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EC91-269 Domestic Poultry Feed Formulation Guide

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The authors do not recommend home mixing for the small flock owner. Too many of the essential dietary components are not available in small quantities. Economically, it is usually less expensive to buy commercial feeds — and far more satisfactory.

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INTRODUCTION

This publication provides basic, practical information about nutrition and diet requirements for poultry. The National Research Council's (NRC) "Nutrient Requirements of Poultry,"[1] Eighth Revised Edition, 1984 was the primary source for the bulletin. Nutrient requirements, diet formulations, feed ingredient analyses, and feeding methods are ever changing. Consequently, this publication will be revised periodically to provide the latest recommendations.

Feed cost is the largest single item of expense in producing poultry meat or eggs. On the average, it accounts for 60% of all costs. Poultry producers should adopt a comprehensive feeding program based on sound nutrition principles tailored to a specific production purpose. This publication provides the basis for such a feeding program.

GENERAL INFORMATION

Energy

Use of Dietary Energy

The diagram (Figure 1) illustrates the proportional relationships in the use of energy consumed as a layer diet. Energy is lost or utilized at various stages following intake of the diet by the hen.

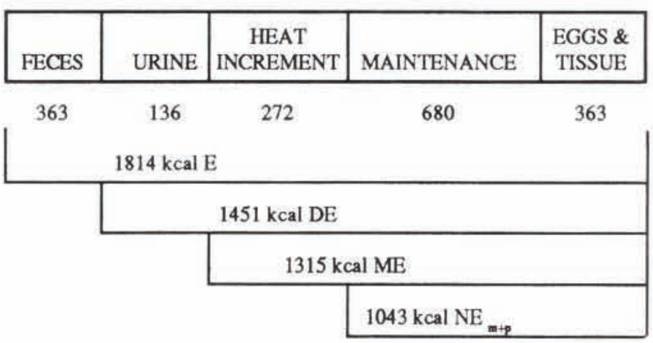

Figure 1. Proportional relationships in use of energy consumed as a layer diet.

Values shown in the diagram indicate that, of 1,814 kcal contained in 1 lb of a particular diet, 1,315 kcal are capable of being metabolized by the hen and about 1,043 kcal are net energy available for maintenance and transfer into body tissue and egg. The relative amounts of both metabolizable and net energy will, of course, vary with the composition of the feedstuffs in the diet. Other factors, such as the species, genetic background, and age as well as the environmental conditions, also influence the precise distribution of dietary energy into the various compartments. Note that nearly all reported values for the metabolizable energy content of feedstuffs have been determined with young chicks. Data are needed for chickens of different ages and for turkeys.

[1]Nutrient Requirmeents of Poultry, c. 1984 by the National Academy of Sciences. Available from the National Academy Press, 2101 Constitution Ave., NW, Washington, DC. 20418. Toll Free 1-800-624-6242. Prepaid $10.25.

Requirements

Poultry tend to eat to satisfy their energy requirements if fed *ad libitum*. It is possible, within limits, to regulate the intake of all nutrients, except water, by including them in the diet in specific ratio to the amount of available energy in the diet. The importance of considering the energy content of the diet to promote the desired intake of all nutrients is obvious.

An absolute requirement for energy in terms of kilocalories per pound of diet (kcal/lb) cannot be stated because poultry adjust their feed intake to obtain their necessary daily requirement. Chickens fed low-energy diets of about 1,179 kcal/lb have been recorded as eating as much as 30% more than similar birds fed diets containing 1,451 kcal/lb. Thus, in comparison to high energy diets, low to moderate energy levels allow birds to eat more and consume greater amounts of nutrients unless lesser concentrations of nutrients are used. If a higher concentration of energy is used in a diet, feed consumption will be reduced. Dietary concentrations of nutrients should be increased in proportion to dietary energy to assure ingestion of the required amounts. Diets with higher concentrations of energy are usually more efficiently utilized in terms of unit amount of gain per unit amount of feed consumed. High-density, high energy diets may result in consumption of excess energy because the decline in feed intake is not directly proportional to the increase in the energy density of the diet. The bulk (volume per unit weight) of a diet may also limit the quantity of nutrients that can be ingested per day. Pelleting of a bulky diet will increase the nutrient density per unit volume of diet and enable the consumption of more nutrients. The addition of fat to a diet increases the energy concentration and decreases the bulk density of the diet.

Feed intake is controlled by certain areas of the brain believed to regulate the fill capacity of the crop and small intestine as well as their emptying rate. Thus, gastrointestinal fill influences the areas of the brain controlling feed intake. Essential amino acids may influence feed intake either through their concentrations in blood coursing through the brain, where they influence other brain receptors, or by influencing the metabolism of amino acids in the liver. Deficiencies or excesses of certain essential amino acids cause feed intake to decline by influencing the areas of the brain controlling feed intake. Forced feeding of diets deficient in those amino acids will increase weight gain compared with that when chicks are fed the same diets *ad libitum*. There is controversy over whether glucose levels in the blood have any effect on regulating feed intake.

Environmental temperature has a marked influence on energy requirement and on feed intake. The warmer the environment, the lower the feed consumption. Feed consumption will decrease about 0.9 to 1.0% for each rise of 1°F above the high end of the thermoneutral zone (about 75°F). Conversely, colder temperatures (below 61°F) cause increases in feed consumption. Diets marginal in a particular nutrient may perform better under colder environments because the birds eat more than at higher temperature and thus consume enough of the marginal nutrient. The necessary concentrations of nutrients in a diet are related to the environmental temperature to which the birds eating the diet are exposed.

Other variable factors affecting dietary requirements for energy, in addition to those of nutritional balance, temperature, and the physical form of the feed, are stress, body size, feather coverage, and rate of growth or egg production. Poultry, through genetic inheritance and environmental circumstances, have a certain potential for performance. The level of dietary energy and the associated nutrient balance should facilitate this potential. Under practical conditions economic considerations may place some limitation on the level of nutritional efficiency achieved.

Energy Values in Tables

To establish a base for the nutrient requirements of poultry, some assumptions were made. It was assumed that the environmental temperatures to which poultry of various species and ages are exposed are ideal, or approach the optimum, for efficient growth and production. On this basis NRC established a practical dietary level of energy for each species and age of poultry and nutrient requirements were determined relative to a diet containing this amount of energy.

The ME values heading the lists of nutrient requirements in the tables should not be regarded as energy requirements. They were chosen as bases for the requirements of the other listed nutrients and represent dietary energy concentrations reasonable under practical conditions of feed formulation and poultry management.

Protein and Amino Acids

Requirements

The dietary requirement for protein is actually a requirement for the amino acids contained in the protein. It is only in the form of the constituent amino acids that protein is absorbed from the intestine. Some of the amino acids are essential in that they have to be provided by the dietary protein or as dietary supplements. Some amino acids can be produced within the body of the bird by the transformation of other amino acids. Protein requirements have two components: (1) the essential amino acids needed by the bird because it cannot synthesize them, or synthesize them rapidly enough, and (2) sufficient protein to supply either the nonessential amino acids themselves or to supply amino nitrogen for their synthesis. A statement of dietary protein concentration thus provides a convenient means of describing diets and serves as a basis for feed control regulations.

Factors affecting daily feed consumption were discussed in the Energy section. The influence of dietary energy on feed consumption is the major factor for consideration at moderate environmental temperatures. A somewhat low protein intake may, however, raise feed consumption. These relationships have stimulated interest in alternatives to dietary concentration as a way to express protein and amino acid requirements.

More research is needed in the general area of amino acid requirements. Currently stated requirements have no reference to environmental conditions. It may generally be assumed that the listed requirements are for a moderate climate (61-75°F). Percentage requirements should probably be raised or lowered respectively in warmer or colder environments in accordance with expected differences in feed or energy intakes. Such adjustments might aid in assuring the required daily intake of amino acids. The amino acid concentrations presented as requirements are intended to promote maximum growth and production. Maximum economic returns may not, however, always be consonant with maximum growth and production, particularly when protein prices are high. The dietary concentrations may, accordingly, be somewhat reduced, lowering growth rate to some degree, but maintaining economic return.

Amino acid requirements for layers are presented as percent of diet and on a daily intake basis. The latter provides a means of adjusting amino acids to varying feed intake, especially as modified by environmental temperature or dietary energy concentration. To make effective use of the daily amino acid intake concept, actual feed intake should be measured.

The productive state of the bird, i.e., rate of growth or egg production, determines amino acid requirements. The turkey poults and chicken broiler have high amino acid requirements per day to meet the requirements for rapid growth. The mature cockerel has a very low requirement compared to the laying hen, even though body size is actually greater and feed consumption similar.

The genetic constitution of the bird determines body size, growth rate, and egg production. Nutrient requirements, therefore, differ among breeds and strains. Genetic differences in nutrient requirements may also occur because of differences in the efficiency of digestion, nutrient absorption, and metabolism of absorbed nutrients.

Dietary protein concentration can affect the requirements for individual essential amino acids. The balance among the essential amino acids, as well as the balance between the concentrations of essential and nonessential amino acids, should be maintained. The maintenance of these optimum balances is important for the efficient utilization of dietary protein. It is desirable to meet the requirements for all the amino acids as closely as possible with avoidance of excesses of protein or of individual amino acids.

Specific Amino Acid Relationships

Methionine-Cystine. Requirement for methionine can be met only by methionine. The requirement for cystine can be met by cystine or methionine. Methionine readily undergoes metabolic conversion to cystine, whereas the reverse is not possible. If sulfate is deficient in the diet, a portion of the cystine that would normally be converted to sulfate may be spared by the addition of sulfates to the diet (e.g. sodium or potassium sulfate).

Phenylalanine-Tyrosine. The requirement for phenylalanine can be met only by phenylalanine. The requirement for tyrosine can be met by tyrosine or phenylalanine.

Glycine-Serine. Glycine and serine can be used interchangeably in poultry diets. Usually when the overall protein requirement is met the amounts of glycine and/or serine are adequate.

Antagonism and Imbalance. The influence of protein on amino acid requirements may be due to interactions among specific amino acids or groups of amino acids. Some interactions, commonly referred to as antagonisms, occur among amino acids that are structurally related, e.g., leucine-isoleucine-valine and lysine-arginine. Increasing the dietary level of one or two of a group may increase the requirement for another from the same group.

Other interactions, referred to as imbalances, occur when diets are supplemented with the second-limiting amino acid, or all essential amino acids except the limiting amino acid. In some instances (e.g. threonine imbalance), several amino acids, individually or as groups, also may cause increased need for the limiting amino acid. Antagonisms appear to have a metabolic basis in which the amino acid(s) present in excess interfere with the retention of the amino acid(s) of the group. Imbalances cause the blood level of the limiting amino acid to decrease without affecting its overall retention. This results in reduced food intake, the major cause of reduced performance. In supplementing diets with limiting amino acids, it is important to supplement first with the most-limiting one, followed by the second-most-limiting one. Inadvertent oversupplementation with only the second-most-limiting amino acid may create an imbalance and accentuate the primary deficiency.

Conversion of Animo Acids to Vitamins

Methionine may partly compensate for deficiencies of choline or vitamin B_{12} by providing needed methyl groups. Tryptophan may alleviate a niacin deficiency through metabolic conversion to niacin. Reliance on these conversions is, however, unwise, both nutritionally and economically.

Amino Acid Availability

When diets are formulated on the basis of feed analysis data, the assumption is generally made that amino acids are 80-90% available from the feedstuff protein. This assumption is not necessarily valid. Native proteins vary markedly in their digestibility. Processing of feedstuffs may improve digestibility. For example, the digestibility of feather protein (keratin) is improved during the manufacture of feather meal. Heat treatment of soybean inactivates compounds that interfere with trypsin digestion of protein in the intestine, thereby improving the availability of amino acids to the bird. Processing may, if not carried out with careful control, reduce digestibility of the product. Overheating during the drying of bloodmeal, meat scrap, and fish or fishwaste can seriously lower digestibility and the availability of specific amino acids (of which lysine is probably the most critical under practical conditions of feed formulation).

Fats

Fats are important ingredients in poultry diets, and although used primarily to supply energy, fats also improve the physical consistency of diets, dispersion of microingredients, and dust control in feed mixtures. Fats used for feeding poultry are of three general sources: animal or poultry fats obtained from the rendering industry, restaurant greases, acidulated soapstocks from the vegetable oil industry, and/or mixtures thereof. Definitions of these fats are presented in the Official Publication of the Association of American Feed Control Officials (AAFCO) available from the Department of Agriculture, Charleston, WV 25305. Quality characteristics of fats that may affect their nutritional value or safety of use are important. Characteristics of fats used to assess nutritional values include moisture, impurities, unsaponifiables, free fatty acids, total fatty acids, and fatty acid composition. Fats for poultry feed should be stabilized against oxidation. Concentrations of undesirable residues (e.g., chlorinated hydrocarbons) in fats used in poultry feeds must not exceed the limits established by state and federal agencies.

Some uncertainty exists about the true contribution of certain fats to the ME of poultry diets. Fatty acid composition of the fat, free fatty acid content of the fat, level of fat inclusion in the diet, ingredient composition of the diet, and age of poultry may influence the ME contribution of fats.

Fats often increase the utilization of dietary energy by poultry in excess of the increase expected when the ME of the fat is added to the ME values of the other dietary constituents. Supplemental fats may increase energy utilization in adult chickens in association with a decreased rate of food passage through the gastrointestinal tract. Furthermore, because the heat increment of feeding fats is less per unit weight than that of carbohydrates, the substitution of fat for a portion of the dietary carbohydrates may enhance energy utilization by reducing the heat increment of feeding.

The fatty acid composition of body fat and egg fat may be altered by dietary fats. This is especially true when substantial levels of unsaturated fats such as corn oil or sunflower oil are used. In these instances, the fatty acid composition of body fat and/or egg fat tends to reflect that of the dietary unsaturated fat. Feeding saturated fats following the feeding of unsaturated fats will cause the body or egg fat to become more saturated.

Minerals

Minerals are required for formation of the skeleton, as components of various compounds with particular functions within the body, as activators of enzymes, and for the maintenance of necessary osmotic relationships within the bird's body. Calcium and phosphorus are essential for the formation and maintenance of the skeletal structure. Sodium, potassium, magnesium, and chloride function with phosphates and bicarbonate to maintain homeostasis of osmotic relationships and pH throughout the body. Most of the calcium in the diet of the growing bird is used for bone formation, whereas in the mature laying fowl most dietary calcium is used for egg shell formation. Other functions of calcium include roles in blood clotting and neuromuscular function. An excess of dietary calcium interferes with availability of other minerals such as magnesium, manganese, and zinc. High concentrations of calcium carbonate (limestone) and calcium phosphates in the diet may make the diet unpalatable. The calcium requirement of the laying hen is difficult to define. The listed requirement of 3.4% is believed to represent the mean dietary concentration for the quantities of feed likely to be consumed (110 grams per hen per day) over a considerable range of environmental temperature. The biological availability of calcium is high from most commonly used supplements.

Phosphorus, in addition to its function in bone formation, is also required in the metabolism of carbohydrates and fats and is a component of all living cells. It is important that sufficient phosphorus be provided in available form. Only 30 to 40% of the phosphorus in plant products is nonphytin phosphorus and considered to be available to poultry. There is disagreement concerning the ability of poultry to utilize phytin phosphorus. Most data, however, indicate that the utilization of phytin phosphorus, by young or adult poultry, is negligible if dietary calcium concentrations are sufficient to meet the birds' requirements. There may be breed differences in this regard. The biological availability of the phosphorus in inorganic phosphorus supplements may vary.

Sodium and chloride are essential for all animals. Dietary concentrations of salt generally employed are those that will just support maximum growth rate or egg production. Higher concentrations lead to excessive consumption of water and attendant problems with ventilation and wet droppings.

Dietary proportions of sodium, potassium, and chlorine are important determinants of acid-base balance. The appropriate balance of these electrolytes is based on sodium and potassium versus chlorine, where each element is expressed in milliequivalents per unit of diet. Experiments show that sodium and potassium are alkalogenic (have an alkaline-producing effect), whereas chlorine is acidogenic (has an acid-producing effect). Chloride tends to decrease blood pH and bicarbonate concentration, whereas sodium and potassium tend to increase blood pH and bicarbonate concentration. The proper dietary balance of sodium, potassium, and chlorine is necessary for growth, bone development, egg shell quality, and amino acid utilization.

Some mineral elements are required in very small amounts. The requirements are often met from concentrations naturally present in feeds. Soils vary, however, in their content of trace minerals. As a consequence, feedstuffs grown in some geographic areas may be marginal or deficient in some elements. Thus, poultry diets may require supplementation to ensure adequate intake of trace minerals. Interactions occur between various minerals (e.g., copper and molybdenum, selenium and mercury, calcium and zinc, or calcium and manganese). Excessive concentrations of an element may result in a deficiency in the amount available to the bird of some other element. Dietary supplementation with trace elements should be undertaken with great care and consideration for the possible interactions. Mineral salts used as feed supplements are not usually pure compounds but contain variable amounts of other minerals.

Table 1. Example trace mineral and selenium premixes.

Mineral	Trace mineral pmx units/lb of pmx	Selenium pmx units/lb of pmx
$CaCO_3$ Carrier (% Ca)	14	37
Zinc (mg)	45,400	---
Manganese (mg)	54,480	---
Iron (mg)	34,050	---
Copper (mg)	4,540	---
Iodine (mg)	1,135	---
Selenium (mg)	---	908

A mineral premix may be formulated that contains the mineral elements normally needed to supplement those not present in large enough quantities in normal feedstuffs. The mineral premix can then be used as any other ingredient in feed formulation. Two mineral premixes were used in the example diets. The mineral concentrations they provided are shown in Table 1.

Vitamins

Vitamins are generally classified under two headings: fat-soluble vitamins A, D, E, and K and water-soluble vitamins, which include the so-called B-complex vitamins and vitamin C (ascorbic acid). Vitamin C is synthesized by poultry and is, accordingly, not considered a required dietary nutrient. There is some evidence, nevertheless, of a favorable response to vitamin C by birds under stress.

Requirements for most vitamins are given in terms of milligrams per pound or kilogram of diet. Exceptions are vitamins A, D, E, and K, for which the requirements are commonly stated in units. Units are used to express the requirements for these vitamins because different forms of the vitamins have different biological activities.

Requirements for some of the vitamins may be met by the amounts occurring as natural components of the customary feedstuffs used in compounding diets. When the conventional feedstuffs are not available, however, the products used in substitution may not supply sufficient amounts of the various vitamins. Formulators of poultry feeds should be alert to the need for dietary supplementation with vitamins usually assumed to be supplied by the feedstuffs.

Requirements for the water-soluble vitamins are interrelated in some instances. They are also dependent upon the nature of the diet. The type of carbohydrate, protein concentration, and amino acid balance are major factors determining the dietary requirements for several vitamins.

Vitamin premixes also may be formulated to supplement those vitamins not present in large enough quantities in normal feedstuffs. Two vitamin premixes were used in the example diets. The vitamin concentrations they provided are shown in Table 2.

Table 2. Example vitamin premixes.

Vitamins	Pmx TC-90 units/lb of pmx	Pmx LB-90 uniits/lb of pmx
Soybn Ml carrier (% prot)	45	45
A (IU)	510,750	510,750
D (ICU)	200,000	164,000
E (IU)	524	---
K (IU)	150	---
B_{12} (μg)	500	790
Choline (mg)	40,000	45,000
Riboflavin (mg)	299	495
Biotin (mg)	5	---
Folacin (mg)	30	---
Pantothenic Acid (mg)	545	844
Niacin (mg)	3482	---

Water

Water must be regarded as an essential nutrient, although it is not possible to state precise requirements. The amount needed will depend upon environmental temperature and relative humidity, the composition of the diet, rate of egg production, and efficiency of kidney resorption of water in individual birds. Generally birds drink about twice as much water as the amount of feed consumed on a weight basis.

Figures given for water consumption in Table 3 are for temperatures of about 70°F except for brooding chicks and poults. With broilers, consumption will increase about 12% for each 1°F above 70°F. Laying hens may consume from 40 to 80 gal (150 to 300 liters)/day/1,000 birds, depending upon temperature. Survival under extremely hot conditions is influenced by the ability to consume large quantities of water, or more precisely, the ability to lose water from the respiratory surfaces of the body. This ability varies from strain to strain.

Water restoration, after extended periods (36 to 40 hours) of water deprivation, may cause a "drunken syndrome" or "water intoxication," leading to death in young turkeys.

The salt content and pH of water may influence the use of the drinking water as an administration route for vitamins and drugs. Turkeys are known to detect very minor differences in the flavor of medicated water and may accept drugs in one water supply but not in another.

Intermittent provision of water is sometimes used to reduce the water content of the droppings and to control feed intake in laying hens. Because birds differ in their ability to conserve body water by increasing kidney resorption, there is a danger of causing dehydration of some birds by practicing water restriction of a flock.

Some water supplies contain considerable concentrations of sulfur or sulfates, nitrates, and various trace minerals. These are usually readily absorbed from the intestine and may be either useful or harmful to the bird.

The National Research Council (1974) suggests the following guidelines for the suitability for poultry of water with different concentrations of total dissolved solids (TDS).

TDS (ppm)	Comments
Less than 1,000	These waters should present no serious burden to any class of poultry.
1,000-2,999	These waters should be satisfactory for all classes of poultry. They may cause watery droppings (especially at the higher levels) but should not affect health or performance.
3,000-4,999	These are poor waters for poultry, often causing watery droppings, increased mortality, and decreased growth (especially in turkeys).
5,000-6,999	These are not acceptable waters for poultry and almost always cause some type of problem, especially at the upper limits, where reduced growth and production or increased mortality probably will occur.
7,000-10,000	These waters are unfit for poultry but may be suitable for other livestock.
Over 10,000	Should not be used for any livestock or poultry.

Table 3. Daily water consumption[a] by chickens and turkeys of different ages.

	per 1,000 birds					
	Chicken Broilers[b]		Leghorn-type Pullets		Turkeys[b]	
Age (week)	Liters	Gallons (U.S.)	Liters	Gallons (U.S.)	Liters	Gallons (U.S.)
1	20	5	19	5	38	10
2	50	13	38	10	76	20
3	90	24	45	12	114	30
4	140	37	64	17	151	40
5	200	53	83	22	189	50
6	260	69	95	25	227	60
7	320	85	106	28	284	75
8	380	100	114	30	360	95
9			132	35	435	115
10			144	38	473	125
12			151	40	568	150
15			158	42	606	160
20			170	45	757	200
			Laying or Breeding			
35			189	50	M 908	240
					F492	130

[a] Will vary considerably depending on temperature and diet composition.
[b] Mixed sexes.

Xanthophyll

Xanthophylls constitute a group of naturally occurring oxycarotenoid pigments responsible for the yellow coloration in egg yolks, the shanks and feet of birds, and the yellow in the fat and skin of poultry. Although the various xanthophyll pigments occur widely in natural plant products, only a few of the natural products used in poultry feeds contain quantities sufficient to affect egg yolk and carcass color. Alfalfa meal, yellow corn, and corn gluten meal are the major sources of xanthophyll pigments in poultry diets.

The term xanthophyll is a generic term frequently applied to the entire group of oxycarotenoids. Individual xanthophylls differ, however, in their ability to impart color. Alfalfa meal contains several types, but the one of greatest abundance and importance is lutein, which tends to impart a yellow color, while corn and corn gluten meal contain primarily zeaxanthin, which tends to impart an orange-red color.

Xanthophylls are unstable and may deteriorate as a result of oxidation during the storage of feedstuffs. The addition of antioxidant offers some protection against storage losses.

The total xanthophyll concentrations found in a few feedstuffs that are rich in these pigments are listed in Table 4. The xanthophylls in algae and marigold petals promote a different shade of color than those in corn and alfalfa. The absorption of xanthophylls from the feed is reduced when birds suffer from coccidiosis and certain other diseases. As a result, reduction in the coloration of shanks and skin is often associated with these diseases.

Unidentified Factors

There are numerous reports of favorable responses to the dietary inclusion of natural products that have not been identified with any of the known nutrients. Stimulation of growth, increased egg production and hatchability, reduced liver fat, improved product quality, and reduced toxicity of minerals have been stated as evidence for the presence of unidentified factors in diverse products such as egg yolk, whey, yeast, fish and meat by-products, soybeans, corn, green forages, and fermentation by-products. Some responses, originally attributed to unidentified factors, have subsequently been shown to be the result of trace minerals. The complexity of optimum dietary balance among the minerals, and the evidence for the essentiality of some of the "newer" trace elements, suggest that components of natural products may, directly or indirectly, be factors associated with the mineral nutrition of poultry.

Table 4. Xanthophyll-rich feedstuffs.

Feedstuffs	Xanthophylls (mg/lb)
Alfalfa meal, 17% protein	118
Alfalfa meal, 20% protein	127
Alfalfa meal, 22% protein	150
Alfalfa juice protein, 40% protein	363
Algae, common, dried	909
Corn, yellow	7.73
Corn gluten meal, 41% protein	80
Corn gluten meal, 60% protein	132
Marigold petal meal	3,182

Antibiotics

Some antibiotics, although not nutrients in the sense that they are required by poultry, stimulate growth and improve efficiency of feed conversion under most conditions when added to the diet at low concentrations (usually 1 to 10 mg/kg of diet and sometimes as high as 50 mg for young birds, depending on the antibiotic). They are, accordingly, classified as additives and as growth promoters. Egg production is also frequently improved by dietary supplementation with antibiotics. It is not clearly understood why antibiotics stimulate growth and under what conditions they may do so. Since antibiotics do not stimulate growth under germ-free conditions, it is likely that stimulus to growth results from either suppression of microorganisms with adverse effects or encouragement of others with desirable effects. The intestinal wall is known to be thinner when antibiotics are fed to chicks.

There is some concern that feeding of low concentrations of antibiotics may favor proliferation of antibiotic-resistant microorganisms with serious consequences when antibiotics are required for disease control in either man or domestic animals. There is, however, no evidence that low-level antibiotic feeding constitutes a public health hazard (National Research Council, 1980). Constraints on the use of particular antibiotics permitted for use in poultry feeds vary among countries and are subject to change.

Detailed information on specific antimicrobial agents, levels of usage, and legal requirements for use may be found in the Feed Additive Compendium published each year by the Miller Publishing company, 2501 Wayzata Boulevard, Minneapolis, MN 55440.

NUTRIENT REQUIREMENTS OF CHICKENS

Chickens vary greatly according to the purpose for which they have been developed. Those intended for the production of eggs for human consumption (Leghorn-type) have a small body size and are prolific layers, whereas those used as broilers or broiler-breeders have rapid growth rates, large body size, and are less efficient egg layers. Methods of feeding differ for the two kinds of chickens.

Leghorn-type chickens are generally fed *ad libitum* during the growing and laying periods. Broilers also are fed *ad libitum* to ensure rapid development to market size. Broiler breeders, however, are maintained for hatching egg production. Since they tend to become obese, feed intake is usually restricted. Feeding schedules that allow the desired levels of restriction are available for broiler-breeders of different genetic stocks. Low-protein and/or amino-acid-imbalanced diets fed *ad libitum* will also retard pullet growth and development.

Restricted feeding of Leghorn-type pullets is seldom practiced during the growing period because restriction of lighting effectively controls feed consumption and sexual development. Feeding programs for Leghorn-type pullets and hens may be modified after maximum rate of egg production has been attained. Occasionally, laying hens will consume excess feed during the latter phases of egg production with resultant obesity. Feed efficiency is reduced and the incidence of fatty liver syndrome is increased under these conditions. Limiting feed intake to 90 to 95% of full feed consumption seems desirable when overconsumption of energy is a problem. Data on feed consumption in individual flocks, together with information on body weight, ambient temperature, and rate of egg production, may be used to determine the desired degree of feed restriction.

There has been a trend to "phase-feed" laying hens to adjust nutrient intake in accordance with the changing nutritional needs of hens as the rate of egg production declines during the laying year. Although phase feeding has been used with apparent success commercially, there is insufficient experimental data to serve as a basis for phase-feeding recommendations.

After 8 to 12 months of egg production, some flocks of hens are molted as a means of recycling hens for another period of production. A combination of feed and light restriction is used to stop egg production and induce molt. The hens are "rested" for up to 4 to 6 weeks. Upon refeeding, and increasing the hours of light, the birds are stimulated to resume egg production.

Nutrient requirements of Leghorn-type laying hens are shown in Table 5 in terms of dietary concentration and on a daily intake basis. Because hens eat primarily to satisfy their

Table 5. Nutrient requirements of Leghorn-type chickens as percentages or as milligrams or units per pound of diet.

		Growing			Laying		Breeding
Energy base kcal ME/lb diet[a]	→	0-6 Weeks 1,318	6-14 Weeks 1,318	14-20 Weeks 1,318	1,318	Daily intake per hen (mg)[b]	1,318
Protein	%	18	15	12	14.5	16,000	14.5
Arginine	%	1.00	0.83	0.67	0.68	750	0.68
Glycine and serine	%	0.70	0.58	0.47	0.50	550	0.50
Histidine	%	0.26	0.22	0.17	0.16	180	0.16
Isoleucine	%	0.60	0.50	0.40	0.50	550	0.50
Leucine	%	1.00	0.83	0.67	0.73	800	0.73
Lysine	%	0.85	0.60	0.45	0.64	700	0.64
Methionine + cystine	%	0.60	0.50	0.40	0.55	600	0.55
Methionine	%	0.30	0.25	0.20	0.32	350	0.32
Phenylalanine + tyrosine	%	1.00	0.83	0.67	0.80	880	0.80
Phenylalanine	%	0.54	0.45	0.36	0.40	440	0.40
Threonine	%	0.68	0.57	0.37	0.45	500	0.45
Tryptophan	%	0.17	0.14	0.11	0.14	150	0.14
Valine	%	0.62	0.52	0.41	0.55	600	0.55
Linoleic acid	%	1.00	1.00	1.00	1.00	1,100	1.00
Calcium	%	0.80	0.70	0.60	3.40	3,750	3.40
Phosphorus, available	%	0.40	0.35	0.30	0.32	350	0.32
Potassium	%	0.40	0.30	0.25	0.15	165	0.15
Sodium	%	0.15	0.15	0.15	0.15	165	0.15
Chlorine	%	0.15	0.12	0.12	0.15	165	0.15
Magnesium	%	0.06	0.05	0.04	0.05	55	0.05
Manganese	mg	27.27	13.64	13.64	13.64	3.30	27.27
Zinc	mg	18.18	15.91	15.91	22.73	5.50	29.55
Iron	mg	36.36	27.27	27.27	22.73	5.50	27.27
Copper	mg	3.636	2.727	2.727	2.727	0.88	3.636
Iodine	mg	0.1591	0.1591	0.1591	13.64	0.03	13.64
Selenium	mg	0.0682	0.0454	0.454	0.0454	0.01	0.0454
Vitamin A	IU	682	682	682	1818	440	1818
Vitamin D	ICU	90.91	90.91	90.91	227	55	227
Vitamin E	IU	4.545	2.273	2.273	2.273	0.55	4.545
Vitamin K	mg	0.2273	0.2273	0.2273	0.2273	0.055	0.2273
Riboflavin	mg	1.636	0.8182	0.8182	1	0.242	1.727
Pantothenic acid	mg	4.545	4.545	4.545	1	0.242	4.545
Niacin	mg	12.27	5	5	4.545	1.10	4.545
Vitamin B_{12}	μg	4.091	1.364	1.364	1.818	0.00044	1.818
Choline	mg	591	409	227	?	?	?
Biotin	mg	0.0682	0.454	0.454	0.454	0.011	0.682
Folacin	mg	0.25	0.1136	0.1136	0.1136	0.0275	0.1591
Thiamin	mg	0.8182	0.5909	0.5909	0.3636	0.088	0.3636
Pyridoxine	mg	1.364	1.364	1.364	1.364	0.33	2.045

a These are typical dietary energy concentrations.

b Assumes an average daily intake of 110 g (.242 lb) of feed/hen daily.

energy needs, it is important to relate dietary metabolizable energy concentrations to energy requirements. Energy requirements of hens at different ambient temperatures may vary substantially. Absolute requirements for protein, amino acids, vitamins, and minerals are, on the other hand, little affected by temperature. Tables 6-11, respectively, show body weights and feed requirements of Leghorn-type pullets and hens, nutrient requirements of broilers, body weights and feed requirements of broilers, nutrient requirements of meat-type hens, body weights and feed allowances for male and female meat-type chickens, and metabolizable energy, required daily by chickens.

Table 6. Body weights and feed requirements of Leghorn-type pullets and hens.

Age (weeks)	Body weight[a] (lb)	Feed consumption[b] (g/week)	Typical egg production (hen-day %)
0	.077	.099	-
2	.297	.198	-
4	.595	.396	-
6	.991	.573	-
8	1.37	.714	-
10	1.74	.848	-
12	2.09	.947	-
14	2.33	1.01	-
16	2.56	1.01	-
18	2.78	1.01	-
20	3.00	1.01	-
22	3.14	1.16	10
24	3.30	1.31	38
26	3.47	1.46	64
30	3.80	1.70	88
40	4.00	1.70	80
50	4.12	1.69	74
60	4.19	1.66	68
70	4.19	1.63	62

a Pullets and hens of Leghorn-type strains are generally fed *ad libitum* but are occasionally control-fed to limit body weights. Values shown are typical but will vary with strain differences, season, and lighting. Specific breeder guidelines should be consulted for desired schedules of weights and feed consumption.

b Based on diets containing 1,318 ME kcal/lb. Consumption will vary depending upon the caloric density of the diet, environmental temperature, and rate of production (see Table 11).

Table 7. Nutrient requirements of broilers as percentages or as milligrams or units per pound of diet.

Energy base kcal/ME/lb diet[a]	→	Weeks 0-3 1,454	Weeks 3-6 1,454	Weeks 6-8 1,454
Protein	%	23.0	20.0	18.0
Arginine	%	1.44	1.20	1.00
Glycine + serine	%	1.50	1.00	0.70
Histidine	%	0.35	0.30	0.26
Isoleucine	%	0.80	0.70	0.60
Leucine	%	1.35	1.18	1.00
Lysine	%	1.20	1.00	0.85
Methionine + cystine	%	0.93	0.72	0.60
Methionine	%	0.50	0.38	0.32
Phenylalanine + tyrosine	%	1.34	1.17	1.00
Phenylalanine	%	0.72	0.63	0.54
Threonine	%	0.80	0.74	0.68
Tryptophan	%	0.23	0.18	0.17
Valine	%	0.82	0.72	0.62
Linoleic acid	%	1.00	1.00	1.00
Calcium	%	1.00	0.90	0.80
Phosphorus, available	%	0.45	0.40	0.35
Potassium	%	0.40	0.35	0.30
Sodium	%	0.15	0.15	0.15
Chlorine	%	0.15	0.15	0.15
Magnesium	%	0.06	0.06	0.06
Manganese	mg	27.27	27.27	27.27
Zinc	mg	18.18	18.18	18.18
Iron	mg	36.36	36.36	36.36
Copper	mg	3.636	3.636	3.636
Iodine	mg	0.1591	0.1591	0.1591
Selenium	mg	0.0682	0.0682	0.0682
Vitamin A	IU	682	682	682
Vitamin D	ICU	90.91	90.91	90.91
Vitamin E	IU	4.545	4.545	4.545
Vitamin K	mg	0.2273	0.2273	0.2273
Riboflavin	mg	1.636	1.636	1.636
Pantothenic acid	mg	4.545	4.545	4.545
Niacin	mg	12.27	12.27	5
Vitamin B_{12}	µg	4.091	4.091	1.364
Choline	mg	591	386	227
Biotin	mg	0.0682	0.0682	0.0454
Folacin	mg	0.25	0.25	0.1136
Thiamin	mg	0.8182	0.8182	0.8182
Pyridoxine	mg	1.364	1.364	1.136

[a] These are typical dietary energy concentrations.

Table 8. Body weights and feed requirements of broilers[a].

Age (weeks)	Body weights (lb) M	Body weights (lb) F	Weekly feed Consumption (lb) M	Weekly feed Consumption (lb) F	Cumulative feed consumption (lb) M	Cumulative feed consumption (lb) F	Weekly energy consumption (ME kcal/bird) M	Weekly energy consumption (ME kcal/bird) F	Cumulative energy consumption (ME kcal/bird) M	Cumulative energy consumption (ME kcal/bird) F
1	.286	.264	.264	.242	.264	.242	385	350	385	350
2	.705	.661	.573	.529	.837	.771	830	770	1,215	1,120
3	1.23	1.13	.859	.782	1.70	1.55	1,250	1,135	2,465	2,255
4	1.89	1.74	1.18	1.10	2.87	2.65	1,710	1,600	4,175	3,855
5	2.75	2.44	1.63	1.42	4.50	4.07	2,370	2,065	6,545	5,920
6	3.72	3.15	2.16	1.76	6.66	5.84	3,135	2,560	9,680	8,480
7	4.62	3.84	2.41	2.00	9.07	7.84	3,505	2,910	13,185	11,390
8	5.55	4.54	2.67	2.14	11.74	9.98	3,870	3,105	17,055	14,495
9	6.44	5.18	2.91	2.22	14.65	12.20	4,225	3,230	21,280	17,725

aTypical for broilers fed well-balanced diets containing 1,454 ME kcal/lb.

Table 9. Nutrient requirements of meat-type hens for breeding purposes[a].

Energy base kcal ME/kg diet		→ 2,850[b]	Daily intake per hen (mg)
Protein	%	14.522,000	
Arginine	%	0.74	1,110
Glycine + serine	%	0.62	932
Histidine	%	0.14	205
Isoleucine	%	0.57	850
Leucine	%	0.83	1,250
Lysine	%	0.51	765
Methionine + cystine	%	0.55	820
Methionine	%	0.35	520
Phenylalanine + tyrosine	%	0.75	1,112
Phenylalanine	%	0.41	610
Threonine	%	0.48	720
Tryptophan	%	0.13	190
Valine	%	0.63	950
Calcium	%	2.75	4,125
Phosphorus, available	%	0.25	375
Sodium	%	0.10	150

[a] Diets are generally fed on a limited intake basis to control body weight gains. Adjust quantity of feed offered based on desired body weights and egg production levels for specific breed or strain.
[b] Diets for laying hens generally are fed to provide daily energy intakes of 375 to 450 ME kcal/day based on body weight, environmental temperature, and rate of egg production. Percentage of nutrients shown is typical of hens given 425 ME kcal/day.

NUTRIENT REQUIREMENTS OF TURKEYS

There are two distinct areas of emphasis in the feeding of turkeys. The more common is feeding for market turkey production. Of great importance, however, is the feeding of breeder stock.

Table 11. Metabolizable energy required daily by chickens in relation to body weight and egg production[a].

	Rate of egg production (%)					
Body weight (kg)	0	50	60	70	80	90
	Metabolizable energy/hen daily (kcal)[b]					
1.0	130	192	205	217	229	242
1.5	177	239	251	264	276	289
2.0	218	280	292	305	317	330
2.5	259	321	333	346	358	371
3.0	296	358	370	383	395	408
3.5	333	395	408	420	432	445

[a] A number of formulas have been suggested for prediction of the daily energy requirements of chickens. The formula used here was derived from that in *Effect of Environment on Nutrient Requirements of Domestic Animals* (NRC, 1981).

$$ME/hen\ daily = W^{0.75}(173 - 1.95T) + 5.5\Delta W + 2.07EE$$

where:
- W = body weight (kg),
- T = ambient temperature (°C),
- ΔW = change in body weight in g/day, and
- EE = daily egg mass (g).

[b] Temperature of 22°, egg weight of 60 g, and no change in body weight were used in calculations.

For market turkey production most turkeys are of the large type. The usual marketing age of male (tom) turkeys is 17 to 23 weeks at live weights of 23 to 35 lb. Those of the younger age are often sold as oven-ready dressed birds; those of the older age are generally used either for further processing or for the restaurant trade. Female (hen) turkeys are frequently marketed at 14 to 15 weeks of age at live weights of about 14.5 lb. Medium and small turkeys (roaster-fryers) are often sold at younger ages and lighter live weights. Usual live body weights for these birds are about 10 lb.

Table 10. Typical body weights and feed allowances for male and female meat-type chickens (replacement stock)[a].

Age (weeks)	Male body weight[b] (lb)	Male feed consumption[c] (lb/week)	Female body weight[b] (lb)	Female feed consumption[c] (lb/week)	Typical egg production (hen-day %)
0	.088	.220	.088	.165	-
2	.551	.551	.496	.496	-
4	.120	.771 - .848	1.00	.694 - .727	-
6	1.75	.859 - .936	1.45	.727 - .771	-
8	2.25	.892 - 1.05	1.85	.771 - .881	-
10	2.75	1.05 - 1.21	2.20	.848 - .980	-
12	3.26	1.19 - 1.38	2.60	.936 - 1.06	-
14	3.74	1.27 - 1.54	3.00	1.01 - 1.21	-
16	4.25	1.38 - 1.69	3.41	1.09 - 1.32	-
18	4.74	1.46 - 1.82	3.81	1.16 - 1.48	-
20	5.29	-[d]	4.25	1.26 - 1.61	-
22	5.81	-	4.65	1.40 - 1.75	10
24	7.05	-	5.40	1.76 - 2.04	15
26	7.80	-	6.01	2.09 - 2.31	30
28	8.26	-	6.34	2.37 - 2.51	56
30	8.59	-	6.61	2.37 - 2.51	75
32	9.01	-	6.81	2.37 - 2.51	80
34	9.30	-	6.89	2.37 - 2.51	78
36	9.56	-	6.96	2.37 - 2.51	76
38	9.80	-	7.00	2.36 - 2.50	73
40	10.00		7.00	2.34 - 2.48	72

[a] Broiler-breeder strains must be grown on a controlled feeding program to limit weight. Values shown are typical but will vary according to strain. Specific breeder guidelines should be consulted for desired schedule of weights and feed allotments.
[b] Values are typical for fall-hatched chicks. Spring-hatched chicks will have decreasing natural daylight during the time of sexual maturity and usually need to be heavier to attain sexual maturity at the desired age.
[c] Adjust as required to maintain desired body weight.
[d] Males and females intermingled.

Table 12. Nutrient requirements of turkeys as percentages or as milligrams or units per pound of feed.

		Age (weeks)							
		M:0-4	4-8	8-12	12-16	16-20	20-24		Breeding
Energy base		F: 0-4	4-8	8-11	11-14	14-17	17-20	Holding	hens
kcalME/lb diet[a]	→	1,273	1,318	1,364	1,409	1,455	1,500	1,318	1,318
Protein	%	28	26	22	19	16.5	14	12	14
Arginine	%	1.6	1.5	1.25	1.1	0.95	0.8	0.6	0.6
Glycine + serine	%	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.5
Histidine	%	0.58	0.54	0.46	0.39	0.35	0.29	0.25	0.3
Isoleucine	%	1.1	1.0	0.85	0.75	0.65	0.55	0.45	0.5
Leucine	%	1.9	1.75	1.5	1.3	1.1	0.95	0.5	0.5
Lysine	%	1.6	1.5	1.3	1.0	0.8	0.65	0.5	0.6
Methionine + cystine	%	1.05	0.9	0.75	0.65	0.55	0.45	0.4	0.4
Methionine	%	0.53	0.45	0.38	0.33	0.28	0.23	0.2	0.2
Phenylalanine + tyrosine	%	1.8	1.65	1.4	1.2	1.05	0.9	0.8	1.0
Phenylalanine	%	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.55
Threonine	%	1.0	0.93	0.79	0.68	0.59	0.5	0.4	0.45
Tryptophan	%	0.26	0.24	0.2	0.18	0.15	0.13	0.1	0.13
Valine	%	1.2	1.1	0.94	0.8	0.7	0.6	0.5	0.58
Linoleic acid	%	1.0	1.0	0.8	0.8	0.8	0.8	0.8	1.0
Calcium	%	1.2	1.0	0.85	0.75	0.65	0.55	0.5	2.25
Phosphorus, available	%	0.6	0.5	0.42	0.38	0.32	0.28	0.25	0.35
Potassium	%	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.6
Sodium	%	0.17	0.15	0.12	0.12	0.12	0.12	0.12	0.15
Chlorine	%	0.15	0.14	0.14	0.12	0.12	0.12	0.12	0.12
Magnesium	%	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Manganese	mg	27.27	27.27	27.27	27.27	27.27	27.27	27.27	27.27
Zinc	mg	34.09	29.55	22.73	18.18	18.18	18.18	18.18	29.55
Iron	mg	36.36	27.27	27.27	27.27	22.73	22.73	22.73	27.27
Copper	mg	3.636	3.636	2.727	2.727	2.727	2.727	2.727	3.636
Iodine	mg	0.1818	0.1818	0.1818	0.1818	0.1818	0.1818	0.1818	0.1818
Selenium	mg	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909
Vitamin A	IU	1,818	1,818	1,818	1,818	1,818	1,818	1,818	1,818
Vitamin D[b]	ICU	409	409	409	409	409	409	409	409
Vitamin E	IU	5.455	5.455	4.545	4.545	4.545	4.545	4.545	11.36
Vitamin K	mg	0.4545	0.4545	0.3636	0.3636	0.3636	0.3636	0.3636	0.4545
Riboflavin	mg	1.636	1.636	1.364	1.364	1.136	1.136	1.136	1.818
Pantothenic acid	mg	5	5	4.091	4.091	4.091	4.091	4.091	7.273
Niacin	mg	31.82	31.82	22.73	22.73	18.18	18.18	18.18	13.64
Vitamin B_{12}	µg	1.364	1.364	1.364	1.364	1.364	1.364	1.364	1.364
Choline	mg	864	727	591	500	432	364	364	455
Biotin	mg	0.909	0.0909	0.0682	0.0568	0.0454	0.0454	0.0454	0.0682
Folacin	mg	0.4545	0.4545	0.3636	0.3636	0.3182	0.3182	0.3182	0.4545
Thiamin	mg	0.9091	0.9091	0.9091	0.9091	0.9091	0.9091	0.9091	0.9091
Pyridoxine	mg	2.045	2.045	1.591	1.591	1.364	1.364	1.364	1.818

[a] These are typical ME concentrations for corn-soya diets. Different ME values may be appropriate if other ingredients predominate.

[b] These concentrations of vitamin D are satisfactory when the dietary concentrations of calcium and available phosphorus conform with those in this table.

Table 13. Growth rate, feed and energy consumption of large-type turkeys.

Age (weeks)	Body weight (lb)		Feed consumption per week (lb)		Cumulative feed consumption (lb)		ME consumption per week (Mcal)	
	M	F	M	F	M	F	M	F
1	.242	.242	.22	.22	.22	.22	0.30	0.30
2	.594	.528	.44	.37	.66	.59	0.60	0.50
3	1.28	1.03	.99	.86	1.65	1.45	1.1	0.80
4	2.20	1.54	1.34	1.01	2.99	2.46	1.7	1.2
5	3.30	2.42	1.54	1.32	4.53	3.78	2.3	1.6
6	4.40	3.52	1.89	1.67	6.42	5.46	2.9	2.1
7	5.72	4.62	2.38	1.96	8.80	7.41	3.5	2.6
8	7.26	5.72	2.86	2.29	11.66	9.70	4.1	3.1
9	8.80	6.82	3.32	2.60	14.98	12.30	4.8	3.6
10	10.34	8.14	3.92	2.95	18.90	15.25	5.2	4.1
11	12.10	9.46	4.38	3.23	23.28	18.48	5.7	4.6
12	13.86	10.56	4.95	3.50	28.23	21.98	6.3	5.1
13	15.62	11.66	5.52	3.74	33.75	25.72	7.1	5.5
14	17.60	12.76	5.85	3.85	39.60	29.57	7.8	5.8
15	19.36	13.86	6.36	4.00	45.96	33.57	8.4	6.1
16	21.34	14.74	6.71	4.22	52.67	37.80	8.8	6.4
17	23.10	15.62	6.87	4.47	59.47	42.26	9.6	6.7
18	24.86	16.50	7.19	4.55	66.75	46.82	10.2	6.9
19	26.62	17.16	7.55	4.73	74.29	51.55	10.9	7.1
20	28.16	17.82	7.92	4.91	82.21	56.45	11.6	7.3
21	29.70	-	8.16	-	90.38	-	12.5	-
22	31.24	-	8.40	-	98.78	-	12.9	-
23	32.56	-	8.67	-	107	-	13.2	-
24	33.88	-	8.91	-	116	-	13.5	-

Table 14. Body weights and feed consumption of large-type turkeys during holding and breeding periods[a].

Age (weeks)	Hens			Toms	
	Weight (lb)	Egg production (%)	Feed /day (lb)	Weight (lb)	Feed /day (lb)
20	15.4	-	.441	26.4	.881
25	17.6	-	.474	29.7	.925
30	19.8	Start light stimulation	.507	35.2	.969
35	20.9	66	.573	37.4	.991
40	20.5	63	.562	39.6	1.01
45	20.0	60	.551	40.0	1.06
50	19.8	50	.529	40.7	1.10
55	19.8	40	.507	41.4	1.12
60	19.8	35	.485	41.8	1.15

[a] These values are based on experimental data involving "in season" egg production (i.e., November through July) of commercial stock. It is estimated that summer breeders would produce 70-90% as many eggs and consume 60-80% as much feed, respectively, as "in season" breeders.

Formulations of the diets fed to market turkeys are modified as the birds grow. Nutrient requirements shown in Table 12 reflect those changes as made at 4- or 3-week intervals. In practice the changes may occur more or less frequently than indicated here. Nutritional adjustments are often made for expected ambient temperature variations to assure that the birds consume the necessary amount of protein vitamins, and minerals, regardless of changes in feed consumption.

Feeding programs for breeder stock are usually divided into prebreeding and breeding periods. The prebreeding or holding diets may be fed when the breeder stock is selected at about 16 weeks of age. Females are fed the holding diet until the time of light stimulation, often at 30 weeks of age. Thereafter breeder diets are fed. In the case of males, light stimulation is normally started at about 26 weeks of age. A nutritionally balanced holding diet may be fed from the time of breeder selection throughout the breeding season. In some programs, the male turkeys' body weights are controlled by limited feeding of the diet.

It is not necessary to feed low-energy diets or to restrict feed intake for hen turkeys in the prebreeding period. Corn-soybean meal type diets may be fed *ad libitum.* Growth restriction does not result in any consistent improvement in reproductive performance and may actually be detrimental under some conditions. The use of "holding feeds" for potential turkey breeders is, however, common. These feeds are usually designed with medium energy concentrations to stabilize development and weight gains after mature body weight is attained. Take care to maintain adequate intake of vitamins and minerals during the holding period so that the breeders are not depleted of these nutrients before the onset of lay. Table 13 shows growth rate, feed and energy consumption of large-type turkeys. Table 14 shows body weights

Table 15. Nutrient requirements of geese as percentages or as milligrams or units per pound of diet[a].

Energy base kcal ME/lb diet[b]	→	Starting (0-6 weeks) 1,318	Growing (after 6 weeks) 1,318	Breeding 1,318
Protein	%	22.0	15.0	15.0
Lysine	%	0.9	0.6	0.6
Methionine + cystine	%	0.75	-	-
Calcium	%	0.8	0.6	2.25
Phosphorus, available	%	0.4	0.3	0.3
Vitamin A	IU	682	682	1,818
Vitamin D	ICU	90.91	90.91	90.91
Riboflavin	mg	1.818	1.136	1.818
Pantothenic acid	mg	6.818	-	-
Niacin	mg	25	15.91	9.091

[a] For nutrients not listed, see requirements for chickens as a guide.
[b] These are typical dietary energy concentrations.

and feed consumption of large-type turkeys during holding and breeding periods.

NUTRIENT REQUIREMENTS OF GEESE

Geese are reared under a variety of feeding programs. In the production of "farm geese," the goslings are given starter feed for about two weeks and then allowed to forage the farm for a variety of pasture and grain feedstuffs. Under these conditions they are marketable at about 18 weeks of age following liberal grain feeding for the last 2 or 3 weeks. In a second program the goslings are fed limited amounts of prepared feed throughout the growing period, but are still allowed considerable foraging. These geese are marketed at about 14 weeks of age following liberal feeding of a high-energy finishing diet. Geese may also be full-fed in confinement and marketed as "junior" or "green geese" at about 10 weeks of age. A fourth program is practiced in European countries and involves the production of goose livers for *pâté de foie gras*. The geese are grown to about 12 weeks of age and are then force-fed a high-grain diet for the production of livers of high-fat content. The practice of force-feeding has been questioned on humane grounds. Geese for breeding purposes are fed holding and breeding diets for the intensive production of fertile eggs. The feeding of the prebreeding diets would commence 6 to 8 weeks before the breeding season.

As shown in Table 15, knowledge of the nutrient requirements of geese is sparse. More research is needed in areas of practical significance to good production in North America.

NUTRIENT REQUIREMENTS OF DUCKS

Ducks are successfully grown in two environments — an open rearing system in which the growing house opens to an exercise yard with water for wading or swimming and a confinement growing system in which ducks are raised in environmentally controlled houses with litter or combination litter and wire floors.

Ducks consume pelleted diets more effectively than mash diets. They are typically provided with two or three feeds during the growing period. In the former case, a starter diet containing 22% protein is fed for two weeks, followed by a grower-finisher diet. In the latter, a 22% protein starter diet, 18% protein grower diet, and 16% protein finisher diet are provided. If ducklings are started with 16% protein, early growth may be retarded but compensatory growth leads to normal body size at market age. Table 16 shows nutrient requirements of Pekin ducks. Table 17 shows typical body weights and feed consumption of Pekin ducks to eight weeks of age.

Table 16. Nutrient requirements of Pekin ducks as percentages or as milligrams or units per pound of diet[a].

Energy base kcal ME/lb diet[b]	→	Starting (0-2 weeks) 1,318	Growing (2-7 weeks) 1,318	Breeding 1,318
Protein	%	22.0	16.0	15.0
Arginine	%	1.1	1.0	-
Lysine	%	1.1	0.9	0.7
Methionine + cystine	%	0.8	0.6	0.55
Calcium	%	0.65	0.6	2.75
Phosphorus, available	%	0.40	0.35	0.35
Sodium	%	0.15	0.15	0.15
Chlorine	%	0.12	0.12	0.12
Magnesium	%	0.05	0.05	0.05
Manganese	mg	18.18	18.18	11.36
Zinc	mg	27.27	27.27	27.27
Selenium	mg	0.0636	0.0636	0.0636
Vitamin A	IU	1,818	1,818	1,818
Vitamin D	ICU	100	100	227
Vitamin K	mg	0.1818	0.1818	0.1818
Riboflavin	mg	1.818	1.818	1.818
Pantothenic acid	mg	5	5	4.545
Niacin	mg	25	25	18.18
Pyridoxine	mg	1.182	1.182	1.364

[a] For nutrients not listed, see requirements for chickens as a guide.
[b] These are typical dietary energy concentrations.

Table 17. Typical body weights and feed consumption of Pekin ducks to 8 weeks of age.

Age (weeks)	Body weight (lb) M	Body weight (lb) F	Feed consumption by 1-week periods (lb) M	Feed consumption by 1-week periods (lb) F	Cumulative feed consumption (lb) M	Cumulative feed consumption (lb) F
0	.11	.11	-	-	-	-
1	.59	.59	.48	.48	.48	.48
2	1.72	1.63	1.69	1.61	2.18	2.09
3	3.04	2.82	2.46	2.44	4.64	4.51
4	4.31	4.00	2.82	2.82	7.48	7.33
5	5.48	5.06	3.26	3.15	10.71	10.47
6	6.51	6.01	3.59	3.50	14.30	13.97
7	7.34	6.73	3.70	3.57	18.00	17.56
8	7.94	7.24	3.70	3.57	21.69	21.14

NUTRIENT REQUIREMENTS OF PHEASANTS, BOBWHITE QUAIL, AND JAPANESE QUAIL

Nutrition and management are inseparable in the overall approach toward the rearing of these game birds. The requirements for many of the nutrients are not established for pheasants and Bobwhite quail. Diets formulated to meet the

Table 18. Nutrient requirements of pheasants[a] and Bobwhite quail[b] as percentages or as milligrams or units per pound of diet.

		Pheasant			Bobwhite quail		
Energy base	→	Starting	Growing	Breeding	Starting	Growing	Breeding
kcalME/lb diet[c]		1,273	1,227	1,273	1,273	1,273	1,273
Protein	%	30.0	16.0	18.0	28.0	20.0	24.0
Glycine + serine	%	1.8	1.0	-	-	-	-
Lysine	%	1.5	0.8	-	-	-	-
Methionine + cystine	%	1.1	0.6	0.6	-	-	-
Linoleic acid	%	1.0	1.0	1.0	1.0	1.0	1.0
Calcium	%	1.0	0.7	2.5	0.65	0.65	2.3
Phosphorus available	%	0.55	0.45	0.40	0.55	0.45	0.50
Sodium	%	0.15	0.15	0.15	0.15	0.15	0.15
Chlorine	%	0.11	0.11	0.11	0.11	0.11	0.11
Iodine	mg	0.1364	0.1364	0.1364	0.1364	0.1364	0.1364
Riboflavin	mg	1.591	1.364	-	1.727	-	1.818
Pantothenic acid	mg	4.545	4.545	-	5.909	-	6.818
Niacin	mg	27.27	18.18	-	13.64	-	9.091
Choline	mg	682	455	-	682	-	455

[a] For values not listed see requirements for turkeys as a guide.
[b] For values not listed see requirements for Leghorn-type chickens as a guide.
[c] These are typical dietary energy concentrations.

Table 19. Nutrient requirements of Japanese quail (Coturnix) as percentage or as milligrams or units per pound of diet.

		Starting and growing	Breeding
Energy base kcal ME/lb diet[a]	→	1,364	1,364
Protein	%	24.0	20.0
Arginine	%	1.25	1.26
Glycine + serine	%	1.20	1.17
Histidine	%	0.36	0.42
Isoleucine	%	0.98	0.90
Leucine	%	1.69	1.42
Lysine	%	1.30	1.15
Methionine + cystine	%	0.75	0.76
Methionine	%	0.50	0.45
Phenylalanine + tyrosine	%	1.80	1.40
Phenylalanine	%	0.96	0.78
Threonine	%	1.02	0.74
Tryptophan	%	0.22	0.19
Valine	%	0.95	0.92
Linoleic acid	%	1.0	1.0
Calcium	%	0.8	2.5
Phosphorus, available	%	0.45	0.55
Potassium	%	0.4	0.4
Magnesium	%	0.03	0.05
Sodium	%	0.15	0.15
Chlorine	%	0.20	0.15
Manganese	mg	40.91	31.82
Zinc	mg	11.36	22.73
Iron	mg	45.45	27.27
Copper	mg	2.727	2.727
Iodine	mg	0.1364	0.1364
Selenium	mg	0.0909	0.0909
Vitamin A	IU	2,273	2,273
Vitamin D	ICU	545	545
Vitamin E	IU	5.455	11.36
Vitamin K	mg	0.4545	0.4545
Riboflavin	mg	1.818	1.818
Pantothenic acid	mg	4.545	6.818
Niacin	mg	18.18	9.091
Vitamin B_{12}	µg	1.364	1.364
Choline	mg	909	682
Biotin	mg	0.1364	0.0682
Folacin	mg	0.4545	0.4545
Thiamin	mg	0.9091	0.9091
Pyridoxine	mg	1.364	1.364

[a] These are typical dietary energy concentrations.

requirements for turkeys have been used successfully for pheasants and Japanese quail. Diets formulated for growing Leghorn-type chicks appear to satisfy the requirements for Bobwhite quail.

Pheasants and quail are fed diets designed to produce the type of bird required for specific markets, i.e., game-release farms or stores selling dressed game birds. Fast early growth is achieved with high-protein diets. Subsequent feeding of diets with lower-protein concentrations encourages the development of lean, flighty birds suitable for release. Pheasants fed either 20% or 30% protein in the diet from the time of hatching will attain similar body weights by 20 weeks of age, although the higher protein concentration will allow the attainment of mature body weight at an earlier age. Japanese quail, which mature at 5 to 6 weeks of age, respond similarly to dietary protein concentration. Nutrient requirements of pheasants, Bobwhite quail are shown in Table 18. Table 19 shows requirements for Japanese quail.

FEEDSTUFFS COMPOSITION

Table 20. Composition of some feedstuffs commonly used for poultry; data on as-fed basis.

Ingredient Name	Dry Mattr %	Crud Fibr %	Ethext %	Met Energ kcal/lb	Crud Prot %	Arginine %	Glycine %	Serine %	Gly + Ser %	Histidine %
Alfalfa ml 17%	92.00	24.10	2.00	623.00	17.50	0.80	0.90	0.77	1.67	0.32
Animal + poul fat			100.00	3,636.00						
Animal + veg fat			100.00	3,864.00						
Animal tallow			100.00	3,455.00						
Barley gr 11.6%	89.00	5.10	1.80	1,200.00	11.60	0.59	0.40	0.42	0.82	0.29
Blood ml spr dr 89%	93.00	0.60	1.00	1,555.00	88.90	3.81	4.00	3.86	7.86	5.26
Blood ml vat dr 81%	94.00	0.50	1.60	1,286.00	81.10	3.63	4.59	3.14	7.73	3.52
Brewers dr gr 25%	92.00	15.30	6.20	945.00	25.30	1.28	1.09	0.80	1.89	0.57
Calcium carbonate										
Corn #2 yllw gr	89.00	2.20	3.80	1,523.00	8.80	0.50	0.37	0.40	0.79	0.20
Corn glu fd 22%	90.00	8.00	2.50	795.00	22.00	1.01	0.99	0.80	1.79	0.71
Corn glu ml 60%	90.00	1.30	2.50	1,691.00	62.00	1.93	1.64	3.07	4.71	1.22
Dicalcium phos										
Distl gr dhy 28%	94.00	11.30	9.20	896.00	27.80	0.97	0.49	0.70	1.19	0.62
Distl sol dhy 29%	92.00	4.00	9.00	1,332.00	28.50	1.05	1.10	1.30	2.40	0.70
Fish anchovy 64%	92.00	1.00	5.00	1,173.00	64.20	3.66	3.59	2.32	5.91	1.53
Fish herring 72%	93.00	0.70	10.00	1,450.00	72.30	4.84	4.61	2.73	7.34	1.70
Fish menhaden 60%	92.00	0.70	9.40	1,282.00	60.50	3.79	4.19	2.25	6.44	1.46
Fish sol dhy 64%	92.00	0.50	9.30	1,286.00	63.60	2.78	5.89	2.02	7.91	2.18
Fish white 63%	91.00	0.70	4.60	1,633.00	62.60	4.02	4.42	3.06	7.48	1.34
Hominy feed	90.00	6.00	6.90	1,316.00	10.40	0.47	0.40	0.50	0.90	0.20
Limestone grnd										
Meat + bone ml 50%	93.00	2.80	8.60	891.00	50.40	3.62	6.79	1.85	8.64	0.90
Meat ml rnd 54%	92.00	8.70	7.10	909.00	54.40	3.73	6.30	1.60	7.90	1.30
Millet pearl gr	91.00	4.30	4.30	1,161.00	15.70	0.74	0.47	0.74	1.21	0.31
Millet proso gr	90.00	6.10	3.50	1,317.00	11.60	0.36				0.21
Oat hulls	92.00	28.70	1.40	182.00	4.60	0.14	0.14	0.14		0.07
Oats gr 11.4%	89.00	10.80	4.20	1,159.00	11.40	0.79	0.50	0.40	0.90	0.24
Oyster shell grnd										
Poul brprd ml 50%	93.00	2.00	13.00	1,214.00	58.00	4.00	5.90	3.68	9.58	1.50
Poul ml + hyfth 86%	93.00	1.00	3.30	1,093.00	86.40	5.42	6.31	9.26	15.57	0.34
Poultry fat			100.00	3,727.00						
Rye gr	88.00	2.20	1.50	1,194.00	12.10	0.53	0.49	0.52	1.01	0.26
Salt (sodium chlrd)										
Soybn ml slv 44%	89.00	7.30	0.80	1,014.00	44.00	3.28	2.29	2.45	4.74	1.15
Soybn ml -hll slv 47%	90.00	3.90	1.00	1,109.00	47.00	3.57	2.22	2.80	5.02	1.28
Soybn sd ml ht 37%	90.00	5.50	18.00	1,500.00	37.00	2.80	2.00	2.17	4.17	0.89
Sorghum gr 8-10%	88.00	2.30	2.90	1,495.00	8.80	0.34	0.35	0.39	0.74	0.19
Sorghum gr >10%	88.00	2.30	2.10	1,460.00	11.00	0.35	0.32	0.45	0.77	0.23
Wheat bran	90.00	11.00	3.00	591.00	15.70	0.98	0.90	0.90	1.80	0.34
Wheat hrw gr 14%	87.00	2.40	1.90	1,273.00	14.10	0.58	0.72	0.63	1.35	0.22
Wheat middlings	88.00	7.50	3.00	818.00	16.00	1.15	0.63	0.75	1.38	0.37
Wheat shorts	88.00	6.80	4.60	983.00	16.50	1.18	0.96	0.77	1.73	0.45
Wheat sww gr 10%	89.00	2.40	1.80	1,418.00	10.20	0.40	0.49	0.55	1.04	0.20
Whey dhy 12%	93.00	0.20	0.80	864.00	12.00	0.34	0.30	0.32	0.62	0.18
Whey dr whprod 16%	91.00	0.30	1.00	950.00	15.50	0.67	1.04	0.76	1.80	0.10
Yeast br dhy 44%	93.00	2.70	1.00	905.00	44.40	2.19	2.09		2.09	1.07
Yeast tr dhy 47%	93.00	2.40	2.50	982.00	47.20	2.60	2.60	2.76	5.36	1.40

Table 20. Composition of some feedstuffs commonly used for poultry; data on as-fed basis (continued).

Ingredient Name	Isoleucine %	Leucine %	Lysine %	Methionine %	Cystine %	Mth + Cys %	Phenylalan %	Tyrosine %	Phnl + Tyro %	Threonine %
Alfalfa ml 17%	0.84	1.26	0.73	0.23	0.20	0.43	0.79	0.56	1.35	0.70
Animal + poul fat										
Animal + veg fat										
Animal tallow										
Barley gr 11.6%	0.49	0.80	0.40	0.17	0.19	0.36	0.64	0.33	0.97	0.42
Blood ml spr dr 89%	0.88	11.82	8.85	0.75	0.86	1.61	6.55	2.49	9.04	3.94
Blood ml vat dr 81%	0.95	10.53	7.05	0.55	0.52	1.07	5.66	2.07	7.73	3.15
Brewers dr gr 25%	1.44	2.48	0.90	0.57	0.39	0.96	1.45	1.19	2.64	0.98
Calcium carbonate										
Corn #2 yllw gr	0.37	1.10	0.24	0.20	0.15	0.35	0.47	0.45	0.92	0.39
Corn glu fd 22%	0.65	1.89	0.63	0.45	0.51	0.96	0.77	0.58	1.35	0.89
Corn glu ml 60%	2.29	10.11	1.00	1.91	1.11	3.02	3.77	2.94	6.71	1.97
Dicalcium phos										
Distl gr dhy 28%	0.99	3.01	0.78	0.40	0.24	0.64	0.94	0.84	1.78	0.49
Distl sol dhy 29%	1.25	2.11	0.90	0.50	0.40	0.90	1.30	0.95	2.25	1.00
Fish anchovy 64%	3.01	4.83	4.90	1.93	0.59	2.52	2.70	2.18	4.88	2.68
Fish herring 72%	3.22	5.34	5.70	2.10	0.72	2.82	2.79	2.27	5.06	3.00
Fish menhaden 60%	2.85	4.50	4.83	1.78	0.56	2.34	2.48	1.98	4.46	2.50
Fish sol dhy 64%	1.95	3.16	3.28	1.00	0.66	1.66	1.48	0.78	2.26	1.35
Fish white 63%	2.72	4.36	4.53	1.68	0.75	2.43	2.28	1.83	4.11	2.57
Hominy feed	0.40	0.84	0.40	0.13	0.13	0.26	0.35	0.49	0.84	0.40
Limestone grnd										
Meat + bone ml 50%	1.40	2.80	2.60	0.65	0.25	0.90	1.50	0.76	2.26	1.50
Meat ml rnd 54%	1.60	3.32	3.00	0.75	0.66	1.41	1.70	0.84	2.54	1.74
Millet pearl gr	0.37	1.14	0.45	0.25	0.24	0.49	0.56	0.35	0.91	0.48
Millet proso gr	0.45	1.15	0.26	0.29		0.29	0.57		0.57	0.40
Oat hulls	0.14	0.25	0.14	0.07	0.06	0.13	0.13	0.14	0.27	0.13
Oats gr 11.4%	0.52	0.89	0.50	0.18	0.22	0.40	0.59	0.53	1.12	0.43
Oyster shell grnd										
Poul brprd ml 50%	2.00	3.70	2.70	1.00	0.69	1.69	2.10	0.54	2.64	2.00
Poul ml + hyfth 86%	3.26	6.72	1.67	0.42	4.00	4.42	3.26	6.31	9.57	3.43
Poultry fat										
Rye gr	0.47	0.70	0.42	0.17	0.19	0.36	0.56	0.26	0.82	0.36
Salt (sodium chlrd)										
Soybn ml slv 44%	2.39	3.52	2.93	0.65	0.69	1.34	2.27	1.28	3.55	1.81
Soybn ml -hll slv 47%	2.49	3.70	3.08	0.70	0.71	1.41	2.05	1.94	3.99	1.85
Soybn sd ml ht 37%	2.00	2.80	2.40	0.51	0.64	1.15	1.80	1.20	3.00	1.50
Sorghum gr 8-10%	0.42	1.18	0.21	0.16	0.16	0.32	0.42	0.38	0.80	0.29
Sorghum gr >10%	0.43	1.37	0.22	0.15	0.11	0.26	0.52	0.17	0.69	0.33
Wheat bran	0.59	0.91	0.59	0.17	0.25	0.42	0.49	0.40	0.89	0.42
Wheat hrw gr 14%	0.58	0.94	0.40	0.19	0.26	0.45	0.71	0.43	1.14	0.37
Wheat middlings	0.58	1.07	0.69	0.21	0.32	0.53	0.64	0.45	1.09	0.49
Wheat shorts	0.58	1.09	0.79	0.27	0.36	0.63	0.67	0.47	1.14	0.60
Wheat sww gr 10%	0.42	0.59	0.31	0.15	0.22	0.37	0.45	0.39	0.84	0.32
Whey dhy 12%	0.82	1.19	0.97	0.19	0.30	0.49	0.33	0.25	0.58	0.89
Whey dr whprod 16%	0.90	1.15	1.47	0.57	0.57	1.14	0.50	0.20	0.70	0.50
Yeast br dhy 44%	2.14	3.19	3.23	0.70	0.50	1.20	1.81	1.49	3.30	2.06
Yeast tr dhy 47%	2.90	3.50	3.80	0.80	0.60	1.40	3.00	2.10	5.10	2.60

Table 20. Composition of some feedstuffs commonly used for poultry; data on as-fed basis (continued).

Ingredient Name	Tryptophan %	Valine %	Calcium %	Totl Phos %	Aval Phos %	Magnesium %	Manganese mg/lb	Chlorine %	Sodium %	Potassium %
Alfalfa ml 17%	0.28	0.84	1.44	0.22	0.22	0.36	13.64	0.47	0.12	2.17
Animal + poul fat										
Animal + veg fat										
Animal tallow										
Barley gr 11.6%	0.14	0.62	0.03	0.36	0.16	0.14	7.27	0.15	0.04	0.48
Blood ml spr dr 89%	1.34	8.60	0.06	0.09		0.40	2.73	0.27	0.33	0.41
Blood ml vat dr 81%	1.29	7.28	0.55	0.42		0.16	2.27	0.27	0.32	0.09
Brewers dr gr 25%	0.34	1.66	0.29	0.52		0.16	17.27	0.12	0.15	0.09
Calcium carbonate			38.00							0.06
Corn #2 yllw gr	0.09	0.52	0.02	0.28	0.10	0.12	2.27	0.04	0.02	0.30
Corn glu fd 22%	0.10	0.05	0.40	0.80		0.29	10.91	0.22	0.95	0.57
Corn glu ml 60%	0.25	2.74		0.50	0.19	0.15	1.82	0.05	0.02	0.35
Dicalcium phos			21.30	18.70	18.70	0.60	136.00	0.01	0.06	0.10
Distl gr dhy 28%	0.20	1.18	0.10	0.40		0.07	10.00	0.07	0.09	0.57
Distl sol dhy 29%	0.30	1.39	0.35	1.33	1.24	0.64	33.64	0.26	0.26	1.75
Fish anchovy 64%	0.74	3.38	3.73	2.43		0.24	4.55	0.29	0.88	0.69
Fish herring 72%	0.81	4.38	2.29	1.70		0.15	2.27	0.90	0.61	1.09
Fish menhaden 60%	0.68	3.23	5.11	2.88		0.16	15.00	0.60	0.41	0.77
Fish sol dhy 64%	0.51	2.22	1.23	1.63		0.30	22.73	0.26	0.37	0.37
Fish white 63%	0.67	3.02	7.31	3.81		0.18	5.45	0.50	0.78	0.83
Hominy feed	0.10	0.49	0.05	0.52		0.24	6.82	0.05	0.08	0.59
Limestone grnd			38.00			2.10			0.05	0.10
Meat + bone ml 50%	0.28	2.00	10.30	5.10		1.12	6.36	0.74	0.72	1.02
Meat ml rnd 54%	0.36	2.30	8.27	4.10		0.58	4.55	0.91	1.15	0.60
Millet pearl gr	0.08	0.49	0.05	0.32		0.16	14.09	0.14	0.04	0.43
Millet proso gr	0.17	0.58	0.03	0.30	0.14	0.16				0.43
Oat hulls	0.07	0.02	0.13	0.10		0.08	6.36	0.11	0.04	0.53
Oats gr 11.4%	0.16	0.68	0.06	0.27	0.12	0.16	19.55	0.11	0.08	0.45
Oyster shell grnd			38.00	0.10	0.10	0.30	45.45	0.01	0.20	0.10
Poul brprd ml 50%	0.53	2.60	3.00	1.70		0.22	5.00	0.54	0.40	0.30
Poul ml + hyfth 86%	0.50	5.57	0.33	0.55		0.20	9.55	0.28	0.71	0.31
Poultry fat										
Rye gr	0.11	0.56	0.06	0.32	0.08	0.12	26.36	0.03	0.02	0.46
Salt (sodium chlrd)			0.30					60.00	39.00	
Soybn ml slv 44%	0.62	2.34	0.29	0.65	0.27	0.27	13.18	0.05	0.04	2.00
Soybn ml -hll slv 47%	0.65	2.64	0.27	0.62	0.24		19.55	0.05	0.03	2.02
Soybn sd ml ht 37%	0.55	1.80	0.25	0.58		0.28	13.64	0.03	0.03	1.61
Sorghum gr 8-10%	0.10	0.53	0.04	0.30		0.15	6.82		0.01	0.35
Sorghum gr >10%	0.09	0.54	0.04	0.32		0.12			0.01	0.33
Wheat bran	0.30	0.73	0.14	1.15	0.34	0.52	51.36	0.06	0.05	1.19
Wheat hrw gr 14%	0.18	0.63	0.05	0.37	0.11	0.17	14.55	0.05	0.04	0.45
Wheat middlings	0.20	0.71	0.12	0.90	0.23	0.16	53.64	0.03	0.12	0.99
Wheat shorts	0.21	0.83	0.09	0.81		0.25	53.18	0.07	0.02	0.93
Wheat sww gr 10%	0.12	0.44	0.05	0.31		0.10	10.91	0.08	0.04	0.40
Whey dhy 12%	0.19	0.68	0.97	0.76		0.13	2.73	0.07	0.48	1.05
Whey dr whprod 16%	0.18	0.30	1.95	0.98		0.25	3.64	2.10	1.50	3.00
Yeast br dhy 44%	0.49	2.32	0.12	1.40		0.23	2.27	0.12	0.07	1.70
Yeast tr dhy 47%	0.50	2.90	0.58	1.67		0.13	5.91	0.02	0.01	1.88

Table 20. Composition of some feedstuffs commonly used for poultry; data on as-fed basis (continued).

Ingredient Name	Copper mg/lb	Choline mg/lb	Folacin mg/lb	Niacin mg/lb	Panto Acd mg/lb	Pyridoxin mg/lb	Riboflavin mg/lb	Thiamin mg/lb	Vit B_{12} µg/lb	Vit E IU/lb
Alfalfa ml 17%	4.55	637.00	1.91	17.27	11.36	2.95	6.18	1.54	1.82	56.82
Animal + poul fat										
Animal + veg fat										
Animal tallow										
Barley gr 11.6%	4.55	450.00	0.32	25.00	3.64	1.36	0.82	0.86		9.09
Blood ml spr dr 89%	3.36	127.00	0.18	5.91	2.27	2.00	0.59	0.23	20.00	
Blood ml vat dr 81%	4.55	316.00	0.05	13.18	1.36	2.00	1.18	0.18	20.00	
Brewers dr gr 25%	9.55	783.00	3.23	13.18	3.64	0.32	0.64	0.23		11.36
Calcium carbonate										
Corn #2 yllw gr	1.36	282.00	0.18	10.91	1.82	3.18	0.45	1.59		10.00
Corn glu fd 22%	21.82	690.00	0.14	30.00	7.73	6.82	1.09	0.91		6.82
Corn glu ml 60%	11.82	150.00	0.09	25.00	1.36	2.82	1.00	0.14		1.09
Dicalcium phos	4.55									
Distl gr dhy 28%	20.45	536.00	0.41	16.82	5.32	2.00	2.36	0.77		
Distl sol dhy 29%	37.73	2,201.00	0.50	52.73	9.55	4.55	7.73	3.14	1.36	25.00
Fish anchovy 64%	4.09	2,004.00	0.09	45.45	6.82	1.82	3.23	0.05	160.00	1.82
Fish herring 72%	2.73	2,412.00	0.36	42.27	7.73	1.82	4.50	0.05	183.00	10.00
Fish menhaden 60%	5.00	1,389.00	0.27	25.00	4.09	1.82	2.23	0.23	47.27	3.18
Fish sol dhy 64%		2,503.00	0.27	123.00	25.00	10.82	3.50	3.36	182.00	2.73
Fish white 63%	2.73	1,409.00	0.14	26.82	4.50	2.68	4.14	0.77	40.91	4.09
Hominy feed	6.36	525.00	0.14	21.36	3.73	5.00	0.95	3.68		
Limestone grnd										
Meat + bone ml 50%	0.91	907.00	0.14	20.91	1.86	5.82	2.00	0.36	31.82	0.45
Meat ml rnd 54%	4.55	944.00	0.14	25.91	2.27	1.36	2.50	0.09	30.91	0.45
Millet pearl gr	10.00	360.00		24.09	3.55		0.73	3.05		
Millet proso gr		200.00		10.45	5.00		1.73	3.32		
Oat hulls	1.36	129.00	0.45	3.18	1.36	1.00	0.68	0.27		
Oats gr 11.4%	3.64	430.00	0.14	5.45	3.55	0.45	0.50	2.73		9.09
Oyster shell grnd										
Poul brprd ml 50%	6.36	2,705.00	0.45	18.18	5.59	2.00	5.00	0.45	141.00	0.91
Poul ml + hyfth 86%	3.18	405.00	0.09	12.27	4.55	1.36	0.95	0.05	35.45	
Poultry fat										
Rye gr	3.18	190.00	0.27	8.64	3.64	1.18	0.73	1.64		6.82
Salt (sodium chlrd)										
Soybn ml slv 44%	10.00	1,270.00	0.59	13.18	7.27	2.73	1.32	2.05		0.91
Soybn ml -hll slv 47%	6.82	1,241.00	1.64	10.00	6.82	2.27	1.32	1.46		1.36
Soybn sd ml ht 37%	7.27	1,300.00	1.91	10.00	5.00	4.91	1.18	5.00		18.18
Sorghum gr 8-10%		304.00	0.09	18.64	5.64	2.36	0.59	1.77		3.18
Sorghum gr >10%										
Wheat bran	6.36	855.00	0.55	84.55	14.09	3.18	2.09	3.64		6.36
Wheat hrw gr 14%	2.73	495.00	0.18	21.82	4.50	1.54	0.64	2.05		5.91
Wheat middlings	8.18	654.00	0.36	44.55	5.91	4.09	1.00	7.50		18.18
Wheat shorts	5.45	824.00	0.77	48.64	10.14	3.27	1.91	8.68		24.55
Wheat sww gr 10%	3.18	455.00	0.18	25.91	5.00	1.82	0.55	1.95		5.91
Whey dhy 12%	20.91	622.00	0.36	4.55	20.00	1.82	12.32	1.86	10.45	0.09
Whey dr whprod 16%	3.18	1,996.00	0.18	8.64	31.36	1.82	20.82	2.59	10.45	
Yeast br dhy 44%	15.00	1,811.00	4.50	204.00	49.55	19.45	16.82	41.73	0.45	0.09
Yeast tr dhy 47%	6.36	1,310.00	10.18	227.00	3.18	16.50	21.68	2.82	1.82	

EXAMPLE DIETS

All example diets were formulated to meet NRC nutrient requirements. In some situations it might be desirable to add a 5-10% safety margin to the listed requirements.

Table 21. Example diets for laying chickens.

Ingredient	Diet use: Pullet Starter 0-6 wk	Pullet Grower 6-14 wk	Pullet Grower 14-20 wk	Layer	Breeder
	%				
Alfalfa ml 17%	2.5	2.5	2.5	---	---
Animal tallow	---	---	---	1.67	1.79
Corn #2 yl gr	64.27	69.45	71.34	69.83	65.5
Dicalcium phos	1.35	1.38	1.18	1.11	1.13
Fish menhaden 60%	---	---	---	---	---
Limestone grnd	1.12	1.14	1.01	7.68	7.7
Meat + bone ml 50%	---	---	---	.1193	---
Methionine dl 98.5%	.0071	.0026	.0032	.0569	.0586
Salt (sodium chlrd)	.3176	.3189	.3202	.3215	.3247
Selenium pmx	.0046	.0048	.0024	.0031	.0031
Sorghum gr 8-10%	---	---	1.82	---	4.07
Soybn ml-hll 47% slv	29.59	24.36	21.54	17.65	17.82
Trace min pmx	.0328	.0343	.014	1.2	1.2
Vitamin pmx TC	.8085	.8084	.2637	.3559	.3914
Calculated Analysis					
Crude protein %	20	18	17	14.5	14.5
Kilocalories of ME/lb	1318	1318	1318	1318	1318
Calcium %	.85	.85	.75	3.4	3.4
Available phos %	.3924	.3924	.35	.32	.32

Table 22. Example diets for broiler chickens.

Ingredient	Diet use: Starter 0-3 wk	Grower 3-6 wk	Grower 6-8 wk	Breeder
	%			
Alfalfa ml 17%	---	---	---	2.5
Animal tallow	7.08	4.93	4.39	---
Corn #2 yl gr	51.53	62.57	66.71	68.36
Dicalcium phos	1.7	1.48	1.18	.7312
Fish menhaden 60%	2.5	2.5	---	---
Limestone grnd	.3839	.2957	1.2	6.39
Meat + bone ml 50%	2.5	2.5	---	---
Methionine dl 98.5%	.2009	.0694	.0027	.0879
Salt (sodium chlrd)	.257	.2583	.3271	.1908
Selenium pmx	.0021	.0024	.0052	.0027
Sorghum gr 8-10%	---	---	---	3.76
Soybn ml-hll 47% slv	33.39	24.94	25.81	16.42
Trace min pmx	.0307	.0338	.0351	1.2
Vitamin pmx TC	.4228	.4228	.3320	.3559
Calculated Analysis				
Crude protein %	23	20	18	14.5
Kilocalories of ME/lb	1454	1454	1454	1295
Calcium %	1.0	.90	.80	2.8497
Available phos %	.45	.40	.35	.25

Table 23. Example diets for turkeys.

Ingredient	Diet use, age wks							
	M: 0-4 F: 0-4	4-8 4-8	8-12 8-11	12-16 11-14	16-20 14-17	20-24 17-20	Holding	Breeder
	%							
Alfalfa ml 17%	---	---	---	---	---	---	2.5	2.5
Animal tallow	2.12	2.63	2.42	2.43	3.14	3.86	---	---
Corn #2 yl gr	40.98	46.65	56.56	66.65	72.77	78.78	86.49	54.13
Dicalcium phos	2.32	1.83	1.46	1.32	1.05	.8831	.7307	1.36
Fish menhaden 60%	---	---	---	---	---	---	---	---
Limestone grnd	1.44	1.23	1.10	.9798	.91	.7798	.7307	5.07
Meat + bone ml 50%	---	---	---	---	---	---	---	---
Methionine dl 98.5%	.1774	.0811	.0194	.0230	---	---	---	---
Salt (sodium chlrd)	.3695	.3204	.2459	.2487	.2511	.2534	.2467	.3236
Selenium pmx	.0068	.007	.0073	.0076	.0078	.0081	.0078	.0080
Sorghum gr 8-10%	---	---	---	---	---	---	---	20.81
Soybn ml-hll 47% slv	51.90	46.59	37.80	27.95	21.48	15.04	8.9	15.05
Trace min pmx	.0453	.0376	.0305	.0340	.0367	.0392	.0408	.0509
Vitamin pmx TC	.6364	.6339	.3670	.3637	.3559	.3559	.3559	.6983
Calculated Analysis								
Crude protein %	28	26	22.74	19	16.5	14	12.23	14.11
Kilocalories of ME/lb	1273	1318	1364	1409	1455	1500	1318	1318
Calcium %	1.2	1.0	.85	.75	.65	.55	.52	2.32
Available phos %	.60	.50	.42	.38	.32	.28	.25	.35

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