Controversies in Avian Nutrition

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There are areas of avian nutrition which are on the cutting edge. The data we have available point us in a direction without giving us the outcome of traveling in that direction. Below I present my conclusions based on the directions the data are pointing from my perspective. Please be aware that the direction that we as nutritionists move may change when more data become available. This is my view of where we are now and were the data seem to lead us and not a detailed outline of the future.

Weight Reduction

Birds regulate food intake with respect to energy density. That is, birds eat primarily to regulate the amount of energy they ingest. Intake of any nutrient is, therefore, regulated by the energy density of the diet and the concentration of the nutrient in the diet. A diet which is high in energy, ie. high in fat, must also be high in all other essential nutrients to be adequate. For example, a diet containing 20% protein and 3.75% fat was found to be adequate for growth in cockatiels (Roudybush and Grau, 1986). To maintain the ratio of protein to calories in the diet, more protein needs to be added to the diet as fat is increased and carbohydrate is decreased. Fat yields about 9 calories per gram when metabolized while carbohydrate yields only 4. When the amount of carbohydrate nears zero and the amount of fat reaches 60%, protein needs to be increased to 30% of the diet to maintain adequacy. This is a factor of 1.5 and is the same number by which all other essential nutrients need to be multiplied to maintain their original calorie:nutrient ratios.

Obesity

Obesity is caused when energy intake exceeds energy utilization over a long period of time. The key to overcoming obesity is to increase energy utilization, decrease energy intake or both. The most effective way to overcome obesity is to do both. Moderate exercise which reduces appetite, both increases energy expenditure and decreases energy intake. It is one of the most effective changes which can be made in a weight reduction program. How increased exercise may be achieved varies with the situation, but a separation of the sources of food and water that forces the bird to move between them may be effective. Diversions which engage the bird in activity may also be effective. Other important steps in weight loss all regulate energy intake. There are a variety of steps which can be useful under various conditions. These include:

1. Regulation of food intake by offering a measured amount of food. When more than one bird is present, dominance of one bird may deny other birds access to the food. This can sometimes be overcome by offering food in more than one place.

2. Changes in food composition to reduce caloric density. Birds can consume and digest only a limited amount of food. If the caloric density is reduced to a low enough level, only a limited amount of energy can be consumed in a period of time. This limits the energy intake of the bird. This can be achieved by removing high energy food items from the diet and increasing rich sources of required nutrients. One commercial diet takes this approach by adding soluble fiber, reducing fat and adding essential nutrients*.

3. Decrease fat in the diet. This has the dual purpose of limiting total energy in the diet and reducing the fat. Dietary fat is directly available for storage in fat tissues. When fat is eaten, it can be absorbed and deposited directly into fat storage cells. If the same amount of energy is ingested as carbohydrate or protein, it must first be converted to fat for storage. Since there are metabolic inefficiencies in the conversion of carbohydrate and protein to fat, equal amounts of energy ingested as carbohydrate or protein result in less fat storage than if the same amount of energy is ingested as fat.

In any weight loss program the bird must be closely monitored to assess the rate of weight loss and whether any newly substituted diet is being consumed. This is best done by weighing the bird at regular intervals. Weight loss should not be more than 3% of the bird's body weight per week. Examination of the bird's droppings is an easy way to determine whether the bird is eating. The dropping color may change, but the volume should be larger than the volume of the urine and bile combined from a fasting bird. In flocks it is difficult to assess the condition of individual birds. Unless birds are caught and weighed at regular intervals, some weaker or less adaptable birds may starve either from competition for food or from failure to consume newly introduced diets. Careful observation of the flock and removal and individual care of the poorer birds may be essential to prevent mortality.

Calcium

Controversy surrounds the requirement for calcium in the diets of birds under maintenance conditions. Levels as high as 1.0% of the diet have been recommended, but no published experiments support this recommendation. In the Nutrient Requirements of Poultry even growing birds are fed as little as 0.55% calcium and nonlaying birds are fed as little as 0.5% calcium (Shane *et al*., 1969). Non-laying hens maintained calcium balance on as little as 0.02% calcium (Rowland *et al*., 1973). Male chickens maintained balance on even less though the authors concluded that 0.02% calcium was adequate for maintenance (Norris *et al*., 1972). Until more data are available a maintenance level of 0.1% calcium appears to be adequate.

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* **Reducing Care Diet, Roudybush, PO Box 908, Templeton, CA, 93465**

For egg laying the level of calcium required in the diet has been stated over a wide range. There, however, is no evidence for a requirement of more than 1.0% calcium in most cage and aviary birds. Cockatiels fed 0.35% calcium were found to maintain shell thickness and conductance and egg production compared to birds fed higher or lower levels of calcium (Roudybush, TE, Grau, CR and Limberg, LA. Unpublished observations). In birds laying large numbers of eggs a level of 0.35% calcium is recommended to maintain bone integrity if laying cannot be stopped.

For growth 0.9% calcium appears to be adequate if balanced with 0.6% available phosphorus. There are no experiments on this though many birds have been raised on 1.0% calcium without morbidity.

Calcium is toxic during growth at levels only slightly above the requirement in birds which have been tested. Levels of 1.2%, (Scott *et al*., 1969) 1.35% (Smith and Taylor, 1961) and 2.5% (Scott *et al*., 1969) have been shown to result in poorer performance than lower levels in growing chickens. Calcium at 2.5% (Scott *et al*., 1969) resulted in high morbidity and mortality in pullets between 8 and 20 weeks of age. From these data it appears that the calcium intake of growing cage and aviary birds should be limited to no more than 1.2% of the diet unless specifically indicated by unique conditions.

Various levels of dietary calcium in excess of 1.2% have produced the following deleterious effects.

Bird	% Calcium	Effect	Reference
Chicken	1.2	Decreased body weight gain	Urban, 1960
Chicken	0.83 vs 1.35	Reduced growth rate Poorer feed conversion	Smith and Taylor, 1961
Chicken	1.2, 2.0, 3.0, 4.5 and 6.5	Above 2.0% poor weight gain, depressed feed intake, increased mortality	Fangauf *et al*., 1961
Pullets 8-20 weeks	1.2, 2.5 and above	Nephrosis, visceral gout, calcium urate deposits, high mortality, reduced feed consumption and	Shane *et al*., 1969
Poultry	Review	Recommend 1.2% or less	NRC, 1980

Iron Storage Disease

Iron storage disease is a frequently observed but poorly understood syndrome. One effective treatment, bleeding, is usually used in conjunction with low iron diets. The cause of excess iron storage and a less invasive treatment have not been elucidated.

Iron excess in the liver is called hemosiderosis if there is no alteration of tissue morphology and function and hemochromatosis if the iron accumulation alters either the appearance or function of the cells or tissues involved (Lowenstine, 1986). Iron excess, usually as hemochromatosis, has been observed in a number of species (Griner, 1983; Lowenstine and Petrak, 1980; Taylor, 1984; Kincaid and Stoskopf, 1987; Taylor, 1984) and remains a problem in many pet and zoo birds. Diets with less than 100 ppm iron are recommended, because most affected birds had been consuming diets in excess of 100 ppm iron. Since practical diets with less than 100 ppm iron are difficult to formulate, this observation may prove to relate to what diets are available rather than what is needed to prevent excess iron storage. Even 100 ppm iron is in excess of the 60-80 ppm (National Research Council, 1984) required for growth in poultry. Corn, a major constituent of poultry diets, contains 300 ppm iron. If this level of iron were the major cause of excess iron storage, major die offs of birds fed corn based diets should have been seen. This has not happened in flocks fed diets containing 250-300 ppm iron for ten years. Other primary causes of excess iron storage need to be considered. Some possibilities are stresses related to disease exposure (immunologic stress -Bafundo *et al*., 1984a, 1984b, 1984c); crowding; and nutritional stress related to periodic starvation associated with diet changes (Borch-Johnson and Nilssen, 1987), since the disease occurs with a high frequency in recently imported birds (Clubb, S; pers. comm.). Periodic starvation has been associated with excess iron storage in the livers of reindeer(22). Immunologic stress may prove to be a factor in iron metabolism since the sequestering of many trace elements occurs after infection with coccidia in poultry (Bafundo *et al*., 1984a, 1984b, 1984c). Another stress which has been shown to be associated with increased iron stores is intoxication with heavy metals (McDonald and Lowenstine, 1983).

With our present level of understanding of iron storage disease it appears that nutrition is, at best, a minor player in the disease. Stress factors as mediators of iron metabolism need further investigation.

Lead and Zinc

Lead and zinc have similar chemical and physical properties. As such, they travel together chemically and often contaminate each other. In most cases the level of contamination is insignificant; such as when zinc is used as a dietary supplement. Since the level of zinc needed is small, and the level of contamination is small, the amount of lead introduced into the diet is insignificantly small for biological purposes.

Lead can be biologically important, however, when zinc is used as a coating on galvanised cages or wire. When wire is hot dip galvanised, it is dipped into a vat of molten zinc. At some temperatures lead sinks to the bottom of the vat and collects as the zinc is removed. At other temperatures lead and zinc are miscible. If lead accumulates without periodic removal, it may contaminate the zinc at a high level. This is improper technique, but it can represent a significant source of lead Most galvanised wire is not a problem, but occasional significant contamination may occur. In some older wire a sheen was considered desirable. This sheen could be achieved with a lead wash. In this case lead would be the dominant metal on the outside of the wire and could be a significant source of lead to the bird.

Simple Sugars

A main consideration in the use of a feedstuff in the feeding of a bird is whether it contains factors which will be harmful. In dietary management of birds simple sugars are of considerable importance. Simple sugars fed to carnivorous birds which subsist mainly on fat and protein may lead to elevated blood sugar levels. Whether this is acceptable depends on the situation and on the biology of the bird, but is clearly a nutritional consideration.

Candida is a common problem in many species of birds. The organism usually infects the crop and causes crop stasis but can become a more generalized infection. Drug treatment usually ends the infection and relieves the problem, though recurrence is known in some cases. The growth of Candida initially and its recurrence can, however, be due to improper diet. Candida is common in the environment and is likely to be encountered by birds. In most cases it passes through the crop fast enough to limit its growth and allow the bird to resist infection. In the presence of sugar, however, the rate of candida growth is accelerated and can exceed the rate of removal leading to infection.

In species in which it is possible diets should be free of sugar. Products such as sugar, glucose, fructose, dextrose, honey, corn syrup, molasses, sucrose, maltose and other ingredients which contain sugar should be avoided. Some commercial diets use only complex carbohydrates as sources of carbohydrate[†] and are less likely to support growth of candida than diets containing sugars.

Milk Products

Milk products can either be a concentrated source of essential nutrients, a source of dietary problems, both, or of little significance in the diet, depending on which milk products are used and in what proportions to other ingredients.

Lactose is the main problem with milk products in the feeding of birds. Lactose is a product of mammals has not been available to birds over evolutionary time periods. Birds do not digest lactose and suffer diarrhea when lactose reaches 10-30% of the diet on a dry weight basis. Thus, lactose in milk products should be avoided; when a milk product is used, the total amount of lactose in the diet should be limited. Significant sources of lactose include dried skim milk with 50% lactose and dried whey which can reach 70% lactose. These and other milk products can, however, provide protein and trace nutrients which enhance marginal diets. They can be useful supplements, but in most cases other sources of missing nutrients can be found and offer safer methods of supplementation.

† **Roudybush, PO Box 908, Templeton, CA, 93465**

Some milk products contain little or no lactose and can be used safely in the diets of birds. Cheeses extract the fat, protein and some of the trace nutrients from milk leaving most of the lactose behind in the whey. In yogurt lactose has been converted to lactate. In experiments with dried skim milk and dried yogurt, the performance of chickens was better when yogurt replaced milk (Simhaee and Keshavarz, 1974).

Animal By-products

Animal by-products are processed whole animals or animal parts. Some of the common animal by-products are meat meal, fish meal, meat and bone scraps, fish solubles, blood meal, feather meal, and bone meal. Animal by-products are used in the commercial feeds as inexpensive sources of protein, phosphorus, and trace nutrients. Nutritionally, they are useful components of balanced diets for a variety of species. They are generally produced by cooking processes which render the by-product sterile at the end of manufacture.

The problems with contamination of these products comes not from an inadequate cooking process but from recontamination. The raw materials from which animal by-products are made are usually high in pathogens (Riemann and Bryan, 1979). In some cases the material to be rendered is available because of the condemnation of material at slaughter houses or because animals have died in animal production. In many cases the trucks which haul the dead animals to the rendering plant are the same trucks which haul the finished product out of the plant. Rendering plants are not usually run in such a way as to prohibit human and machine traffic between the finished product and the raw material being rendered. In surveys of finished animal by-products as much as 80% has been found to contain significant numbers of pathogens. This industry is largely unregulated and finished products are not generally tested for contamination. Until verifiably clean supplies of animal by-products can be obtained they should be considered sources of contamination in feeds.

These products have been shown to be sources of disease in commercial meat and egg production; so efforts have been made to limit their impact. Pelleting is used to cook finished feeds to kill pathogens. Pelleting as it is done in most feed mills has been shown to be incompletely effective at killing pathogens. While some pathogens do survive pelleting, the reduction of pathogens has had a positive impact. Since some limited numbers pathogens may survive pelleting, however, the use of animal by-products in feeds for birds of significant economic and emotional value is a questionable practice.

Gout

Gout may not prove to be a nutritional disease in birds except under unusual circumstances such as a vitamin A deficiency. In humans it was long thought that gout was due to high levels of protein in the diet. More recently human gout has been found to be due to hyperuricemia caused by hereditary or environmental factors. Dietary therapy is used only as an adjunct to drug therapy and is considered to be only moderately effective (Zeman, 1983).

In birds gout is a common disease of unknown origin. Gouty chickens selected to develop gout when fed high protein diets required 70% protein to produce the disease (Petersen, DW: pers. comm.). Birds with active cases of gout may or may not show elevated levels of uric acid in the blood (Altman, 1986). The use of low protein diets in gouty birds may be of some use depending on the cause of the disease. Low protein diets can reduce both liver and kidney stress by reducing the work load of these organs. If either organ is compromised in a way which leads to gout, low protein diets may reduce clinical signs or facilitate recovery by enhancing organ function rather than by reducing blood uric acid levels. The prognosis for birds with gout is grave; drug therapy is not generally useful (Altman, 1986; Halliwell, 1986).

Crop Stasis

Crop stasis is the name which has been applied to failure of the crop to empty. Crop stasis has previously been improperly called crop impaction. In most cases the failure of the crop to empty is a response to physiologic stress. The physiologic stress can vary from improper brooding or food temperature to infection, trauma or other causes. The stress can be nutritional, such as feeding an excess of water during hand feeding. This is easily corrected by bringing the concentration of the food in the mix to 20-30% dry matter with the remaining percentage being water. Other nutritional factors may contribute to crop stasis depending on other conditions of temperature, sanitation and management. Crop stasis is usually followed by crop infection, if infection is not the primary cause. Crop stasis should always be considered a sign of crop infection. In cases in which the primary cause of crop stasis is corrected, infection can remain and cause the crop stasis to continue.

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