

RECENT ADVANCES ON THE NUTRITION OF GAME BIRDS

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Summary

The information on the nutrient requirements of game birds, and the suggested levels of nutrients in their diets is summarized. As all species of game birds have the same relative amounts of amino acids in their carcass, they should have similar amino acid requirements. The dietary protein requirement depends upon the rate of protein deposition in their carcass. Least cost formulation of a game bird diet is described.

I. INTRODUCTION

In their natural habitat, the game birds consume a variety of foods at anytime. The availability of foods depends upon the season and its abundance. The baby chicks consume more of animal matter than the adults. The game birds, in general, are quite cosmopolitan in their food habits and relish cereals, seeds of weeds and grasses fruits, berries, leafy green vegetation; snails, earthworms; insects and their larvae; pieces of snakes, mice, lizards, and many other animals. It would be impractical to provide this gourmet menu to birds raised in large numbers in captivity. However, the game birds do equally well on diets blended from the same ingredients as are used in poultry diets.

The diet provides metabolizable energy, essential and non-essential amino acids, essential and non-essential lipids, carbohydrates, minerals, vitamins and other essential nutrients. Before we could formulate game bird diets, we must have an idea about their quantitative need for the various nutrients, and the nutrient composition of various ingredients available for blending. The formulation of diets is a mere exercise to match the nutrient requirements of birds with a blend of nutrients from the available ingredients at an acceptably minimum cost.

II. NUTRIENT REQUIREMENTS OF GAME BIRDS

The meagre information about the nutrient requirements of some game birds, turkeys, ducks and geese as compiled by the National Academy of Sciences (NAS, 1977) is given in Table 1. The data in parenthesis are estimated values not derived from direct experiments. The paucity of information is evident from this table. We know more about turkey poults of 0-4 weeks of age than about the rest of game birds.

Our experience indicates that most of the game birds grow normally if fed the turkey starter diets containing 2800 kcal/kg metabolizable energy and 28% or 24% crude protein. In the latter case, the amino acid levels are also reduced proportionally. No statistically significant differences in the body weights of pheasants, partridge or coturnix fed either 25%, 30% or 35% crude protein were observed by the time they reached an age of 10 weeks, 14 weeks and 6 weeks, respectively (Vohra, 1973).

In absence of more information, the nutrient requirements of turkeys can be used as desirable levels to attain in diets for game birds. This supposition is amply justified if we scrutinize the data on the profiles of amino acids in the carcass of various game birds as in Table 2. The data are for carcasses devoid of feathers and digesta (USDA, 1979, Gertson et al., 1974). The main difference between the wild and domesticated species is in their carcass fats. The wild species have a lower fat content. But the protein content of the carcass on a fat free basis is about the same and averages at 22.5%.

The amino acid profiles of carcass protein are quite similar relative to an assigned value of 100 for lysine. The implication is that the relative amounts of various essential amino acids in all animal carcasses are similar (Williams et al., 1954). In all probability, all animals need relatively all the essential and unessential amino acids in the same ratios in their diets. As we have a better idea about the nutrient requirements of turkey poults, we could use similar diets for growing game birds.

III. DIETARY PROTEIN REQUIREMENTS.

The average body weights of some species of game birds and their cumulative feed consumptions are given in Table 3. From these data, we can calculate the growth rates of these species by using the logistic equation (Robertson, 1923)

$$K = (\ln W - \ln W_0) / (t - t_0)$$

where K is growth rate, W = body weight at time t and W₀ = initial body weight at anytime t₀, and may be considered equal to hatching weight at t₀ = 0.

The growth rates (K) calculated from Table 3 are presented along with growth rates of broiler chickens, turkeys and ducks in Table 4. The time needed to double the body weights is equal to 0.693/K.

Domestic ducks are the fastest growing species followed by turkeys, chickens, pheasants, partridge and quail. However, a good part of this increase in body weights of ducks and broilers is due to deposition of fat. The game birds are less fatty. If we should consider the rate of protein deposition by multiplying the growth rate (K) with the crude protein (C.P.) content of the carcasses, these species would be ranked in the following descending order: turkeys, pheasants, chickens, quail, partridge and ducks.

The rate of protein deposition is a better measure for estimating protein requirements than the rate of growth as measured from body weight.

The turkey poults are started on diets containing 28% crude protein, and other species perform optimally on diets containing about 24% crude protein. Domestic ducks need less protein than chickens. Partridge are started on diets containing 25% protein. From the rate of protein deposition, partridge should need about as much protein in their diets as needed by ducks. However, the protein requirement is related to the dietary energy content also.

IV. SUGGESTED LEVELS OF NUTRIENTS

The levels of nutrients suggested in Table 5 may be used for formulation of game bird diets. The level of vitamins are satisfactory in meeting the requirements of birds, yet some nutritionists tend to add vitamins A and D at double the levels suggested here.

V. NUTRIENT CONTENT OF INGREDIENTS

The nutrient contents of some of the most commonly used ingredients as summarized by NAS (1977). The list covers a total of 43 nutrients for 73 ingredients. We select a reasonable number of these ingredients which are easily available to us, and using their current prices, we formulate least cost diets to choose blends of ingredients which meet our specifications.

FORMULATION OF DIETS

The diets given in Table 6 meet the nutrient requirements of upland game birds. However, we have switched over to least cost formulations using a microcomputer system program developed by Hempleman and Burger (1980). The constraints used along with the price list of ingredients used by us are given in Table 7. The results of a computer print out to meet these specifications are given in Table 8. The calculated nutrient contents, and the range of prices of individual ingredients over which the composition would not change is also provided.

We are using these types of diets for game birds for their optimal performance (Woodard et al., 1977).

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TABLE 1 - Nutrient requirements of turkeys and some game birds^{1a}
(in percentage or amount per kg of feed) (NAS, 1977)

Nutrient	Turkeys 0-4 wks	Pheasant		Bobwhite quail	
		Starting	Growing 6-20 wks	Starting and Growing	Breeding
M.E., kcal/kg	2,800	2,800	2,700	2,800 ^b	2,800
Protein, %	28	30	16	28 ^b	(24)
Lysine, %	1.7	(1.5)	(0.8)	(1.4)	(0.7)
Methionine + cystine, %	1.05	(1.0)	(0.6)	(0.9)	(0.6)
Glycine + serine, %	1.0	(1.8)	(1.0)	(1.6)	(1.6)
Vitamin A, IU	4,000	(3,000)	(3,000)	(3,000)	(3,000)
Vitamin D, ICU	900	(1,200)	(900)	(900)	(900)
Riboflavin, mg	3.6	(3.5)	(2.6)	3.8	(4.0)
Pantothenic acid, mg	11	10	(10)	12.6	(15)
Niacin, mg	70	60	(40)	31	(20)
Choline, mg	1,900	(1,500)	(1,000)	1,500	(1,000)
Linoleic acid, %	1.0	(1.0)	(1.0)	(1.0)	(1.0)
Calcium, %	1.2	1.0	(0.7)	0.65	2.3
Chlorine, %	(0.8)	0.11	(0.11)	0.11	(0.15)
Phosphorus, %	0.8	0.8	(0.6)	0.65	1.0
Sodium, %	0.15	(0.1)	(0.1)	0.085	(0.15)
Iodine, mg	0.4	(0.3)	(0.3)	0.3	(0.3)
Magnesium, mg	(500)	(600)	(400)	(600)	(400)
Magnesium, mg	55	(90)	(70)	(90)	(70)
Zinc, mg	75	(60)	(50)	(60)	(50)

TABLE 1 - CONTINUED

Nutrient	Japanese quail		Ducks		Geese	
	Starting and Growing	Breeding	Starting and Growing	Breeding	Starting 0-6 wks	Breeding
M.E., kcal/kg	3,000	2,800	2,900	2,900	2,900	2,900
Protein, %	24 ^c	(24)	16	(15)	22	(15)
Lysine, %	1.4	(1.1)	(0.9)	(0.7)	0.9	(0.6)
Methionine + cystine, %	0.75	(0.8)	(0.8)	(0.55)		
Glycine + serine, %	1.7	(0.9)				
Vitamin A, IU	(5,000)	(5,000)	(4,000)	(4,000)	(1,500)	(4,000)
Vitamin D, ICU	(480)	(1,200)	220	(500)	(200)	(200)
Riboflavin, mg	(4.0)	(4.0)	4	(4)	4	(4)
Pantothenic acid, mg	(10)	(20)	11	(10)		
Niacin, mg	40	(20)	55	(40)	55	(20)
Choline, mg	2,000	(1,500)				
Linoleic acid, %	(1.0)	(1.0)				
Calcium, %	0.8	2.5	0.6	(2.75)	(0.8)	(2.25)
Chlorine, %	(0.15)	(0.15)				
Phosphorus, %	0.65	0.8	0.6	(0.6)	(0.6)	(0.6)
Sodium, %	(0.15)	(0.15)	0.15	(0.15)		
Iodine, mg	(0.3)	(0.3)				
Magnesium, mg	150	(500)	(500)	(500)		
Manganese, mg	(90)	(70)	40	(25)		
Zinc, mg	25	50				

^aThe values in () are estimates, not experimentally determined values.

^bMay be reduced to 20% at 6 weeks of age.

^cMay be reduced to 20% at 3 weeks of age.

TABLE 2 - Carcass composition of some game birds

	Chicken ^a	Duck ^b		Goose ^b	Guinea ^b	Partridge ^c	Pheasant ^b	Quail ^b	Turkey ^a
	broiler	Wild	Domestic	Domestic	fowl	Chicken		Bobwhite	
Moisture, %	66.3	66.5	48.5	49.7	68.8	69.6	66.8	69.4	70.6
Crude protein, %	18.3	17.4	11.5	15.9	23.4	17.5	22.6	19.6	20.4
(CP, % fat free basis)	(21.4)	(20.5)		(23.9)	(25.0)	(20.0)	(24.9)	(21.8)	(22.2)
Lipids, %	14.6	15.0	39.3	33.5	6.5	12.0	9.3	10.1	8.1
Relative amino acid content of protein									
Arginine	79	77		78			70	78	78
Cystine	17	18					15	21	12
Histidine	36	31		35			43	42	33
Isoleucine	62	60		59			61	62	56
Leucine	91	99		106			93	98	86
Lysine	100	100		100			100	100	100
(Lysine, %)	(8.02)	(8.43)		(8.39)			(8.24)	(8.22)	(9.03)
Methionine	33	32		30			32	36	31
Phenylalanine	49	49		53			44	50	44
Threonine	52	50		56			55	51	48
Tryptophan	14	16					15	17	12
Tyrosine	40	44		40			36	52	42
Valine	61	61		62			61	62	58

^aFlesh, skin, giblets and neck (USDA, 1979)

^bFlesh and skin, without neck (USDA, 1979)

^cFlesh, skin, giblets and neck (Gertonson et al., 1974)

TABLE 3 - Average body weights of some game birds and their cumulative feed consumption at different ages

Age (weeks)	Ringnecked pheasants			Partridge chukars			Japanese quail		
	Average weight, g		Feed intake, kg (Mean)*	Average weight, g		Feed intake, kg (Mean)*	Average weight, g		Feed intake kg (Mean)*
	Male	Female		Male	Female		Male	Female	
0	20	20	----	17	17	----	7	7	----
1	42	42	0.06	30	29	0.03	23	23	0.03
2	82	82	0.15	55	51	0.09	43	43	0.07
3	136	136	0.28	106	100	0.22	73	73	0.11
4	204	190	0.45	164	150	0.37	90	95	0.18
5	272	250	0.62	220	197	0.53	100	115	0.26
6	363	330	0.86	263	236	0.73	105	130	0.34
7	455	418	1.16	332	303	0.97	110	140	0.45
8	570	480	1.46	390	344	1.20	115	145	0.57
9	660	545	1.75	435	377	1.43	115	150	0.72
10	760	615	2.10	471	401	1.66	115	150	0.86
11	860	680	2.52	521	438	1.91	120	150	1.02
12	960	750	2.96	562	463	2.20	120	160	1.19
13	1065	820	3.39	581	472	2.49	120	160	1.37
14	1160	860	3.86	595	482	2.72	125	160	1.48
15	1240	890	4.32	605	493	2.95	125	165	1.61
16	1290	900	4.82	612	501	3.14	125	165	1.74
17	1300	920	5.32	620	512	3.33	125	170	1.87
18	1320	930	5.82	630	520	3.52	130	170	2.02

*Mean for both sexes

Avg. feed intake for
adults, g/day

70

35

22

TABLE 4 - Growth rates of some species of birds and the time needed to double their body weights over first.6 weeks.

Species	Growth rates K			Days to double body weights		Rate of protein deposit. Kx% car- cass E.P.
	Males	Females	Avg.	Males	Females	
Chickens	0.078	0.075	.076	8.88	9.24	0.014
Ducks	0.094	0.093	.093	7.37	7.45	0.010
Partridge	0.065	0.063	.064	10.66	11.00	0.011
Pheasants	0.069	0.067	.068	10.04	10.34	0.015
Quail	0.064	0.069	.066	10.82	10.04	0.013
Turkeys	0.086	.082	.084	8.06	8.45	0.017

time (days)=0.693/ K

TABLE 5 - Suggested Levels of Nutrients in Diets of Game Birds

Nutrient	Upland birds ^a			Ducks		Geese	
	Starting	Growing	Breeding	Starting	Growing and Breeding	Starting	Growing and breeding
Metabolizable energy (kcal/kg)	2500-2800	2500-2800	2500-2800	2500-2800	2500-2800	2300-2800	2300-2600
Total protein (%)	25	20	15	20	15	20	15
Lysine (%)	1.3	0.7	0.7	0.9	0.7	0.9	0.7
Sulfur amino acids (%)	0.9	0.6	0.5	0.6	0.5	0.6	0.5
Calcium (%)	1.2	1.0	2.25	1.0	2.75	1.0	2.25
Phosphorus, Inorganic (%)	0.6	0.4	0.4	0.5	0.4	0.5	0.4
NaCl (%)	0.37	0.37	0.37	0.37	0.37	0.37	0.37
Mn (%)	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Zn (%)	0.006	0.007	0.007	0.007	0.007	0.007	0.007
Mg (%)	0.05	0.05	0.05	0.05	0.05	0.05	0.05
K (%)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Vitamin supplements/kg diet							
Vitamin A (IU)	5000	2500	5000	5000	5000	4400	4400
Vitamin D (ICU)	1500	750	1500	1100	1100	1100	1100
Vitamin E (mg)	20	10	20	5	5	5	5
Thiamin ^b (mg)	2	1	2	2	2	2	2
Riboflavin (mg)	4	2	4	4	4	4	4
Pantothenic acid (mg)	20	10	20	15	15	15	15
Pyridoxine ^b (mg)	3	0.15	3	3	3	3	3
Folacin (mg)	1.0	0.5	1.0	0.5	0.5	0.5	0.5
Biotin ^b (mg)	0.2	0.1	0.2	0.2	0.2	0.2	0.2
Vitamin B ₁₂ (ug)	4	2	4	4	4	4	4
Choline chloride (mg)	2000	1000	2000	1000	1000	1000	1000
Niacin (mg)	50	50	50	50	50	50	50

^aUpland birds include grouse, pheasants, partridge, quail, and wild turkey.

^bMay be omitted from supplements for conventional nonpurified diets.

TABLE 6 - Composition of some diets for upland game birds
(inclusions, g/kg diet)

	Starter	Grower	Breeder
Alfalfa meal (20% protein)	75.0	50.0	50.0
Maize, ground	280.0	520.0	567.0
Meat and bone meal (50% protein)	80.0	-----	-----
Sorghum, ground	100.0	-----	-----
Soybean meal (45% protein)	280.0	275.0	147.0
Wheat, ground	150.0	-----	-----
Wheat middling	20.0	-----	168.0
CaCO ₃	-----	10.0	41.0
CaHPO ₄ ·2H ₂ O	-----	15.0	15.0
Salt, iodized	7.0	4.0	5.0
DL-methionine	3.0	1.0	2.0
Premix ¹	5.0	5.0	5.0

¹Supplied the following (in mg): MnSO₄·H₂O, 100; ZnO, 120; menadione bisulfite, 2; riboflavin, 6; niacin, 40; calcium pantothenate, 20; folacin, 0.5; vitamin B₁₂, 0.005; choline chloride, 2000; zinc bacitracin, 10; ethoxygrin, 100; (in IU): vitamin A, 5000; vitamin D₃, 1500; vitamin E, 20.

TABLE 7 - Constraints used in diet formulation and prices of ingredients.

	Constraint
Less or equal	Leucine, 2.0%
	Sulfur amino acids, 1.0%
Greater or equal	Isoleucine, 0.85%
	Lysine, 1.3%
	Methionine, 0.5%
	Crude protein, 25%
Equal	Unit weight, 1
	ME., 2.8 kcal/g
	Calcium, 1.2%
	Phosphorus, 0.8%
	Salt premix, 0.25%
	Vitamin premix, 0.25
Price US \$/100kg. (March, 1980)	
Corn, 12.70;	Milo, 12.10
Cottonseed meal, 16.70	Soybean meal, 19.50
Fat, 35.20	Vitamin premix, 88
Fish meal, 46.80	Wheat bran, 11.60
Lysine, 407	Wheat, 12.10
Methionine, 330	Salt premix 6.40
Meat meal, 29.70	Calcium carbonate, 2.70
	DiCalcium phosphate, 26.60

TABLE 8 - Least cost formulation for game bird starter diet (inclusions, g/kg diet)

Ingredient	Inclusion	\$ Price/ 100 kg diet
Soybean meal	287.4	5.60
Cottonseed meal	201.1	3.36
Corn, ground	457.9	5.81
Salt premix ¹	2.5	0.02
Vitamin premix ²	2.5	0.22
Fat	11.7	0.41
Lysine	0.1	0.02
Methionine	1.2	0.39
CaCO ₃	19.5	0.05
CaHPO ₄ ·2H ₂ O	16.1	0.43
	<u>1000.0</u>	<u>16.31</u>

¹NaCl (iodized) 2.3g; MnSO₄·H₂O, 100 mg; ZnO, 120 mg.

²See Table 6

Calculated nutrient content:

ME., 2.80 kcal/g	Crude protein, 25.0%
Ca, 1.20%	P, 0.8%
Arginine, 2.09%	Histidine, 0.64%
Isoleucine, 1.12%	Leucine, 2.00%
Lysine, 1.3%	Methionine, 0.5
Meth. + cyst., 0.89%	Phenylalanine, 1.32
Tyrosine, 0.78%	Threonine, 0.96
Tryptophan, 0.31	Valine, 1.29

Ranges of prices over which diet composition would not change CaHPO₄·2H₂O, none to \$40.9; soybean meal, \$18.3-21.47; Methionine, \$15.47 - 1246.7; CaCO₃, \$none - 27.4; corn, \$9.48 - 13.27; Lysine, \$239.9 - 506.8; fat, \$30.08 - 48.29; Cottonseed meal, \$15.68 - 17.57.