Application of modern nutrition principles in poultry

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Considerable savings can be realized and performance can be improved by formulating poultry feeds based on the daily feed intake and nutrient needs of the chicken. Programmes have been developed for commercial layers, broiler breeders, and replacement pullets for commercial egg production. Programmes have also been suggested for broiler breeder replacements for this purpose. Suggestions have been made for feeding broilers on the basis of age and daily feed intake although feed depression is an important consideration in this situation.
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Aansienlike besparings kan teweeggebring word en produktiwiteit kan verhoog word deur pluimveevoeding te baseer op die daaglikse voerinname en voedingsbehoefte van die hoender. Programme is ontwikkel vir kommersiële lêhenne, braaikuikens en plaasvervanger-henne vir kommersiële eierproduksie. Programme is ook voorgestel vir gebruik by die teel van braaikuiken-plaasvervangers. Voorstelle is gemaak vir die voer van braaikuikens gebaseer op ouderdom en daaglikse voerinname, alhoewel verlaging in voerinname 'n belangrike aspek is om mee rekening te hou in hierdie situasie.
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All animals have a need for a certain amount of each nutrient every day in order to accomplish desired performance. Programs have been developed at the University of Florida to formulate feeds for commercial layers, broiler breeders, and replacement pullets for commercial egg production on an intake basis. A programme has been developed for broiler breeder replacements and some suggestions have been made for developing a similar programme for broilers. A brief review of each programme will be made and recommendations will be given for formulating feeds on this basis.

Commercial laying hens

For years it has been recognized that the nutrient composition of feeds for laying hens should be changed when temperature changes. This is necessary because the hen eats less feed in hot weather than in cold weather. In addition, there are other factors which control the amount of feed which the hen eats. Therefore, it was necessary to develop recommendations for daily intake of certain nutrients for the laying hen. The first recommendations from the University of Florida (Harms, Douglas, Christmas, Damron & Miles, 1978) are shown in Table 1. A daily intake of 610 mg of sulfur amino acids and 730 mg of lysine was recommended. At this time recommendations were not made for any of the other amino acids. Recommendations were also made for sodium and calcium. It was suggested that the level of phosphorus be reduced as the hen aged in order to improve eggshell quality.

Since the level of phosphorus was changed for three different stages of life, it was decided that it would be appropriate to make other modifications (Harms, 1979) in order to feed the bird more efficiently. These are shown in Table 2. A high

Table 1 Suggested daily nutrient intake for commercial layers

Nutrient	Daily intake
Sulfur amino acids	610 mg
Lysine	730 mg
Vitamins[a]	–
Sodium	170 mg
Calcium	3,4 g
Phosphorus	
20 – 36 weeks of lay	650 mg
37 – 52 weeks of lay	550 mg
53 weeks to end of lay	450 mg

[a]Levels of vitamins in finished feed must meet minimum daily intake as suggested by the National Research Council (NRC).

Table 2 Suggested daily intake of various nutrients when commercial layers are fed based on feed intake

	Age (weeks)		
Nutrient	20 – 36	37 – 52	53
Sulfur amino acids (mg)	610	590	570
Lysine (mg)	730	706	680
Tryptophan (mg)	180	174	168
Arginine (mg)	920	890	860
Sodium (mg)	170	170	170
Calcium (g)	2,9	3,4	3,6
Phosphorus (mg)	650	550	450
Vitamins[a]			

[a]Levels of vitamins in finished feed must meet minimum daily intake as suggested by the NRC.

level of amino acids was recommended for 20 – 36 weeks of age with the lowest level of calcium and the highest level of phosphorus. The amino acid levels were reduced with age reducing the margin of safety and as a means of reducing the cost of the feed. This reduction was not made because the amino acid requirements of the hen decrease with age. The level of calcium was increased and the level of phosphorus decreased as the hen aged. These changes were made in an effort to get better eggshell quality.

In 1981 the recommendations (Harms, 1981) were again modified and specifications were made for six different age groups (Table 3). The recommendations for 20 – 27 weeks were the same as had previously been recommended. The recommendations for 36 – 43 weeks were also the same as had previously been recommended for 37 – 52 weeks of age. The intermediate phase from 28 to 36 weeks was formulated by taking an average of these two. The basis for this was that if the requirements were to be changed at 36 weeks, why not make an intermediate change and save some money while improving the performance of the hen? The recommendations after 51 weeks were the same as those used previously. The 44 – 51 week recommendation was an average of the original phase 2 and phase 3. The sixth program was formulated to meet the bare minimum requirements of the hen and is to be fed six weeks before hens go to market or are force moulted. This change is again made primarily in an effort to save money, however, the programme includes an increase in calcium and a reduction in phosphorus which has been shown to give an improvement in eggshell quality.

In order to show how the composition of the feed changes when the feed intake changes, the amino acid specifications for phase 1 (20 – 28 weeks) are shown in Table 4. The sulfur amino acid level ranges from a high of 0,789% when the hens are eating 17 lb per 100 birds per day to a low of 0,537% when the hens are consuming 25 lb per day. The other amino acids follow the same pattern. A suggestion is given for protein. However, it is not necessary that this level be met if amino acids are adequate. The specifications for minerals and vitamins are also shown in Table 4. The phosphorus level ranges from a high of 0,84% total phosphorus at the 17 lb intake to a low of 0,57% for the 25 lb intake. The calcium and sodium are also phased down. However, a calcium level higher than 3,3% is not recommended regardless of feed intake. It is quite well established that if the feed contains more calcium than necessary, it will reduce feed intake. With young hens, it is desirable to get them to eat as much as they will in order to increase egg size as rapidly as possible. The necessity of changing feed formulation as the feed intake changes, is shown in Table 5. If the feed is formulated to meet the specifications for 22 lb intake, and the hen eats this

Table 3 Suggested daily intake for commercial egg production hens when fed based on daily intake

	Age (weeks)					6 weeks before termination
Nutrient	20 – 27	28 – 36	36 – 43	44 – 51	51 –	
Sulfur amino acids (mg)	610	600	590	580	570	550
Lysine (mg)	730	720	706	693	680	656
Tryptophan (mg)	180	177	174	171	168	162
Arginine (mg)	920	905	890	875	860	830
Calcium (g)	2,9	3,2	3,4	3,5	3,6	3,8
Phosphorus (mg)	650	600	550	500	450	425
Sodium (mg)	170	170	170	170	170	170

Table 4 Protein, amino acids, mineral and vitamin specifications for layer feeds (20 – 27 weeks of age) based on feed intake

Feed intake/ hen/day (lb)	Protein %	SAA[a] %	Lysine %	Tryptophan %	Arginine %	Ca %	P %	Na %	Vitamins (lb)
0,17	18,0	0,789	0,945	0,234	1,190	3,30	0,84	0,21	6,4
0,18	17,5	0,746	0,892	0,220	1,124	3,30	0,79	0,21	6,0
0,19	17,0	0,706	0,845	0,208	1,065	3,30	0,75	0,20	5,8
0,20	16,5	0,671	0,801	0,198	1,012	3,19	0,71	0,19	5,5
0,21	16,0	0,639	0,765	0,189	0,964	3,04	0,68	0,18	5,3
0,22	15,5	0,610	0,730	0,180	0,920	2,90	0,65	0,17	5,0
0,23	15,0	0,583	0,689	0,172	0,880	2,77	0,62	0,16	4,8
0,24	14,7	0,559	0,669	0,165	0,843	2,65	0,60	0,16	4,5
0,25	14,0	0,537	0,643	0,158	0,810	2,55	0,57	0,15	4,3

[a]Sulfur amino acids

Table 5 Daily nutrient intake of hens when fed the same feed at different feed intakes

Nutrient	Feed/100 hens/day		
	20	22	24
Protein (g)	14,7	15,5	16,5
SAA (mg)	559	610	671
Lysine (mg)	669	730	801
Tryptophan (mg)	164	180	196
Arginine (mg)	838	920	1002
Calcium (g)	2,74	2,90	3,07
Phosphorus (mg)	600	650	710
Sodium (mg)	160	170	190

amount, she will receive 15,5 g of protein per day, 610 mg of sulfur amino acids, 730 mg of lysine, 180 mg of tryptophan, and the other nutrients which are desired. However, if this same feed is used, and the hens only consume 20 lb per 100 birds per day, they will receive 10% less of all nutrients than is desired. In other words, instead of getting an intake of 610 mg of sulfur amino acid, the hen would get 559 and all other nutrient intakes would be reduced proportionately. On the other hand, if this same feed is given and the hen consumes 24 lb/100 birds/day, they will consume approximately 10% more of all nutrients than is necessary. This is very expensive and could possibly reduce performance of the hens.

Considerable money can be saved by the formulation of feed based on intake as shown in Table 6. This is the ingredient cost of feeds which meet the requirement when hens are consuming 22 or 25 lb per day. Assumptions are that corn costs US $100 per ton and soybean US $150 or 350. With the US $150 per ton cost for soybean meal, the ingredients for a ton of finished feed for the 22 lb intake would cost US $107,20. If the feed was formulated to meet the requirement of the hen, when she was consuming 25 lb per 100 birds per day, the cost would be US $103,83 or a difference of US $3,37. If the price of soybean meal increased to US $350 there would be a US $10,65 difference per ton in savings in ingredient cost. There would also be additional savings because the energy content of the feed would be increased. When the protein level is decreased, soybean meal is replaced with corn, and the energy level of the feed increases. If corn and soybean meal were used to formulate a feed for 22 and 25 lb intake, there would be a difference of 41 kcal per lb of feed. The hen reduces her feed intake by 1% for each 14 kcal increase, therefore, she would reduce the amount of feed consumed by 2,21% (2,21% of the $107,20 is $2,37). When this is added to the $3,37 for savings in ingredient cost there is a savings of $5,77, and at the $350/ton for soybean meal the savings would be $13,84.

Table 6 Saving realized from a ton of feed when nutrient requirements are based on daily intake

Basis	Cost (US $) SBM/ton	
	150	350
22 lb/day	107,20	114,45
25 lb/day	103,83	133,80
Difference	3,37	10,65
Energy savings[a]	2,37	3,19
Total	5,67	13,84

[a]Saving due to 2,21% increase in energy content

If feeds are to be formulated on these specifications, it is necessary to use the same nutrient profile for the ingredients. The amino acid composition of corn and soybean meal which are used for the specifications from the University of Florida are shown in Table 7. If different values are used it is necessary to adjust the nutrient recommendations accordingly.

Table 7 Amino acid content of corn and soybean meal

Nutrient	Corn (%)	SB (49%) (%)
SAA	0,37	1,43
Lysine	0,24	3,04
Tryptophan	0,09	0,73
Arginine	0,52	3,70

Broiler breeder program

After developing a programme for feeding commercial layers based on the daily feed intake, a similar programme was developed for broiler breeders (Harms & Wilson, 1983). Based on previous research, specifications for daily nutrient intake of broiler breeders were established (Table 8). The original specifications were for 23 g of protein, 850 mg of sulfur amino acids, 4,5% of calcium, 750 mg phosphorus and 170 mg sodium. After conducting a series of two experiments it was found that these suggestions were approximately 20% higher than the requirement (Table 8). The requirement for protein was no more than 18,6 g and the sulfur amino requirement was no more than 682 mg. A requirement for methionine, lysine, arginine and tryptophan was also established. The mineral requirements previously suggested were also higher than necessary. Based on these results, new specifications were established (Table 8). The original requirements were reduced by 10% as shown in the right-hand column. The original requirements were much higher than the revised, and the revised recommendations were still much higher than the actual requirements. These recommendations carried a 10% margin of safety and if the amount of feed broiler breeders get each day is actually measured, these recommendations could be reduced even further. The recommendations for

Table 8 Original and revised recommended daily nutrient intake and requirement for broiler breeders

Nutrient	Daily intake		
	Original	Requirement	Revised
Protein (g)	23	18,6	20,6
Sulfur amino acids (mg)	850	682	754
Methionine (mg)	–	361	400
Lysine (mg)	–	808	938
Arginine (mg)	–	1226	1379
Tryptophan (mg)	–	223	256
Calcium (g)	4,50	3,66	4,07
Phosphorus[a] (mg)	750	613	683
Sodium (mg)	170	139	170
Vitamins[b]			

[a]Expressed as total phosphorus
[b]Levels of vitamins in finished feed must meet minimum daily intake as suggested by NRC

Table 9 Nutrient specifications for broiler breeder hens based on feed allowance

Feed intake/ hen/day (lb)	Protein %	SAA %	Meth. %	Lysine %	Arginine %	Tryptophan %	Ca %	P %	Sodium %	Vitamins (lbs/ton)
0,28	15,97	0,584	0,310	0,727	1,069	0,198	3,21	0,529	0,132	5,7
0,29	15,66	0,573	0,305	0,713	1,049	0,195	3,10	0,519	0,129	5,5
0,30	15,15	0,554	0,294	0,689	1,014	0,188	2,99	0,502	0,125	5,3
0,31	14,65	0,536	0,285	0,667	0,981	0,182	2,89	0,486	0,121	5,2
0,32	14,20	0,520	0,276	0,646	0,950	0,176	2,80	0,471	0,117	5,0
0,33	13,76	0,504	0,267	0,627	0,921	0,171	2,72	0,456	0,114	4,9
0,34	13,36	0,489	0,259	0,608	0,894	0,166	2,64	0,442	0,110	4,7
0,35	12,97	0,475	0,252	0,591	0,868	0,161	2,56	0,430	0,107	4,6
0,36	12,61	0,462	0,245	0,574	0,844	0,157	2,49	0,418	0,104	4,4
0,37	12,28	0,449	0,238	0,559	0,822	0,153	2,43	0,407	0,101	4,2
0,38	11,96	0,438	0,232	0,544	0,800	0,149	2,36	0,396	0,099	4,1
0,39	11,64	0,426	0,226	0,530	0,780	0,145	2,30	0,386	0,096	3,9
0,40	11,36	0,221	0,221	0,517	0,760	0,141	2,24	0,376	0,094	3,8

formulation of feeds based on various daily feed allowances are shown in Table 9. The levels of amino acid decrease as feed allowance increases. For instance, the sulfur amino acid content of the feed at a 28 lb daily allowance would be 0,584% and is reduced to 0,416% if 40 lb of feed is given. The other amino acids decrease in the same proportion. The specifications for minerals and vitamins are also shown in Table 9. The calcium level is 3,21% at the 28 lb allowance and is reduced to 2,24% at the 40 lb intake. All these levels would result in the hen getting 4,07 g calcium per day which would meet the requirement. The vitamin, phosphorus and sodium levels also vary in the same manner.

If this programme is followed, it would also result in considerable savings in feed cost as shown in Table 10. These prices are based on US $100 per ton of corn and US $150 per ton of soybean meal. There would be a savings of US $2,73 per ton in ingredient cost if the feed were formulated on the specifications for a 32 lb intake and we were actually giving them 36 lb. The energy level would also be increased when reformulating the feed. This would result in 2,7% less feed being given each day, and would result in a US $2,96 per ton savings. The total savings would be US $5,69 with a cost difference of only $50 per ton for corn and soybean. If the difference is increased, the savings would be greater.

Table 10 Savings from formulation based on nutrient specifications for daily allowance

Basis	Cost SBM/ton (US $150)
32 lb/day	109,74
36 lb/day	107,01
Difference	2,73
Energy savings[a]	2,96
Total	5,69

[a]Savings due to 2,7% increase in energy content

Commercial egg replacement pullet

Feeding replacement pullets are discussed next. A graphic presentation of one method of feeding replacement pullets as compared to the new method is shown in Figure 1. Until approximately 6 years ago, we were recommending that the

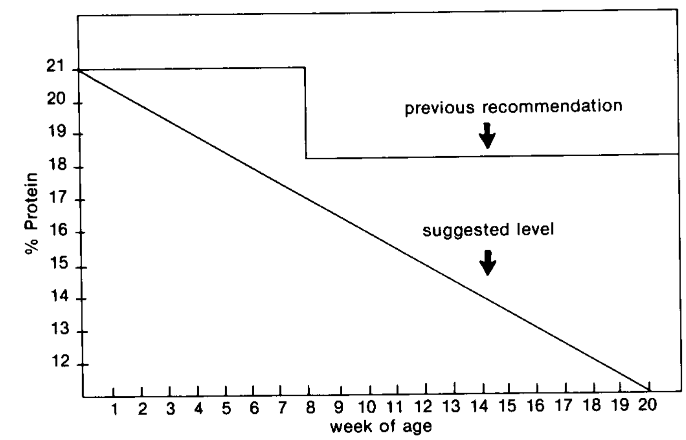

Figure 1 Previous recommendation and suggested levels of protein for commercial egg replacement pullets.

pullets be fed 21% protein for the first 8 weeks of life, and 18% thereafter, especially if they were placed in the laying house after March 15. This was necessary to get the maximum bodymass on the pullet before placing it in the laying house in order to get the best production during the hot weather. However, the general recommendation is to lower the level of protein at about 6 weeks, again at 12 and again at 16. If the requirement decreases in this manner it is more logical to decrease it in a linear fashion (Figure 1). Experiments using a stepwise reduction in protein were conducted at the University of Florida and it was found that this program resulted in maximum performance of the pullet. Subsequently studies were conducted to establish the amino acid requirement of the pullet (Harms & Douglas, 1981) as shown in Table 11. Note that an eighth feed program is suggested for the pullet. A sulfur amino acid level of 0,68% is recommended for the first 5 weeks, and is gradually reduced to 0,42% from 19 to 20 weeks. If the flock is large enough to necessitate the delivery of 16 loads of feed, formulations should be based on specifications for 16 feeds. These recommendations are for corn/soybean meal diets and the approximate energy level is shown in the right-hand column. To convert these values to the nutrient requirement per megacalorie, divide the requirement by this energy level and multiply by 1000. Mineral recommendations are also shown in Table 11. The requirement decreases as the pullet ages; however, sodium was left constant at 0,15% of the diet. More research is needed on the sodium requirement of the pullet.

Table 11 Suggested nutrient requirements of the replacement pullet for corn-soybean meal diets

Age (weeks)	Methionine %	M + C %	Lysine %	Tryptophan %	Arginine %	Ca %	P[b] %	Na	kcal/lb[a] %
0 – 5	0,36	0,68	0,86	0,23	1,12	0,80	0,65	0,15	1384
6 – 8	0,31	0,61	0,79	0,20	1,00	0,75	0,60	0,15	1404
9 – 10	0,29	0,54	0,64	0,17	0,92	0,70	0,55	0,15	1440
11 – 12	0,28	0,52	0,60	0,16	0,86	0,68	0,53	0,15	1446
13 – 14	0,25	0,47	0,57	0,15	0,82	0,65	0,50	0,15	1451
15 – 16	0,23	0,46	0,55	0,14	0,77	0,63	0,48	0,15	1459
17 – 18	0,22	0,44	0,52	0,13	0,72	0,60	0,45	0,15	1468
19 – 20	0,21	0,42	0,48	0,12	0,67	0,57	0,43	0,15	1475

[a]Indicates approximate energy level when corn and soybean meal (49%) are used. Requirement per therm of energy may be calculated by dividing requirement by energy level and multiplying by 1000.

[b]Requirement expressed as total P when corn and soybean meal are used

Research has not been conducted with broiler breeder replacements. However, the same approach could be used as is used with egg production pullets.

Factors affecting feed intake

There are factors which affect feed intake and in turn will influence feed formulation and also nutrient level requirements of the feed expressed on a percentage basis. During the past 10 – 15 years, experiments have been conducted on the influence of copper on growth of broilers and turkeys as well as the influence of monensin on growth of broilers. Robbins & Baker (1980) studied the influence of increasing amino acids, minerals, and vitamins in a purified diet with and without added copper. Their conclusions were that this diet was adequate in vitamins, minerals, and amino acids in the presence or absence of added copper. However, close examination of the data (Table 12) indicated that this was not true.

The addition of amino acids to the basal diet containing no supplemental copper resulted in increasing bodymass by 8 g, which was not statistically significant (pooled error 4,2 g). The addition of minerals and vitamins gave no further improvement in bodymass. However, there is a different pattern of performance of the chicks receiving the diet with and without added copper. With copper the addition of amino acids resulted in increasing growth rate by 11 g, which was statistically significant. The addition of minerals to the diet with added amino acids resulted in another numerical improvement in growth. Also when additiōnal vitamins were added to the diet containing added amino acids and minerals a further significant increase in growth was obtained. These data indicate that the depression in bodymass gain from the addition of copper was partially due to depressed feed and nutrient intake.

Table 12 Mass gain and feed consumption of chicks fed zero and 500 μg/g copper with and without added amino acids, minerals and vitamins

Dietary addition			Gain (g)		Feed intake (g)	
Amino acid[a]	Minerals[b]	Vitamins[c]	Basal	Copper	Basal	Copper
–	–		103	66	166	128
+	–	–	111	77	145	132
+	+		113	85	143	131
+	+	+	113	99	147	139

[a]50% increase; [b]25% increase; [c]100% increase

In the same study, the addition of amino acids to the diet resulted in reducing feed intake (Table 12) when the basal diet was fed containing no added copper. The addition of vitamins and minerals did not influence this further. The addition of copper resulted in decreasing feed intake. When the amino acids were added to the copper-containing diet, a slight improvement in feed intake was noted. The addition of minerals did not affect feed intake, but a dramatic increase in feed intake was obtained when chicks received added vitamins, minerals and amino acids. It is obvious that a large portion of the growth depression from copper was due to decreased feed intake which resulted in the birds not receiving an adequate daily intake of vitamins, minerals, or amino acids. Undoubtedly, there is a toxic effect from 500 μg/g of copper in this diet. However, the majority of the growth depression was due to an inadequate intake of nutrients. With this in mind, an experiment was designed to determine if it is possible to overcome the growth depression from adding 500 μg/g of copper supplied as copper sulfate to practical corn-soybean meal type diets (Christmas & Harms, 1982). The approach was to increase the level of all nutrients that might be limiting when feed intake was decreased. A list of these nutrients is shown in Table 13. Salt, phosphorus, calcium, and micro-ingredients were increased by 20% over the levels in the basal diet. Lysine and methionine were increased and folic acid, pyridoxine, biotin, potassium, magnesium and sulfate were added. A diet was fed which contained 20,7% protein which has been shown to support near maximum growth especially with a low level of supplemental methionine (Table 14). When

Table 13 List of critical nutrients added to basal diets to increase intake of limiting nutrients

Nutrient	Increase
NaCl	20%
P	20%
Ca	20%
Micro-ingredients	20%
Lysine	0,15%
Methionine	0,4%
Folic acid	0,55 mg/lb
Pyridoxine	3 mg/lb
Biotin	0,1 mg/lb
$KMgSO_4$	2 lb/ton

Table 14 Bodymass and feed consumption of broilers fed zero and 500 μg of copper (Cu) at two levels of protein with and without added critical nutrients (CN)

Protein	Bodymass (g)			Feed consumption (g/bird/day)		
%	Basal	Cu	Cu + CN	Basal	Cu	Cu + CN
20,7	559	446	586	38,7	32,3	38,0
25,0	585	486	588	38,1	34,4	36,2

copper and the critical nutrients listed above were added, normal bodymass was obtained. When the diet contained 25% protein, the bodymass was greater than with chicks receiving the 20,7% protein. When copper was added to the high-protein diet, depression in bodymass was obtained. However, the depression was not quite as great as noted in the diet containing the low level of protein. The addition of the critical nutrients restored bodymass gains. It is suggested that the growth depression from the addition of copper was primarily due to the depression of feed intake. The addition of copper to either diet resulted in decreasing feed intake (Table 14). However, when the critical nutrients were added, growth rate was restored and feed intake returned to normal. This indicated that the addition of critical nutrients, insuring that the birds were getting an adequate daily intake, resulted in overcoming the copper toxicity.

An experiment has been conducted with laying hens which indicates that the level of nutrients in the diet must be increased to overcome a copper toxicity (Table 15). Three levels of copper were fed (0, 250, and 500 μg/g of copper). Nutrient density of 100% indicates the daily requirements as suggested by Harms (1981) are met and that a 14% margin of safety is possible. The 118% indicates that all nutrients in the diet were increased by 18%. Therefore, the diets would have contained 32% more nutrients than would normally be needed. The addition of 500 μg/g copper to the diet containing 100% of the nutrient requirements resulted in a significant decrease in egg production, egg masses, and feed consumption. Increasing the level of nutrients in the diet by 18% did not affect egg production in diets containing 0 or 250 μg/g. However, when 500 μg/g copper was included in the diet, a significant increase in egg production, egg masses

Table 15 Performance of hens receiving three levels of copper and two levels of nutrient density

Nutrient density (%)	Copper (μg/g)	Egg production %	Egg-mass %	Feed consumption %
100	0	72,2	65,5	85,3
	250	72,6	64,8	89,2
	500	38,7	61,5	62,3
118	0	73,1	66,3	90,7
	250	70,7	65,6	88,8
	500	62,1	65,2	75,5

Table 16 Bodymass and feed consumption of chicks fed two levels of protein, with and without coban and added nutrients

Protein (%)	Coban[a]	Critical nutrients	Bodymass (g)	Feed consumption (g/bird/day)
21	–	–	574 + 10	39,6 – 0,6
	+	–	539 + 13	37,2 + 1,4
	+	+	566 + 12	36,9 + 1,1
25	–	–	573 + 9	38,2 + 0,6
	+	–	553 + 13	36,0 + 0,6
	+	+	592 + 11	38,5 + 1,0

[a] + indicates 120 g monensin per ton

and feed consumption was obtained at the high level of nutrient intake. These data indicate that copper is depressing feed intake of the birds and they do not obtain enough nutrients to support maximum egg production. However, there is an indication of a copper toxicity which is not totally overcome by increasing the nutrient level of the diet.

These results led us to conduct an experiment (Christmas & Harms, 1984) to determine whether increasing the nutrient content of the diet would overcome the growth depression from monensin (Table 16). Two levels of protein were fed (21 and 25%), with and without monensin addition. The addition of monensin to either level of protein resulted in significantly decreased bodymasses. Addition of critical nutrients resulted in significantly increased bodymasses. When the critical nutrients were added tó the diet containing 25% protein and monensin, a significant growth increase was obtained. The addition of monensin to the diet containing either level of protein resulted in decreased feed intake. However, the addition of critical nutrients resulted in restoring part of this reduced feed intake.

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