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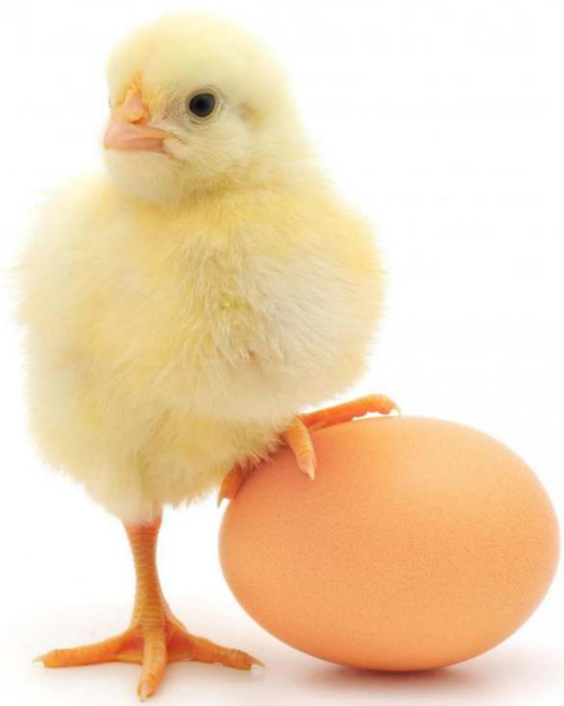

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Efficient Feeding of Molted Hens with Different Feeding and Formulation Methods

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Abstract: An experiment was conducted to determine the effect of feeding method (constant vs. variable) and method of formulation (lysine vs. protein) on the performance and profits of molted Dekalb Delta hens from 86 to 94 wk of age as influenced by egg and feed prices. Treatments 1 to 5 were formulated based on lysine to contain 0.69 to 0.57% TSAA and fed continuously regardless of feed consumption (constant feeding). Treatments 6 to 10 were formulated based on lysine to supply 650 to 570 mg TSAA and treatments 11 to 15 were formulated base on protein to supply 660 to 580 mg TSAA per hen per d and were fed based on feed intake. Dietary TSAA level had no overall significant effect on feed consumption, egg production, egg weight, mortality, or body weight. Hens fed diets using constant method of feeding had slightly higher egg production than hens fed diets formulated based on lysine or protein using variable method of feeding. However, egg weight, egg specific gravity, and body weight were not different. Two variable feeding methods had no significant effects on feed consumption, egg production, egg weight, egg specific gravity, or body weight. These results demonstrate that there can be no fixed TSAA or protein requirement of molted hens for maximum profits.

Key words: Molted hens, feeding method, formulation method, layer performance, profit

Introduction

Forced molting is an economic practice of laying hens to extend their productive life. Since 1960's, forced molting has become the dominant replacement program for the U.S. table egg industry. Age at flock sale has grown from 75 to 105 wk for two cycle flocks, and more than 125 wk for three cycle flocks (Bell, 1995). In 1987 it was estimated that approximately 60 percent of hens nationwide and 90 percent of hens in California were force molted (Holt, 1993). According to USDA published data (1996), at any given time in the United States over six million hens are being molted by the poultry and egg industries. Feeding molted hens is a challenge to sustain their optimum production performance and retain essential body nutrients at the same time. Yet the commercial White Leghorn layers (molted or non molted) in the United States are generally phase fed with subsequent adjustment based upon their daily feed intake levels. Egg producers have streamlined such feeding methodologies with little or no changes even under dynamic market conditions. Laying flock, after peak production, are generally fed a series of diets based on daily feed intake to provide a fixed and predetermined TSAA intake without considering the productivity level or the effect of market variables like egg price and feed price on production costs and returns. These ration formulations are based either on lysine or protein. A lysine-based diet is formulated by keeping lysine and TSAA ratios constant and allowing the protein level to float. To do so, feed is supplemented with synthetic methionine. Amino acid manufacturers generally recommend this method. In the protein method of feed formulation, the ration is formulated by keeping protein constant and allowing lysine level to float. This method is proposed in breeder management guide (Hy-Line, 1992).

The cost of energy vs protein, particularly corn and soybean oil meal (SBOM), can substantially affect feed cost and subsequently production cost depending upon which formulation method is being used. For example if the price ratio between corn (energy) and SBOM (protein) is comparatively narrow, feed formulation based upon protein could be more profitable, as it will be cheaper to add more SBOM for higher protein content in the ration to attain maximum production performance. When protein is expensive it may be more feasible to balance the ration with synthetic amino acids using less protein. There is little research information available on these two methods of feed formulations in regard to economics of feeding particularly in molted hens. Considerable research data however, is available on different levels of TSAA required to obtain optimum laying hen performance. The National Research Council in their (NRC, 1994) publication has recommended 580 mg per hen per d of TSAA. Schutte *et al.* (1994) found no difference in egg production or egg weight between hens fed TSAA levels ranging from 685 to 820 mg per hen per d from 25 to 49 wk of production.

Calderon and Jensen (1990) reported methionine requirements of 381, 388 and 414 mg per hen per d for

Table 1: Experimental Design

	Diets	Feeding Method	Formulation Method
Comparison 1	1 to 5 vs	Constant vs	Based on Lysine
	6 to 10	Variable	Based on Lysine
Comparison 2	1 to 5 vs	Constant vs	Based on Lysine
	11 to 15	Variable	Based on Protein
Comparison 3	6 to 10 vs	Variable vs	Based on Lysine
	11 to 15	Variable	Based on Protein

diets containing 13, 16 and 19% CP, respectively, at TSAA intakes varying between 659 and 773 mg per hen per d. Cao *et al*. (1992) estimated the requirement for methionine and TSAA to be 424 and 785 mg per hen per d, respectively for an egg mass of 54.3 g per hen per d. All of the above mentioned requirements by various researchers were determined with an objective of obtaining optimum performance.

The objectives of this research however, were to:

1 Determine the best method of formulation: lysine or protein and

2 To gather data necessary to determine the TSAA requirement for maximum profits using molted Dekalb® Delta hens from 86 to 94 wk of production with various egg and feed prices.

Materials and Methods

A total of 1920, 86-wk-old molted Dekalb® Delta hens were randomly divided into 15 dietary treatments. There were 8 replications of 16 hens per treatment. The hens were housed four per cage (30.5 x 40.6 cm) in a two-tier cage house. Feed and water were provided for *ad libitum* consumption. The experiment was conducted (86-94 wk of age) in the summer months with house temperature cycling between 21.1 to 28.9 °C (average 25.6 °C) in a computerized temperature controlled building. Computer-linked sensors monitored the inside temperature and accordingly adjusted in-house temperatures. The photoperiod provided was 16 h light: 8 h dark.

Treatments 1 to 5, formulated based on lysine and fed constantly, varied in protein levels from 16.10 to 14.22%, and TSAA levels from 0.69 to 0.57% (constant feeding, Table 2). Each treatment group was fed the diet shown (Table 2) throughout the experiment regardless of feed intake. These were typical industry diets formulated on the basis of 90 to 108 g per hen per d feed intake to supply 620 mg per hen per day TSAA if they were fed based on feed intake. However, because they were not fed based on feed intake, TSAA intake for treatments 1 to 5 ranged from 714 to 628 mg per hen per d.

Dietary treatments 6 to 10 (variable feeding) were formulated based on lysine and fed based on feed intake to supply 650, 630, 610, 590, or 570 mg of TSAA per hen per d intake. These diets (6 to 10) were formulated on the basis of lysine and were designed around the formula generally used by layer producers.

Treatments 11 to 15 (variable feeding) diets provided daily intakes of either 660, 640, 620, 600, or 580 mg of TSAA per hen per d. These diets were formulated on the basis of protein and were designed around a breeder's specification (Hy-Line, 1992). Two levels above and two levels below a recommendation of 620 mg per hen per d TSAA were used. For each of the last 10 experimental treatments (6 to 15) 10 formulas for each treatment were prepared for intake levels ranging from 77 to 118 g per hen per day but only those diets needed based on feed intake were mixed and used. The formulations fed for each treatment (6 to 15) were determined based on the previous 7-day feed intake average. The formula for 100 g per hen per day feed intake for treatments 6 to 15 along with treatments 1 to 5 (constant diets) are presented in Table 2. All hens in treatments 6 to 15 were initially fed 104 g per hen per d feed and as soon as the consumption changed (based on weekly average feed consumption data), they were switched to the next appropriate feed and so forth. Producers using the variable feeding method feed diets based on feed consumption to maintain a fixed intake of TSAA.

For analysis purposes the experiment was divided into three different comparisons (Table 1). In comparison 1, treatments 1 to 5 formulated based on lysine and fed using the constant method of feeding were compared to treatments 6 to 10, variable feeding formulated based on lysine. The diets between each feeding method were pooled together and then compared with each other for possible TSAA effect. In comparison 2, treatments 1 to 5 of the constant method of feeding were compared to treatments 11 to 15 of the variable method of feeding formulated based on protein. In comparison 3, the two variable methods of feeding formulated based on lysine (treatments 6 to 10) and protein (treatments 11 to 15) were compared. For example the first variable feeding diet (lysine formulation), which contained the highest TSAA level (0.65%) was pooled with the diet of variable feeding (protein formulation) which contained the highest TSAA level (0.66%) and so on till the respective diets in each method were pooled with each other and then these diets were compared for possible TSAA effect.

Diets, feeding method and formulation method were compared in Table 1.

The performance criteria used in this experiment were feed consumption, egg production, egg weight, shell

Table 2: Ingredient and nutrient composition of Experimental diets[1]

	Experimental Diets														
	Constant-lysine[5]					Variable-lysine[6]					Variable-protein[7]				
Ingredients (%)	1	2	3	4	5	6[1]	7	8	9	10	11	12	13	14	15
Corn	65.3	67.1	68.3	69.6	70.5	67.9	68.0	69.6	70.5	71.3	61.1	62.7	64.4	66.1	67.7
SBOM 48%	21.8	20.4	19.2	18.0	17.0	19.5	18.6	17.8	17.0	16.1	24.5	23.2	21.8	20.4	19.1
Limestone	7.07	7.08	7.11	7.14	7.09	7.60	7.60	7.61	7.61	7.61	7.58	7.59	7.59	7.60	7.60
Pullet size $CaCO_3$	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Dical phosphate	1.88	1.89	1.84	1.80	1.91	1.42	1.42	1.43	1.43	1.44	1.40	1.40	1.41	1.42	1.42
Poultry oil	0.80	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	2.38	2.10	1.82	1.53	1.25
NaCl	0.44	0.42	0.42	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.40	0.41	0.41	0.41	0.41
Vitamin premix[2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mineral premix[3]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-methionine	0.14	0.12	0.10	0.10	0.08	0.13	0.12	0.11	0.10	0.09	0.09	0.09	0.08	0.07	0.07
Cost/ton $	117	112	111	109	108	110	109	106	106	105	118	111	113	110	108
Calculated Analysis[4]															
Protein	16.10	15.54	15.09	14.63	14.22	15.2	14.9	14.5	14.2	13.9	17.0	16.5	16.0	15.5	15.0
ME kcal/kg	2751	2777	2790	2803	28412	2784	2793	2801	2810	2819	2671	2695	2718	2742	2765
Calcium	4.0	4.0	4.0	4.0	4.0	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.10
Total phosphorus	0.64	0.64	0.63	0.61	0.63	0.55	0.55	0.54	0.54	0.54	0.56	0.56	0.55	0.55	0.55
Avail phosphorus	0.45	0.45	0.44	0.43	0.45	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Methionine	0.43	0.40	0.37	0.36	0.34	0.40	0.39	0.37	0.36	0.35	0.39	0.38	0.36	0.35	0.34
TSAA	0.69	0.65	0.61	0.60	0.57	0.65	0.63	0.61	0.59	0.57	0.66	0.64	0.62	0.60	0.58
Lysine	0.83	0.79	0.76	0.73	0.70	0.77	0.74	0.72	0.70	0.67	0.90	0.86	0.83	0.79	0.75

[1]Diets 6 to 15 were formulated for 100 g/hen per day (22 lbs/100 hens per day) feed intake; although the actual feed intake for respective experimental birds was different since they were fed based on intake. [2]Provided per kilogram of diet: vitamin A, 8000 IU; cholecalciferol, 2200 IU; vitamin E, 8 IU; vitamin B_{12} 0.02 mg; riboflavin, 5.5 mg; d-calcium pantothenate, 13 mg; niacin, 36 mg; choline, 500 mg; folic acid, 0.5 mg; thiamin, 1 mg; pyridoxine, 2.2 mg; biotin, 0.05 mg; menadione sodium bisulfite complex, 2 mg. [3]Provided per kilogram of the diet: manganese, 65 mg; iodine, 1 mg; iron, 55 mg; copper, 6 mg; zinc, 55 mg; selenium 0.3 mg. [4]The chemical analysis for protein, methionine, cystine, and lysine was 8.29, 0.19, 0.19, and 0.24% for corn and 48.9, 0.52, 0.78, and 3.08% for soybean meal, respectively. [5]Treatments 1 to 5, formulated based on lysine and fed constantly [6]Treatments 6 to 10, formulated based on lysine and fed variably [7]Treatments 11 to 15, formulated based on protein and fed variably

Table 3: Influence of feeding method (constant vs variable-lysine) and formulation method (lysine vs protein) on laying hen performance (86-94 wk) [1]

Feeding and Formulation method	Feed consumption (g/h/d)	Egg production (%h/d)	Egg weight (g)	Egg specific gravity	Body weight (pound)
Comparison 1	ns	*	ns	ns	ns
Constant-lysine (diets 1-5)	107	79.7	66.5	1.0822	3.97
Variable-lysine (diets 6-10)	105	78.0	66.2	1.0823	3.98
Comparison 2	ns	ns	ns	ns	ns
Constant-lysine (diets 1-5)	107	79.7	66.6	1.0822	3.97
Variable-protein (diets 11-15)	106	78.6	66.7	1.0822	3.97
Comparison 3	ns	ns	ns	ns	ns
Variable-lysine (diets 6-10)	105	78.1	66.2	1.0823	3.98
Variable-protein (diets 11-15)	106	78.6	66.7	1.0822	3.97

[1]Average values from 8 replicates of 16 hens over the entire experimental period, *Significantly different (P<0.07), ns: non significant

quality (egg specific gravity), and body weight. Feed consumption and hen day egg production were determined weekly. Egg weight was determined bi-weekly and egg specific gravity at 90th and 94th wk of age on all the eggs saved on two separate days. Egg specific gravity was determined by dipping eggs in graded salt solutions of 0.005 increments. Body weight of 64 individual hens for each treatment was determined at the end of the experiment. The data were analyzed as a completely randomized block design with cage row location as a block using the General Linear Model Procedure of SAS® (1990).

The farm income was calculated using the following formula:

Farm income over feed cost (FIOC) = Farm egg income - Non-feed production cost - Feed cost.

FIOC = Farm egg income - 18¢ - feed cost.

The FIOC here reflects the net gain at the production level. Production cost includes the non-feed cost like farm management, labor, utilities, etc. The last variable in the FIOC formula is the cost of mixed feed for layers.

Results and Discussion

Comparison 1: The TSAA content of dietary treatments 1 to 10 in comparison 1, constant vs variable-lysine method of feeding, had no overall significant effect on feed consumption, egg production, egg weight, egg specific gravity, or body weight. The data for TSAA (dietary treatments) comparisons and interaction between the TSAA and feeding methods for all three comparisons, being statistically non significant, are not presented. Hens fed diets 1 to 5 using the constant method of feeding and lysine formulation had significantly (P<0.07) higher egg production (1.7%) than those fed based on variable method of feeding and formulated based on lysine. Feed consumption, egg weight, egg specific gravity, and body weight however, were not different between the two methods of feeding (Table 3). There was no difference in mortality between treatments (TSAA) or method of feeding (data not shown). There was also no interaction found between the diets (TSAA) and feeding methods.

Comparison 2: The TSAA level of dietary treatments 1 to 5 and 11 to 15 in comparison 2, constant-lysine vs variable-protein method of feeding, had no significant effect on feed consumption, egg production, egg weight, egg specific gravity, or body weight (data not shown). Hens fed diets 1 to 5 using the constant method of feeding had no significant difference in feed consumption, egg production, egg weight, and body weight than hens fed diets 11 to 15 using the variable method of feeding formulated based on protein (Table 3). There was no difference in mortality between dietary treatments or method of feeding (data not shown). There was no interaction found between diets (TSAA) and method of feeding in any of the performance criteria.

Comparison 3: The TSAA level of dietary treatments 6 to 15 in comparison 3, variable-lysine vs variable-protein, had no significant effects on feed consumption, egg production, egg weight, egg specific gravity, or body weight (data not shown). The two methods of formulation: lysine or protein did not produce any significant effect in feed consumption, egg production, egg weight, egg specific gravity, or body weight (Table 3). There was no difference in mortality between either treatment or method of feeding (data not shown). There was no interaction found between diets (TSAA) and method of feeding in any of the performance criteria, except egg production that was significantly lower when hens were fed diet 15 with the lowest TSAA level.

TSAA, feeding or formulation methods did not significantly affect any of the production performance in any of the comparisons, except egg production in comparison 1 (P<0.07) due mainly to higher nutrient density to supply 714 to 628 mg/h/g TSAA. Molted hens, 86 to 94 wk of age, in this study were non responsive to

Table 4: Effect of feed price, influenced by corn, soybean oil meal and egg price, on profits and nutrient requirements of Delta hens (86-94 wk) fed experimental diets

			Typical feed cost[1]			High corn, low SBOM[2]			Low corn, high SBOM[3]		
			ME	Feed cost	FIOC[4]	Feed cost	FIOC		Feed cost	FIOC	
Diets	Feed con	TSAA	kcal/h/d	$/ton	¢/doz	$/ton	¢/doz Spread		$/ton	¢/doz Spread	
	g/hen/d	mg/h/d					high[5]	low[6]		high[5]	low[6]
Constant-lysine											
1	103	714	290	116.50	31.27	193.65	17.98	8.09	147.56	25.90	16.01
2	106	686	297	112.10	31.15	191.34	17.04	7.24	139.69	26.24	16.44
3	108	657	304	110.00	31.57	191.67	17.22	7.56	134.86	27.20	17.54
4	108	646	303	108.57	30.87	191.63	16.19	7.04	130.81	26.94	17.79
5	110	628	313	108.24	31.09	192.61	15.58	5.88	128.95	27.28	17.58
Variable-lysine											
6	103	641	290	109.68	30.72	191.78	16.25	7.09	132.79	26.65	17.49
7	106	638	299	108.56	30.96	191.77	15.74	6.13	129.81	27.08	17.46
8	107	603	302	105.95	32.00	198.10	15.22	5.33	123.09	28.87	18.98
9	104	593	293	106.28	32.01	191.60	17.26	7.91	123.72	29.00	19.64
10	106	580	300	105.08	32.05	191.44	16.69	7.13	120.52	9.30	19.74
Variable-protein											
11	104	657	293	117.72	29.70	194.00	16.16	6.67	150.36	23.90	14.41
12	108	661	305	111.20	31.33	192.12	16.82	6.94	136.73	26.76	16.87
13	104	615	294	112.70	31.05	192.62	16.81	7.01	139.36	26.30	16.50
14	107	586	300	110.18	31.72	191.94	17.20	7.32	133.82	27.52	17.63
15	104	572	296	107.75	31.78	191.27	17.25	7.80	128.49	28.18	18.73

[1]Typical feed cost: corn $2.50/bushel; SBOM $197/ton [bushel = 56 lbs (25.5 kg), ton = 2000 lbs (909 kg)]; typical egg price: jumbo $0.77; extra large $0.71; large $0.66; medium $0.47; small $0.31; check $0.29/doz. [2]Corn $5.80/bushel; SBOM $200/ton. [3]Corn $1.93/bushel; SBOM $400/ton. [4]FIOC = Farm income - non-feed production cost - feed cost. [5]High egg spread: jumbo $1.05; extra large $0.99; large $0.94; medium $0.75; small $0.59; check 0.44. [6]Low egg spread: jumbo $0.91; extra large $0.89; large $0.86; medium $0.85; small $0.72; check $0.42

dietary manipulations (between 0.57 to 0.69% TSAA level) to enhance their production performance. This may have been due to the dense diets fed to these hens. Had there been a wider nutrient range fed to these experimental birds, we might have observed some deficiencies at the lower end. The objective of feeding molted hens, given the above findings, therefore, should be to maintain their production performance at most feasible price. They have already achieved their peak performance and exhausted their most body nutrient reserves. Sustaining optimal performance at the most efficient feed cost considering the market price of ingredients and egg prices should be the primary objective.

The 15 experimental diets, which ranged in TSAA content from 0.57 to 0.69% although produced almost no difference in egg production but their cost per ton varied between $105 to $117 because of the ingredient prices used (Tables 2 and 4). When farm income over feed cost (FIOC) were calculated, the diet 10 that supplied 580 mg per hen per d TSAA formulated based on lysine and fed variably costing only $105/ton proved the most profitable under the typical conditions of feed and egg prices (corn, $ 2.50/bushel and SBOM, $197/ton; Table 4). For Delta® hens in their late production phase (86-94 wk), price spread between medium and large eggs had little influence on FIOC because very few medium eggs were produced. Therefore, change in feed prices has a greater influence on FIOC and the TSAA requirement. As the price of SBOM increases (from $200 to $400/ton) in relation to corn, the diets (6-10) formulated based on low protein become more feasible (Table 2 and 4) due to less cost for each additional unit of protein added in the ration. Because of this, the method of feeding and TSAA required for maximum profits varied.

These results are in agreement with those of Schutte *et al.* (1994), who did not find any difference in egg production or egg weight when hens were fed diets supplying 690 to 820 mg TSAA per hen per d. Our main emphasis however, was not to determine the TSAA requirement for maximum performance but to gather data so that TSAA requirements could be determined under any given market conditions using different feeding and formulation methods as there can be no fixed requirement for protein or TSAA for maximum profits. These results demonstrate that the TSAA requirement can vary from at least 580 to 714 mg/hen/day using different feed and egg prices. Because TSAA intakes ranging form 572 to 714 had little or no influence on hen performance, in order to determine the optimal TSAA and protein requirements for molted commercial White Leghorn hens, all the related aspects of production, management, environment, feeding and formulation methods, and market variables (feed and egg prices) need to be carefully analyzed.

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