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The objectives of the present investigation are to determine (1) whether restricting feed intake will reduce the rate of lay while lengthening the laying period and improving egg shell quality, (2) whether dietary protein level is involved and (3) whether carbonic anhydrase activity of the shell gland or calcium binding protein of the duodenal lining or the shell gland are related to shell quality.

Layer diets with two levels of protein, 12 and 16%, were fed to control groups without restriction and to restricted groups at 80% of the rate at which the control groups were fed. Two strains of pullets were placed on each of the four treatments. The birds were caged at 22 weeks of age. Five replicates of 12 birds each were used for each strain and each treatment.

Egg production, feed consumption, egg size, Haugh Units, shell thickness and shell breaking strength have been measured every 4 weeks for a period of 60 weeks. The experiment is still in progress and the measurements are being continued, since it is expected that the effects of the various treatments will be long term and may not show themselves until a few more months have passed. However, some intermediate results for the effects at 60 weeks are shown in Table 1. These indicate the following: (1) there were no significant differences in hen-day egg production, egg weight and Haugh Units between the two strains of birds; (2) strain 3 seemed to have lower feed consumption, but examination of the data suggests that this might be the result of variability in feed restriction; (3) strain 1 laid eggs with greater breaking strength; and (4) restricting feed consumption reduced hen-day egg production and increased Haugh Units but had no effect on shell thickness or breaking strength. Possibly, as the birds age, additional differences will be found.

In an additional experiment with old hens carried out early this summer, 53 laying hens 72 weeks of age were fed a 16% protein, corn-soy diet without restriction for 28 days. The hens were individually caged and their eggs were collected daily, weighed and subjected to shell breaking strength and thickness measurements. With that information five birds laying eggs with high quality shells and five laying eggs with poor quality shells were selected and sacrificed for biochemical examinations. The data are summarized in Table 2.

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The data in Table 2 show (1) no significant differences between the two groups as concerns either shell gland or duodenal calcium binding protein and (2) a higher carbonic anhydrase activity in the birds laying eggs with shells of high quality when based on units per gram of tissue (but not when based on mg. protein).

In view of the above, these and additional measurements will be made on selected birds from the experiment now in progress near the conclusion of the experiment.

Table 1. Effects of Dietary Protein Level, Strain of Bird and Restriction of Feed Intake on Egg Production and Shell Quality

	Treatments				Strains	
	Unrestricted feeding		Restricted feeding			
	16% protein	12% protein	16% protein	12% protein	1	3
Hen-day egg production (%)	64.5[a][1]	62.8[a]	54.6[b]	45.4[c]	57.2	56.5
Feed consumption (g./hen/day)	101.6[a]	100.9[a]	83.1[b]	81.7[b]	94.1	89.7**
Feed efficiency (g./egg/g. feed)	.41[ab]	.39[b]	.42[a]	.35[c]	.38	.40*
Protein consumption (g./hen/day)	16.3	12.1	13.3	9.8	13.2	12.6
Egg weight (g.)	63.9[a]	62.0[c]	63.0[b]	62.9[b]	62.7	63.2
Haugh Units	79.5[d]	81.7[c]	82.7[b]	85.0[a]	82.6	81.9
Shell thickness (m.m. x 100)	33.3	33.0	33.2	33.2	33.6	32.7**
Shell breaking strength (kg. pressure)	3.18	3.17	3.22	3.24	3.27	3.13**

[1] Means with unlike superscripts are significantly different at the 5% level.
* Significantly different at the 5% level.
** Significantly different at the 1% level.

Table 2. Carbonic Anhydrase and Calcium Binding Protein in Tissues of Hens Laying Eggs With High- vs Low-quality Shells

	High-quality shells	Low-quality shells
Eggs produced during 24-day period	19	14
Shell thickness (m.m. x 100)	35.7 ± .7	25.5 ±1.4**
Breaking strength (kg. pressure)	3.66± .21	1.76± .15**
Duodenal calcium binding protein		
(Units/g. tissue)	10.3 ±5.1	5.6 ±1.7
(Units/mg. protein)	.42± .26	.22± .08
Shell gland calcium binding protein		
(Units/g. tissue)	2.9 ±1.1	2.3 ±0.6
(Units/mg. protein)	.20± .07	.15± .05
Shell gland carbonic anhydrase		
(Units/g. tissue)	297 ±64	173 ±60*
(Units/mg. protein)	4.1± .4	3.5 ±1.1

* Significantly different at the 5% level.
** Significantly different at the 1% level.