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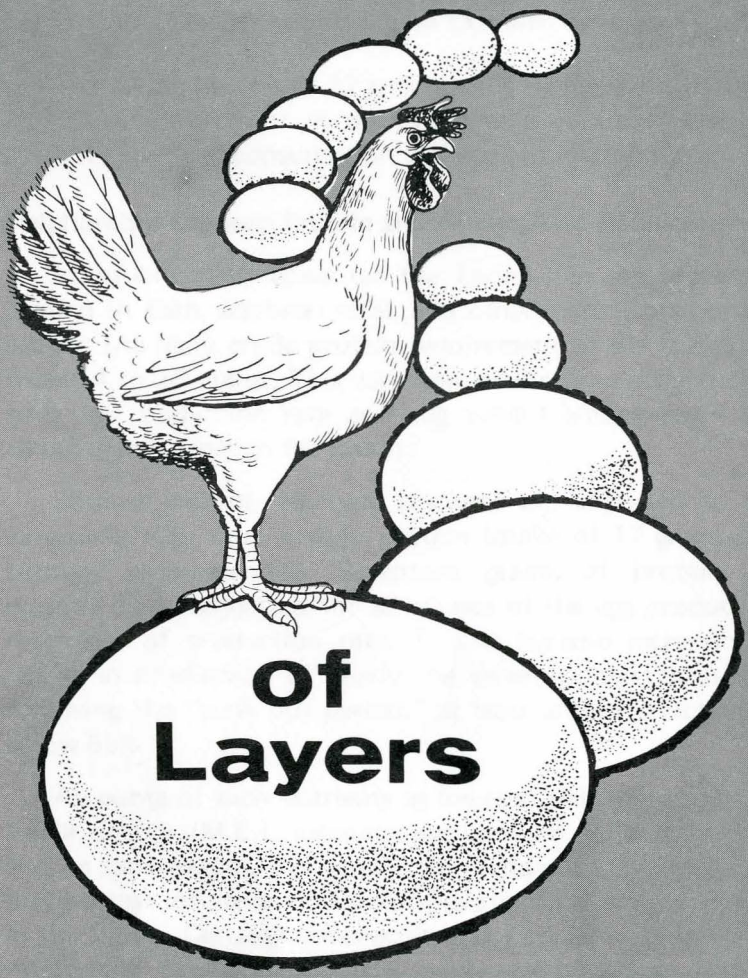
Daily Amino Acid Requirements of Layers



EXTENSION WORK IN "AGRICULTURE, HOME ECONOMICS AND SUBJECTS RELATING THERETO,"
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DAILY AMINO ACID REQUIREMENTS for Layers

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The laying hen needs 12 amino acids. These essential amino acids must each be present in the ration at a minimum level based on current daily feed consumption and egg production rates.

Relationship Between Protein and Amino Acid Requirements

Essential amino acids for the laying hen are provided by the protein in corn, soybean meal, and other ingredients present in the ration. The daily crude protein requirement of the laying hen varies from 14 to 18 grams. This variation results from differences in body size, egg production rate and egg weight among birds, as well as amino acid balance in the ration.

Because hybrid, egg-type chickens are expected to lay at an extremely high rate, a daily protein intake of 17 grams per bird is strongly recommended. Seventeen grams of protein daily has recently been suggested for all phases of the egg production cycle, regardless of production rate. This is because increasing egg size results in production of nearly the same egg mass both during and following the "peak out period," at least until production rate falls below 65%.

Amounts of such nutrients as the essential amino acids, metabolizable energy (M.E.), calcium, and sodium influence performance and, to some extent, the protein requirement of layers. M.E. level has the greatest influence on levels of protein and amino acids required in the ration. Certain amino acids may be lacking or deficient in the ration and limit performance, while other amino acids may be present in excess of the requirement. Excess amino acids are metabolized (or reconstructed) and utilized for energy by the bird.

Utilization of excess amino acids for energy is not desirable or efficient relative to either the hen's metabolism or the poultryman's pocketbook.

Amino acid requirements of laying chickens may be expressed in several ways. Scott *et al.* (1976) suggested that requirements might be expressed as: (1) grams of each amino acid per bird per day; (2) grams of each amino acid per 1000 kcal. M.E.; (3) percentages of the ration; or (4) percentages of the protein.

Tying the amino acid requirement to the energy content of the diet (No. 2) is probably the best and most practical, especially in least-cost formulation of rations.

The most precise way to express amino acid requirements is expressed in No. 1. This, however, does not lend itself to use by feed manufacturers.

No. 3 is unsatisfactory because feed consumption of the chicken is highly influenced by energy content of the diet, environmental temperature, body size, egg production rate, and other factors. Therefore, the percentage of each amino acid present in the diet must be increased when the dietary energy is increased and when chickens consume less feed.

No. 4 is based on a certain minimum dietary protein level which provides adequate and well balanced amino acid levels. Feed consumption rate also would have to be considered with this method. Unfortunately, feed intake can be overlooked with this and No. 3.

Recommended practical levels of amino acid in rations for laying chickens are given in Table 1. These levels are expressed in units of the ration for each 1000 kcal. of M.E. Amino acid levels recommended for practical rations containing 1250 to 1300 kcal. of M.E. per pound are also listed. These amino acid levels are recommended for hybrid, egg-type layers from 20 to 72 weeks of age, when an egg/bird/day is potentially possible and expected from most hens.

Daily Amino Acid Requirements

The sulfur-containing amino acids, methionine and cystine, plus tryptophan are most likely to be deficient in layer rations composed

largely of corn (and/or milo) and soybean meal. A laying chicken should consume a minimum of 280 to 300 milligrams (mg) of methionine daily for optimum egg production. The total sulfur amino acid (T.S.A.A., methionine and cystine) consumption should be at least 530 to 550 mg per bird each day. Methionine can substitute for cystine but the reverse is not true. The minimum daily tryptophan and lysine requirements are not well established, but are apparently between 140 and 180 mg per bird for tryptophan and between 550 and 700 mg per bird for lysine.

Methionine, Cystine and Total Sulfur Amino Acid Requirements

Special attention should be given to the methionine and cystine or T.S.A.A. requirement of layers. Methionine is the most limiting (or most likely to be deficient) amino acid in practical, corn-soybean meal rations. Methionine is available in synthetic, purified chemical form for addition to practical rations.

Minimum daily requirements of methionine, cystine and T.S.A.A. in milligrams per bird/day are given in Table 2. These daily intake levels are suggested for hybrid, egg-type birds for optimum egg production. Margins of safety from 10 to 20% are suggested to compensate for variations in the amino acid composition of feed ingredients and errors which are likely to occur in calculating feed intake of birds in commercial units.

The methionine intake in milligrams per bird daily can be easily determined, if daily feed intake per 100 birds is known along with the methionine level in the rations, as shown in Table 3. Also, the methionine level necessary in the ration to obtain the desired daily intake can be determined from Table 3. For example, if a flock is consuming 21 pounds of feed (per 100 birds) daily, and a daily methionine intake of 340 mg per bird is desired, the ration should contain 0.36% methionine.

Table 4 is similar to Table 3 in that T.S.A.A. daily intake or ration levels can be obtained for different feed consumption rates. If daily methionine and T.S.A.A. intakes are adequate, a daily protein intake of about 16 to 17 grams per bird should allow optimum layer performance. Table 5 illustrates how daily protein intake in grams per bird will vary depending on feed consumption rate and protein level in the ration.

Table 1. Approximately practical levels of amino acids in rations for laying chickens (hybrid, egg-type) from 20 to 72 weeks of age.

Nutrient	*A.A./megacalorie (1000 kcal M.E.)*[a,b]	*A.A. levels for rations containing 1250-1300 kcal M.E./lb.*
M.E., kcal./lb	1000	1250-1300
M.E., kcal./kg	2205	2756-2866
Protein, %	--------	17.0
	Units	%
Arginine	0.63	0.81
Histidine	0.25	0.32
Isoleucine	0.63	0.81
Leucine	0.95	1.22
Lysine	0.53	0.68
Methionine[c/]	0.27	0.35
Cystine[c/]	0.20	0.26
or Meth. & cyst.	0.47	0.61
Phenylalanine	0.58	0.74
Tyrosine	0.25	0.32
Threonine	0.46	0.60
Tryptophan	0.13	0.17
Valine	0.54	0.69

[a/] *Scott, M. L., M. C. Neshein and R. J. Young, 1976. Nutrition of the Chicken, 2nd ed., M. L. Scott & Associates Publishers, Ithaca, N.Y.*

[b/] *To determine the actual percent of the amino acid required in the diet, multiply the ratio in the table by the metabolizable megacalories per pound of proposed diet. A 1300 kcal/lb diet contains 1.3 megacalories.*

[c/] *Methionine can be used to furnish part or all of the cystine requirement.*

Energy level in the ration and daily consumption rates are very important in regard to optimum egg production and the most efficient utilization of nutrients, especially the amino acids. Research data and extensive field reports have indicated that hybrid, egg-type layers will consume 240-260 kcal. of M.E. per bird daily in summer months, and 275-290 kcal. per bird daily in the winter. These daily

M.E. intake levels can usually be obtained with rations containing 1200 to 1350 kcal. of M.E. per pound (2640 to 2970 kcal. M.E./kg).

The influence of feed consumption levels of 73 to 109 g/hen/day (16 to 24 lb/100 hens/day) on the daily intake of protein and certain critical amino acids is illustrated in Table 6. This illustration is based on the consumption of typical, corn-soybean meal rations supplemented with 0.05% of methionine (1.0 lb/ton).

Data in Table 6 illustrate that estimated daily requirements of tryptophan (140-180 mg/hen) and lysine (550-700 mg/hen) are met at the lowest consumption rate (16 lb/100 hens or 73 g/hen) with rations containing between 16 to 18% protein. If tryptophan and lysine requirements are to be met in this manner, rations with 16 to 18% protein should be composed largely of corn and soybean meal. When daily feed consumption rates are 22 to 24 lb/100 hens or 100-109 g/hen, a 14% ration composed largely of corn and soybean meal will provide adequate tryptophan and lysine. Therefore, in formulating layer rations, protein level should be allowed to "float" between 14 to 18% to provide adequate tryptophan, lysine, and other amino acid levels. Supplemental methionine or methionine hydroxy analog should then be added to provide levels adequate to meet the hen's daily requirement based on feed consumption rate. Added methionine levels can apparently be as high as 0.15 to 0.20% (3 to 4 lb/ton) without difficulty.

Table 2. Suggested daily intake of methionine, cystine or total sulfur amino acids for optimum performance of hybrid, egg-type layers.

Age of birds	*Methionine*	*Cystine*	*T.S.A.A.*	*Remarks*[a/]
weeks		Daily intake/bird, mg		
20 - 40	340	300	640	Min. + 20%
41 to finish	322	288	610	Min. + 15%

[a/] *Intake levels presented for either methionine, cystine or T.S.A.A. are based on recent studies and N.R.C. recommendations. These levels include margins of safety as indicated.*

Table 3. Daily methionine intake when hens are consuming different amounts of feed.

Feed intake/day		*% Methionine and approx. % crude protein[a/] in ration*				
100 hens	*1 hen*	*.30*	*.32*	*.34*	*.36*	*.38*
		15.0	*16.5*	*18.0*	*19.5*	*21.0*
lb	grams	Daily methionine intake/hen, mg				
25.0	113	339	362	384	407	429
24.0	109	327	349	371	392	414
23.0	104	312	333	354	374	395
22.0	100	300	320	340	360	380
21.0	95	285	304	323	342	361
20.0	91	273	291	309	328	346
19.0	86	258	275	292	310	327
18.0	82	246	262	279	295	312
17.0	77	231	246	262	277	293
16.0	73	219	234	248	263	277

[a/]Approximate crude protein levels which correspond to the indicated methionine levels in rations composed largely of corn and soybean meal and supplemented with 0.05% added methionine or 1 lb/ton.

Table 4. Daily total sulfur amino acid (T.S.A.A.) intake when hens are consuming different amounts of feed.

Feed intake/day		*% T.S.A.A. and approx. % crude protein[a/] in ration*				
100 hens	*1 hen*	*.54*	*.58*	*.62*	*.66*	*.70*
		15.0	*16.5*	*18.0*	*19.5*	*21.0*
lb	grams	Daily T.S.A.A. intake/hen, mg				
25.0	113	610	655	701	746	791
24.0	109	589	632	676	719	763
23.0	104	562	603	645	686	728
22.0	100	540	580	620	660	700
21.0	95	513	551	589	627	665
20.0	91	491	528	564	601	637
19.0	86	464	499	533	568	602
18.0	82	443	476	508	541	574
17.0	77	416	447	477	508	539
16.0	73	394	423	453	482	511

[a/]Approximate crude protein levels which correspond to the indicated T.S.A.A. levels in rations composed largely of corn and soybean meal and supplemented with 0.05% added methionine or 1 lb/ton.

Table 5. Daily protein intake when hens are consuming different amounts of feed.

Feed intake/day		*% protein in ration*					
100 hens	*1 hen*	*14*	*15*	*16*	*17*	*18*	*20*
lb	grams	Daily protein intake/hen, grams					
25.0	113	15.8	17.0	18.1	19.2	20.3	22.6
24.0	109	15.3	16.4	17.4	18.5	19.6	21.8
23.0	104	14.6	15.6	16.6	17.7	18.7	20.8
22.0	100	14.0	15.0	16.0	17.0	18.0	20.0
21.0	95	13.3	14.2	15.2	16.2	17.1	19.0
20.0	91	12.7	13.7	14.6	15.5	16.4	18.2
19.0	86	12.0	12.9	13.8	14.6	15.5	17.2
18.0	82	11.5	12.3	13.1	13.9	14.8	16.4
17.0	77	10.8	11.6	12.3	13.1	13.9	15.4
16.0	73	10.2	11.0	11.7	12.4	13.1	14.6

Table 6. Influence of ration composition and feed consumption rate on daily intake of protein and critical amino acids.

	Feed consumption rate				
	lb/100 hens/day				
	24	*22*	*20*	*18*	*16*
Nutrient levels in ration[a/]	*grams/hen/day*				
	109	*100*	*91*	*82*	*73*
	Daily intake, grams[b/]				
Protein, 14%	15.3	14.0	12.7	11.5	10.2
Methionine, 0.28%	.305	.280	.255	.230	.205
Cystine, 0.23%	.251	.230	.209	.189	.168
T.S.A.A., 0.51%	.556	.510	.464	.418	.372
Tryptophan, 0.16%	.174	.160	.146	.131	.117
Lysine, 0.70%	.763	.700	.637	.574	.511
	Daily intake, grams[b/]				
Protein, 16%	17.4	16.0	14.6	13.1	11.7
Methionine, 0.31%	.338	.310	.282	.254	.226
Cystine, 0.26%	.283	.260	.237	.213	.190
T.S.A.A., 0.57%	.621	.570	.519	.467	.416
Tryptophan, 0.19%	.207	.190	.173	.156	.139
Lysine, 0.86%	.937	.860	.783	.705	.628
	Daily intake, grams				
Protein, 18%	19.6	18.0	16.4	14.8	13.1
Methionine, 0.34%	.371	.340	.309	.279	.248
Cystine, 0.28%	.305	.280	.255	.230	.204
T.S.A.A., 0.62%	.676	.620	.564	.508	.453
Tryptophan, 0.22%	.240	.220	.200	.180	.161
Lysine, 1.01%	1.101	1.010	.919	.828	.737
	Daily intake, grams				
Protein, 20%	21.8	20.0	18.2	16.4	14.6
Methionine, 0.36%	.392	.360	.328	.295	.263
Cystine, 0.32%	.349	.320	.291	.262	.234
T.S.A.A., 0.68%	.741	.680	.619	.558	.496
Tryptophan, 0.25%	.272	.250	.228	.205	.182
Lysine, 1.17%	1.275	1.170	1.065	.959	.854

[a/] *Nutrient levels correspond approximately to those furnished by rations containing the indicated protein levels and composed largely of corn and soybean meal with 0.05% supplemental methionine or 1 lb/ton.*

[b/] *One gram = 1,000 mg or g x 1000 = mg.*