United States Department of Agriculture

Natural Resources Conservation Service

Ecological Sciences Divison

October 2003

Nutrient Management Technical Note No. 4

Feed and Animal Management for Poultry

Introduction

Commercial poultry operations involve four types of birds: broiler (meat producing) chickens, layer (table egg) chickens, turkeys, and ducks. Each type differs greatly in size and nutrient requirements. Breeder flocks for each of the species are a major part of the industry, and those flocks also have different nutrient requirements. Distinctly different diets are required for each species and the different stages of each species' life cycle. These diets result in different volumes and nutrient compositions of the manure produced by the different species. This technical note briefly highlights some factors affecting nutrient excretion. It also points out some potential dietary adjustments that can be made to minimize excess nutrient excretion.

Selected nutrient requirements for the different types of poultry are listed in table 1. This table was developed from material in the National Research Council's (NRC) publication *Nutrient Requirements of Poultry*, 9th revised edition, 1994. Reference to this NRC publication is recommended for a thorough evaluation of the poultry diets used by a commercial operation or from internal research on specific genetic lines of birds used at the operation.

This is the fourth in a series of nutrient management technical notes on feeding management.

Series was prepared by **Dr. Alan Sutton,** professor of Animal Science at Purdue University, West Lafayette, Indiana, and **Charles H. Lander,** national agronomist, NRCS, Washington, DC. This series was developed from material published by the Federation of Animal Science Societies (FASS), Savoy, Illinois.

Diet formulation

Phase feeding. Dividing the growth period into several periods, each with a smaller interval between body weights, allows producers to provide diets that more closely meet the bird's nutrient requirements. Phase feeding of several diets during the grow-out period can significantly reduce nitrogen (N) and phosphorus (P) excretion. However, most companies cannot utilize more than 3 to 4 diets for broilers and 5 to 6 diets for turkeys, primarily because of mill handling, economic and logistical constraints, and trucking costs.

New, rapid-growing genetic lines have been shown to have up to 69 percent reduced P excretion and up to 55 percent reduced N excretion as compared to older, slower-growing genetic lines. These reductions have come about primarily through reduced time to market age and, therefore, reduced maintenance requirements. Some feed manufacturers are currently formulating poultry feeds on an **ideal protein** basis. An ideal protein is one in which synthetic amino acids are used to balance protein intake to closely match the birds' requirements for synthesis and maintenance of lean tissue protein. Although nutritionists cannot prepare a perfect amino acid balance from natural feed ingredients, having an array of different feed ingredients and synthetic amino acids allows feed manufacturers to produce feeds that have reduced amino acid excesses. This results in less N being excreted.

Formulate diets on an available nutrient basis. A high proportion (56 to 81 percent) of the P in cereal grains and oilseed meals occurs as phytate. Phosphorus in this form is not well utilized by poultry because they lack sufficient amounts of the intestinal enzyme phytase. This enzyme is needed to remove the phosphate groups from the phytate molecule. Supplemental inorganic P is, therefore, added to the diet to meet the bird's growth requirements. The nondigestible P and any additional P added to the diet that is beyond the bird's requirements are excreted in the manure. Because some feedstuffs are high in phytate and because there is some endogenous phytase in certain small grains (wheat, rye, triticale, barley), the bioavailability of P in feed ingredients varies widely. This natural source of phytase may have some value for layers with mash diets. Currently, however, the industry disregards this phytase source. If the diet is pelleted, the phytase is destroyed. The P in corn is only 12 to 15

Table 1 Selected nutrient requirements for poultry [1]

Nutrient (percent or unit/kg of diet; 90% dry matter)	Layer [2 3] 80	Layer [2 3] 100	Layer [2 3] 120	Broiler 0–3 wk	Broiler 3–6 wk	Broiler 6–8 wk
Protein, %	18.80	15.00	12.50	23.00	20.00	18.00
Calcium, %	4.06	3.25	2.71	1.00	0.90	0.80
Non-phytate phosphorus, %	0.31	0.25	0.21	0.45	0.35	0.30
Potassium, %	0.19	0.15	0.13	0.30	0.30	0.30
Copper, mg/kg	?	?	?	8.00	8.00	8.00
Zinc, mg/kg	44.00	35.00	29.00	40.00	40.00	40.00
Sodium, %	0.19	0.15	0.13	0.20	0.15	0.12
	Turkey [4] 0–4 wk	Turkey [4] 4–8 wk	Turkey [4] 8–12 wk	Turkey [4] 12–16 wk	Turkey [4] 16–20 wk	Turkey [4] 20–24 wk
Protein, %	28.00	26.00	22.00	19.00	16.50	14.00
Calcium, %	1.20	1.00	0.85	0.75	0.65	0.55
Non-phytate phosphorus, %	0.60	0.50	0.42	0.38	0.32	0.28
Copper, mg/kg	8.00	8.00	6.00	6.00	6.00	6.00
Zinc, mg/kg	70.00	65.00	50.00	40.00	40.00	40.00
Sodium, %	0.17	0.15	0.12	0.12	0.12	0.12
	Duck 0–2 wk	Duck 2–7 wk	Duck breeding	Broiler breeding	Turkey breeding tom	Turkey breeding hen
Protein, %	22.00	16.00	15.00	19.5 g/d	12.00	14.00
Calcium, %	0.65	0.60	2.75	4.0 g/d	0.50	2.25
Non-phytate phosphorus, % c	0.40	0.30	?	350.0 mg/d	0.25	0.35
Copper, mg	?	?	?	?	6.00	8.00
Zinc, mg	60.00	?	?	?	40.00	65.00
Sodium, %	0.15	0.15	0.15	150.0 mg/d	0.12	0.12

1 Adapted from tables 2–3, 2–6, 3–1, and 5–1 in *Nutrient Requirements of Poultry*, 9th revised edition, 1994, National Research Council (NRC), National Academy of Sciences, National Academy Press, 2101 Constitution Avenue, Washington, DC 20418 (J.L. Sell, chair, Subcommittee on Poultry Nutrition).
2 Grams intake per hen daily.
3 Based on dietary metabolizable energy concentration of approximately 2,900 kcal/kg and an assumed egg production of 90 percent (90 eggs daily per 100 hens).
4 Genetic improvements in BW gain have led to an earlier implementation of these levels at 0–3, 3–6, 6–9, 9–12, 12–15, and 15–18 weeks of age for males and 0–3, 3–6, 6–9, 9–12, 12–14, and 14–16 weeks of age for females.

percent available while the P in wheat is 50 percent available. On a comparative basis with dicalcium phosphate set at 100 percent, the P in dehulled soybean meal is more available than the P in cottonseed meal (23 percent vs. 1 percent), but neither source of P is as highly available as the P in meat and bone meal (66 percent) or fishmeal (93 percent). Similarly, the sources of micronutrients used in the diet can vary in availability for animal use. To reduce excretion levels, formulate these nutrients on an available basis when this is possible.

Supplementing the diet with the enzyme phytase and reducing the dietary P level are effective means of increasing the breakdown of phytate P in the digestive tract and reducing P excretion in the excreta. Using phytase allows feeding a lower P diet because phytase releases the phosphate from phytate, making the P more available. The inclusion of phytase increases the availability of P in a corn-soy diet by three-fold, from 15 percent up to 45 percent. Broiler chicken experiments have shown that nonphytate P levels may be reduced by 13 percent, resulting in a 24 percent reduction in excreted P. Adding a vitamin D_3 derivative, 25-hydroxy-cholecalci-ferol and citric acid, has been demonstrated to increase the absorption of P by 10 percent. Inclusion of Lactobacillus-based probiotics in broiler diets allows 18 percent lower dietary P and results in a 25 percent decrease in excreted P. Also, research has demonstrated as a starting point that these feed additives used in combination have a potential to reduce P excretion by more than 50 percent.

Feed management

Controlling feed wastage improves flock feed conversion and reduces nutrient losses. Feed wasted in manure storage can add considerably to the nutrients that need to be applied to the land. Maintaining birds under comfortable, thermo-neutral environmental conditions also reduces feed consumption, improves feed utilization, and thereby reduces nutrient excretion.

The mineral content of the water supply should be considered with regard to the total intake of dietary minerals. Depending on the quality of the water supply available, water intake may contribute substantially to daily mineral intake, particularly with regard to sulfur and, in some areas of the country, salt. Routine water sampling can help the nutritionist formulate properly for the amount of minerals needed in the diet to meet the animal's actual requirements.

Controlling diseases and parasites and using good management practices are further examples of how one can improve the birds' health and growth rate, thereby improving its feed conversion efficiency, and reducing its nutrient excretion. Grinding (note: fine grinding has been shown to increase the passage rate and therefore, reduction retention) and further processing feed, i.e., into crumbles or pellets, are also effective ways in improving feed utilization and decreasing dry matter and nutrient excretion. By reducing the particle size, the surface area of the grain particles is increased, potentially allowing for greater interaction with digestive enzymes. In some cases it may be more important to establish an optimal particle size to maintain a slower rate of passage that is critical for digestion, absorption, and nutrient retention. Addition of enzymes, such as phytase, amylase, protease, and glucanase, releases nutrients that also enhance nutrient retention and reduce excretion. For nutrient excretion to be reduced, supplementary inorganic minerals in the diet must, of course, be reduced if the normally nondigestible components of the diet are released using enzymes.

Summary

Refer to the National Research Council's *Nutrient Requirements for Poultry* (1994) and consult a qualified nutritionist to accurately evaluate current or planned diet composition during the development of a Comprehensive Nutrient Management Plan (CNMP). Remember that some commercial operations do not formulate diets based strictly on NRC recommendations. Rather, they formulate diets based on new internally conducted research that is often proprietary.

Using multiple strategies in the formulation of poultry diets and management of birds during grow-out can significantly reduce the nutrient content of excreta. Reductions of up to 25 percent N and 50 percent P are possible.

Much recent research has demonstrated that nutrient levels can be amended to reduce nutrient excretion and potentially decrease feed cost. Data in table 2 shows the potential of various feed management techniques to reduce poultry manure N and P content.

The actual impact of a feed management strategy or strategies on a poultry operation can only be determined by analysis of the manure after the strategy has been implemented. During the development of CNMPs, the potential impact of such strategies can be estimated using values in table 2. In using data from this table, planners are encouraged to be conservative in selecting strategies. Also, it is important to remember that the impact of using multiple strategies in a single diet is not likely to be additive for each single strategy being used. Rather, it is more likely to be something greater than the value for the strategy with the smallest impact, but less than the sum of the values for all the individual strategies used.

During the development of CNMPs, it is better to underestimate the potential impact of feed management than to overestimate it. Later, the plan can be modified based on data accumulated from the actual production operation.

Table 2 Potential for feed management to impact the nutrient content of poultry manure [1]

Strategy	Nitrogen reduction %	Phosphorus reduction %
Formulate diet closer to requirement	10–15	10–15
Reduced protein/AA supplementation	10–25	n/a [2]
Use of highly digestible feeds	5	5
Phytase/low phosphorus diet	n/a [2]	20–30
Selected enzymes	5	5
Growth promotants	5	5
Phase feeding	5–10	5–10
Split-sex feeding	5–8	n/a [2]

1 Adapted from the Federation of Animal Science Societies (FASS) publication, *Dietary Adjustments to Minimize Nutrient Excretion from Livestock and Poultry*, January 2001.

2 Not applicable.

Glossary

Available nutrient basis. Formulating a diet based on the bioavailability of the nutrients from the feed ingredients in the diet for the intended production purposes.

Bioavailability of nutrients. The amount of a nutrient in the diet that is released in the digestion process and that can be absorbed in a form that can be used in the body for the normal metabolic functions of the nutrient.

Concentrates. Plant materials that contain relatively high starch content.

Diet formulation. The process of combining an assortment of feed ingredients into a diet that will meet the nutrient and energy requirements of the animal for the intended purpose for which the animal is produced.

Endogenous phytase. The enzyme naturally derived within the animal or from microbial sources within the animal that degrades phytate and releases phosphorus.

Ideal protein basis. Formulation of a diet based on the concept that the protein content of the diet has a balance of amino acids that exactly meets an animal's amino acid requirements.

Monogastric (nonruminant) animals. Animals that have simple stomachs (one compartment) and must utilize concentrates.

Phase feeding. Changing the nutrient concentrations in a series of diets formulated to meet an animal's nutrient requirements more precisely at a particular stage of growth or production.

Phytase. An enzyme that degrades phytate, making phosphorus available to nonruminants.

Phytate phosphorus. A complex, organic form of phosphorus that is bound to the phytate molecule and is not readily digested by nonruminant animals.