

Small Flock Poultry Nutrition¹

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Introduction and Overview

Animals require feed that contains the six major nutrients: carbohydrates, lipids, proteins, minerals, vitamins, and water. Carbohydrates, lipids, and proteins can supply energy to animal cells in the form of calories, most of which come from carbohydrates followed by lipids. Although proteins can be broken down to provide energy, they are used mainly for other functions. Once consumed, calories and nutrients facilitate maintenance first, then production if any nutrition remains. In poultry, productive purposes include growth and egg production. Meat-type birds, commonly referred to as broilers, use these nutrients to add muscle mass until slaughter, which typically occurs before the bird reaches sexual maturity. Egg-type birds, however, use the nutrients to add the majority of their body weight until they reach sexual maturity. At this point, the hen only uses a small amount of nutrition for maintenance. The rest assists in egg production. Since these types of birds have such different purposes, they are quite different genetically. Certain breeds known as dual-purpose birds can be used for either meat or egg production. However, their efficiency at these processes is lower than that of the birds that are genetically selected for a specific purpose.

In order to express the genetic potential for which they were selected, meat- and egg-type birds must receive the correct amount of nutrients and energy. Inadequate nutrition results in substandard growth rates as well as decreased egg production and weight. The selective breeding of

high-performing birds over the past 70 to 80 years has increased the genetic potential of domestic poultry. For example, in 1934, the expected final body weight of a broiler was roughly 2.9 pounds approximately 95 days from hatch. The feed conversion of these animals, or the amount of feed required (in pounds) to gain one pound of body weight, was 4.3. In other words, a bird would have needed to consume 12.5 pounds of feed over time to reach 2.9 pounds (2.9 x 4.3). In 2015, broilers reach a body weight of 6.6 pounds in 42 days with a feed conversion of 1.7. Now, the average commercial laying hen produces 310 eggs per year for a yield over two times larger than a typical yield in 1945.

The final ration consists of feedstuffs. Feedstuffs can be thought of as a vehicle that carries the energy and nutrients into the diet. For poultry rations in the United States, corn is the primary source of carbohydrates (calories) and soybean meal is the major contributor of protein. Other commonly used feedstuffs in poultry rations are grain sorghum (milo), barley, oats, wheat, fish meal, canola meal, animal by-product meal, meat meal, meat and bone meal, and others. The final ration must be a mixture of the aforementioned items, since no single feedstuff contains enough calories and nutrients to meet the requirements of any type of poultry.

Life-cycle feeding is very popular. It involves feeding a different ration to the animal based on where it is in its life

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cycle and which nutrients it needs at that age. For instance, younger animals require more protein (amino acids) than older animals. Energy requirements also change based on the age and activity of the animal. Commercial broiler companies typically use three different diets during the growout period, but can use as many as five. Commercial egg layers usually use five diets during the life of the bird, but may use as many as eight. Poultry feeds are also available in different forms: mash, pellets, and crumbles. Feed in mash form is a well-mixed feed consisting of all of the different ingredients that have been ground to the proper particle size. Pelleted feed is mash feed that has been put through a pellet mill to make an appropriately sized pellet of feed. Crumble feed is pelleted feed that a roller mill crushes to make a particle smaller than the pellet, but larger than mash. Poultry rations purchased from a reputable dealer are formulated to meet all nutrient requirements of the birds for which they are labeled.

The maintenance requirement for poultry is not always constant. Many factors can change it, and one of the most important factors is ambient temperature. If you keep your birds inside an enclosure for the entirety of their growout and production phases, then you can control temperature. However, most backyard or small flock owners must deal with changes in the weather and temperature. Cold weather increases the maintenance requirement for energy and the amount of feed consumed because it takes more calories to keep the bird warm. Therefore, other ingredients may be adjusted based on the increased feed intake of the flock. Conversely, poultry decrease feed consumption during hot weather. However, their need for nutrients still exists, so feed may be formulated to increase protein and other nutrients based on the lower caloric intake.

Needed Nutrients

When considering the formulation for a poultry ration, the nutritionist must include enough calories for the bird to use for maintenance, growth, production, and health. Energy and nutrient requirements vary based on the species, breed, age, environmental conditions, and sex of the bird. For example, a turkey will have higher requirements for energy and nutrients than a broiler or laying hen. Each nutrient group consists of individual components that make up the whole of the needed amount. For example, there are four fat-soluble vitamins and numerous water-soluble vitamins that poultry need in appropriate quantities. Using various feedstuffs to meet all of these nutrient requirements is not cheap and explains why 70 to 80% of the cost of poultry production is feed cost. Additional information about the nutrient requirements of poultry can be found in *Nutrient*

Requirements of Poultry, 9 Ed. (a free PDF download of the text can be found at <http://www.nap.edu/catalog/2114/nutrient-requirements-of-poultry-ninth-revised-edition-1994>).

Water

Water is the most important nutrient. It constantly leaves the animal's body via urine, feces, respiration, and evaporation from the skin. Laying hens also lose water through eggs, since eggs are approximately 65% water. Animals can lose 50% of their body protein and practically all of their body fat and still survive. However, if they lose only 10% of the water in their body and do not have the opportunity to replace it, they will die quickly. Poultry tend to consume twice as much water, by weight, as food. Therefore, the best practice for flock owners is to provide the animals with ready access to clean water at any time they should want it. It should also be noted that water consumption increases during periods of hot weather and may decrease slightly during periods of cool weather.

Carbohydrates

A poultry diet consists mostly of carbohydrates because they supply the majority of energy (calories) to the diet. In general, the most expensive component of a poultry diet is the energy supplier (i.e., carbohydrates). Grains such as corn, wheat, and grain sorghum are often the major contributors of calories. These grains contain high concentrations of amylose and amylopectin, which are the two major components of plant starch. Starch is an easily digested carbohydrate made of chains of glucose molecules. Complex carbohydrates such as cellulose are classified as crude fiber and cannot be digested by poultry. Following digestion of the starch, the glucose molecules are available for absorption into the body to be used for energy and other purposes.

Proteins and Amino Acids

Protein is the most complex nutrient group. There are approximately 20 amino acids that are the “building blocks” of the more complex protein. Each amino acid is different with respect to its molecular structure and has specific function(s) in the bodies of poultry and other animals. The main function of amino acids is to serve as the base molecules for protein synthesis within the body. These proteins are used in the synthesis of muscle, feathers, proteins that are found in the egg, and others. Certain amino acids can be synthesized by the body; however, there are other amino acids that must be supplied by the diet. These amino acids are referred to as “essential.” In

poultry, there are ten essential amino acids: threonine, histidine, arginine, tryptophan, phenylalanine, isoleucine, leucine, lysine, valine, and methionine. Both essential and nonessential amino acids must be present in the correct quantities for protein synthesis to take place. The major sources of essential amino acids are plant and animal proteins. In general, animal proteins are of higher quality than plant proteins. This is why certain diets contain animal by-product meal(s). Soybean meal contains 44 to 49% crude protein and is often the major source of protein in the poultry diet in the United States. Even with this high concentration, soybean meal does not contain all of the essential amino acids in the correct amounts for a complete poultry ration. In these cases, these “limiting amino acids” need to come from a different source. In poultry diets the first limiting amino acid is methionine. This is why the amount of methionine in the feed is printed on the feed tag of the ration. Certain feed companies use animal protein sources for this methionine, but many others use synthetic methionine instead.

Lipids (Fats and Oils)

Lipids consist of fats, oils, and other fat-soluble substances. Lipids contain 2.25 times the amount of calories by unit weight than carbohydrates or proteins and thus contribute a significant amount of energy to the diet. Fats are lipids that are solid at room temperature, while oils are liquid at room temperature. In general, fats must be heated and liquefied before being added to the diet, whereas oils can be added directly. Lipids consist of long chains of carbon atoms with hydrogen atoms attached at various points, also commonly known as fatty acids. Just as ten of the amino acids are considered essential to a poultry diet, two of these fatty acids are also considered essential and should be added to the feed. These plant-derived fatty acids are linoleic acid and linolenic acid. In addition to the other fatty acids, they play important roles in animal cells to provide structure and integrity to cell membranes. Certain fatty acids assist in hormone synthesis and also maintain fertility and hatchability in poultry that produce hatching eggs. Lipids must also be present in the diet so that fat-soluble vitamins can be absorbed from the intestinal tract and used. These four fat-soluble vitamins are A, D, E, and K. Finally, if needed, the fatty acids act as an additional source of energy.

Vitamins

Vitamins are separated into two groups: fat-soluble vitamins and water-soluble vitamins. The fat-soluble vitamins are A, D, E, and K. These vitamins must be accompanied by lipids to be absorbed into the body from the digestive tract. The water-soluble vitamins are B-complex (thiamine,

riboflavin, niacin, folic acid, biotin, pantothenic acid, pyridoxine, and vitamin B₁₂) and ascorbic acid (vitamin C). Animals are able to store the fat-soluble vitamins in the body for extended periods of time; however, the water-soluble vitamins cannot be stored in this manner. Vitamins do not provide energy, but many of the water-soluble ones assist enzymes that carry out complex, energy-yielding biochemical reactions. Poultry are able to synthesize vitamin C, so they do not need that particular supplement in most cases. Typically, flock owners add vitamin C to a diet to help the birds cope with stressful situations. Complete poultry rations include a vitamin premix which provides the required amount of fat-soluble and water-soluble vitamins.

Minerals

As with vitamins, minerals are sorted into two groups: macrominerals and microminerals. This distinction is made based on the size of the mineral amount that the animal needs; “macro” refers to a large amount, while “micro” designates a small amount. All of these minerals are necessary, and the exclusion or improperly sized allotment of any of them can cause serious metabolic issues. The macrominerals are calcium, phosphorus, sodium, potassium, chloride, magnesium, and sulfur. Diets commonly contain these minerals in concentrations greater than 0.01% or 100 parts per million. Microminerals, sometimes referred to as trace minerals, are typically found in concentrations that are less than 100 parts per million. The microminerals include zinc, manganese, molybdenum, iron, iodine, fluorine, chromium, cobalt, copper, and selenium. Mineral concentrations may differ for poultry of different age groups or designated purposes. An example of this is calcium. For growth and bone formation, calcium is needed in the diet at about 1% (10,000 parts per million). However, the amount of calcium that actively laying hens need for egg production can be as high as 4.5 to 5.0% (45,000 to 50,000 parts per million). These high concentrations can be detrimental to younger birds and males by causing kidney damage. Contrast the need for calcium to the maximum allowable concentration of selenium in the diet, which is 0.00003% (0.3 parts per million). As with vitamins, mineral premixes are added to the poultry ration to meet the animal’s mineral needs.

Feed Additives

In many cases, poultry diets contain other components that are not commonly found in the natural feed ingredients. The animal feed industry refers to these products as “feed additives.” These products are meant to improve the quality of the feed, the animal products, and the animal’s health

and performance. Examples of feed additives include antioxidants, binders, coccidiostats, and occasionally antibiotics. These products have been tested by university researchers as well as governmental agencies and are safe to use in the animals' diets. One of the most common feed additives is a coccidiostat, a chemical that helps to control the protozoan disease known as coccidiosis. Coccidiosis typically affects young birds, so it is common to find a coccidiostat in starter diets.

Additional Considerations for Poultry Nutrition

Grit Supplementation

It is a common belief that oyster shells, large particles of limestone, or "pullet" size limestone are adequate substitutes for grit. This is not true. Limestone and oyster shell are soluble in the upper part of the gastrointestinal tract, namely the proventriculus and gizzard. The reason for this is that both limestone and oyster shell are composed mainly of calcium carbonate (CaCO_3), which is soluble in the highly acidic environment of the upper GI tract. When used as an ingredient in poultry rations, both limestone and oyster shell should be considered only as soluble forms of calcium. Actual grit, made of granite, is not soluble in the upper GI tract. This is the type of grit that should be used if poultry are consuming whole grains, weed seeds, grasses, insects, etc. The grit wedges itself in the grooves of the gizzard and assists in the mechanical digestion of the aforementioned items. Grit usually comes in two sizes, hen and chick. All three types of commercial poultry feed eliminate the need for granite grit because they break down easily in the poultry GI tract.

Separate Feeds for Separate Ages

Because the energy and nutrient requirements vary for birds of different ages and purposes, it is always advisable to purchase a feed that has been formulated specifically for the needs of your flock. Starter, grower, and finisher diets are formulated to contain different amounts of energy, protein, and minerals. For example, a grower or finisher diet typically has lower levels of protein than a starter diet. If either diet is fed to young birds, it cannot provide the amount of protein needed for growth and muscle formation. Conversely, a starter diet does not typically harm older birds, but it causes the owner to lose money because the diet contains more nutrition than is required that will simply be expelled in the birds' feces. Another common mistake is feeding a layer diet to young and growing birds.

As explained above, the high calcium level in the layer diet can damage the kidneys of young and growing birds.

Feeder and Waterer Height

It is best practice to have adequate receptacles for the flock's food and water. They must be the correct shape and height based on the needs of the flock at the time. A general rule is that the lip of the feeder or waterer should be the same height as the shoulder of the bird. Placing the feeders and waterers on the ground for newly hatched chicks is acceptable, but raising the containers as the birds grow prevents food waste.

Feeding Mistakes

As discussed earlier, one of the most common feeding mistakes is to provide the wrong feed for birds of a certain age or purpose. Commercially prepared rations are formulated to contain the correct concentration of energy and nutrients for the specified age or purpose. These feeds should never be blended together. A complete ration should not be diluted with ground or whole grains. Grains are rich in energy, but they do not provide other nutrients in the requisite amounts. Scratch grains are often purchased as a complete ration. The use of either of these methods results in an imbalanced diet. In addition, you should not rely on forage or range to provide the correct nutrition for your flock. The maximum nutrition percentage that a bird can get from range is 15%, but it is frequently much lower. For a flock to produce (either eggs or meat) at its potential, it must have access to a complete ration that suits the flock's age and purpose.

Reference

Subcommittee on Poultry Nutrition, Board on Agriculture, and National Research Council. 1994. *Nutrient Requirements of Poultry*. 9th ed. Washington, D.C.: National Academy Press. <http://www.nap.edu/catalog/2114/nutrient-requirements-of-poultry-ninth-revised-edition-1994>