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Calcium Metabolism and Egg Shell Quality in Laying Hens

Chang Won Kang¹, R. A. Nelson¹, C. W. Carlson¹ and O. E. Olson²

This experiment was designed to determine whether diet alterations that cause a somewhat reduced rate of lay could influence shell quality and whether certain chemical and biochemical measurements could be related to a decline in shell quality.

A corn-soy layer diet at two protein levels, 12 and 16%, was used. An effort was made to feed both diets at an unrestricted and restricted (80% of restricted) rate. Eight replicates of 8 birds each were used per treatment. Treatments began when the birds were 20 weeks of age and the experiment was concluded after a period of 56 weeks.

Feed consumption, egg production, egg size, Haugh units, shell thickness, and shell breaking strength were determined every 4 weeks during the experiment. At the conclusion of the work, one bird per replicate was killed and tissues were taken for chemical and biochemical analysis. The data are summarized in table 1.

The data have not been subjected to thorough statistical analysis as yet, but they suggest the following observations:

1. The attempted restriction in feed consumption failed, so only the effects of protein level should be observed.
2. Reducing protein level of the diet increased feed intake, appeared to reduce hen-day egg production and egg size, did not affect Haugh units, increased the grams of feed required per gram of egg, and had no effect on shell thickness or shell breaking strength.
3. Except for carbonic anhydrase, the chemical and biochemical measurements on tissues were not affected. In the case of carbonic anhydrase, the apparent lowering of the level of this enzyme by reducing the protein in the feed was not statistically significant because of rather large deviations within treatments.

In addition to the above, a different method involving a pressure increase mechanism for measuring shell breaking strength was tried. The correlation between its values and shell thickness (0.78) was better than that for the dropping ball method (0.45) used in obtaining the above data.

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During the course of the experiment, shell thickness decreased at a rate of 0.0015 mm per period and breaking strength decreased at a rate of 0.15 cm per period.

This experiment is now being repeated with improved procedures for feed consumption control. Toward the conclusion of the experiment, individual data on egg production and shell quality will be collected in order to improve the selection of birds for chemical and biochemical studies.

Table 1. Effect of Protein and Restricted Feeding Time on Egg Production and Calcification Parameters

	Treatment	Treatment	Treatment	Treatment
	1	2	3	4
	Unrestricted feeding		Restricted feeding ¹	
	16% protein	12% protein	16% protein	12% protein
Feed consumption (gm/hen/day)	103.8	110.2	103.3	107.3
Protein consumption (gm/hen/day)	16.6	13.2	16.5	12.9
Egg weight (gm)	63.6	62.7	65.5	63.0
Hen-day egg production (%)	70.2	67.6	65.5	63.0
Haugh units	78.4	79.4	79.8	79.2
Feed efficiency (gm egg/gm feed)	0.43	0.39	0.41	0.37
Shell thickness (mm)	0.33	0.33	0.34	0.34
Shell breaking strength (cm) (height of falling ball)	12.9	12.9	12.9	13.3
Serum calcium (mg/100 ml) ²	20.3 ± 3.2	22.2 ± 5.0	22.5 ± 3.2	24.4 ± 4.3
Bone ash (%) ²	66.0 ± 1.6	64.9 ± 0.9	67.6 ± 3.8	65.1 ± 1.3
Bone phosphorus (% of ash) ²	17.2 ± 0.2	17.4 ± 0.3	17.2 ± 0.3	17.4 ± 0.2
Bone calcium (% of ash) ²	38.6 ± 0.6	38.7 ± 0.6	38.5 ± 0.3	38.5 ± 0.2
Calcium binding protein ²				
Duodenal (units/mg protein)	0.037 ± 0.016	0.047 ± 0.023	0.040 ± 0.005	0.039 ± 0.017
Shell gland (units/mg protein)	0.012 ± 0.002	0.011 ± 0.002	0.011 ± 0.002	0.011 ± 0.002
Carbonic anhydrase in shell glands (units/mg protein) ²	10.0 ± 5.6	8.6 ± 4.1	10.4 ± 6.0	7.1 ± 2.9

¹Feeders were covered from 8 a.m. to 4 p.m. each day.

²Data are shown with standard deviations.