normal growth, rate by influencing functionality of the small intestine by altering the proliferation and mat- uration of cells of the intestinal mucosa.104 Hyperprolifer- ation of enterocytes, decreased number of goblet cells, decreased alkaline phosphatase activity, and decreased expression of brush-border enzymes are all correlated with vitamin A deficiencies.104