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The Effect of Corn Oil Reduction in the Diet on Laying Hen Performance

Author(s)

Harms RH
Russell GB
Bohnsack CR
Merkel WD

Department of Animal Sciences, University of Florida, Gainesville, FL, USA.

Mail Address

RH Harms
Departament of Animal Science
University of Florida
Gainesville, FL 32611
Phone: 352 392 1924
Ffax: 352 392 5595

E-mail: harms@animal.ufl.edu

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ABSTRACT

Hy-Line W36 hens were fed diets containing zero or 6% corn oil (CO) from 26 to 38 wk of age. At 38 wk, the hens receiving the diet with 6% CO were divided into three groups. One group continued to receive the diet with 6% CO. The level of CO in the diet was reduced to zero or 3% in the other two groups. The hens previously fed the diet without CO continued to receive the control diet. Egg weight was significantly heavier when the diet contained 6% CO and was not significantly reduced when the level of CO was reduced to 3%. Egg weight from control hens was significantly lower than the EW from hens that had received CO in the diet until 38 wk but none thereafter. Hens fed the diet with CO consumed more energy than hens fed the control diet. However, when CO level was reduced to zero at 38 wk, the hens consumed less energy than hens fed the control diet. These findings indicate that the hen cannot adjust feed intake with diets based on changing energy concentration in the range from 2,783 to 3,089 kcal/kg.

INTRODUCTION

Hill *et al*. (1956) reported that the dietary energy content controlled the amount of feed that a hen would consume. Therefore it has been accepted for several decades that the energy content of the diet is a primary factor controlling the amount of feed the hen will eat. However, Harms *et al*. (2000) found that the laying hen did not recognize an increase of 10% in dietary energy when 5.963% corn oil (CO) was included in the diet. This resulted in a 7% increase in energy intake and significantly increased egg weight (EW). Bohnsack *et al.* (2001) and Merkel *et al.* (2002) confirmed these results.

Jensen *et al*. (1958) were the first to report that the addition of corn oil to the diet increased EW. These workers concluded that corn oil contained an unidentified factor necessary for maximum EW. Subsequently, other workers (Shutze *et al.*, 1958; Shutze *et al.*, 1959; Balnave, 1971; Whitehead, 1981) concluded that the response to corn oil was due to its linoleic acid (LIN) content. However, Grobas *et al*. (1999) suggested that the increase in energy intake was the primary cause of the increased EW. They found no increased EW when feeding greater than 1.15% LIN, and that basal diet contained a higher level than 1.15%. This also supports the conclusion that the increased EW was due to increased energy intake, and not due to increased LIN intake.

The increase in EW is desirable with young hens. However, many producers prefer that the average EW does not exceed 61 g. Therefore, an experiment was conducted to determine the influence of removing CO from the diet on EW and feed consumption.

MATERIAL AND METHODS

Three hundred twenty Hy-Line W36® hens (36 wk of age) were used in this experiment. Four dietary treatments were fed in two separate houses. The temperature of one house was thermostatically controlled to maintain a minimum of 29.4°C ± 1 and it will be referred to as the warm house. The temperature of the other house was allowed to cycle from 10 to 29.4°C and it will be referred to as the cool house. During an 8-wk pre-experimental period, 40 hens in each house were fed the control corn soybean meal diet (Table 1). These hens received the control diet throughout the experimental period (0-0 Treatment). A hundred twenty hens in each house were fed a diet with 6% corn oil. They were divided into three groups of 40 hens. One group (6-6 Treatment) continued to get the diet with 6% corn oil. Another group was fed a diet with 3% corn oil (6-3 Treatment). The third group was fed the control diet (6-0 Treatment). Protein, amino acids, Ca, P and salt were increased when corn oil was added to the diet. Adjustments were made to ensure that diets would not be deficient when feed intake would be reduced, as a result of increased dietary energy. Amino acid values were based on analyses of corn and soybean meal, and the values of NRC (1994) were used for other nutrients. The hens in each group were subdivided into eight replicate groups of five individually caged hens.

The EW was measured weekly on one egg from each hen. Average EW per replicate was calculated weekly and summarized for the entire experiment. Daily egg production (EP) was recorded by hen; however, replicate averages were used. Feed consumption was measured bi-weekly, and analyzed for the entire experiment. Egg mass (EM) was calculated by multiplying EW by EP.

Data were analyzed for the six-week period using a two-way analysis of variance (SAS Institute, 1990). There was no significant interaction of house x treatment for any measurement. Therefore, the data for the two houses were combined, and replicates x treatment interaction were used as to test significance of the diet. Significant differences among treatments were determined by Duncan's multiple-range test (1955).

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RESULTS AND DISCUSSION

Egg production (EP) was not significantly different among the four treatments (Table 2). EP was significantly higher in the cool house (92.5 *vs* 86.5) when the temperature of the house was allowed to cycle. The interaction between weeks and treatment was not significant (P = 0.561).

Table 1 - Composition of the experimental diets.

Ingredient	Dietary Corn Oil (%) 0	3	6
		(%)	
Yellow corn	65.35	59.08	52.83
Soybean meal	24.17	26.89	29.60
Ground limestone	8.32	8.68	9.03
Salt	0.38	0.40	0.42
Vitamins[1]	0.25	0.25	0.25
Minerals[2]	0.25	0.25	0.25
Dicalcium phosphate[3]	1.17	1.32	1.48
DL-Methionine	0.11	0.13	0.14
Corn oil	——-	3.00	6.00
Calculated analyses (%)[4]			
Protein	16.63	17.42	18.20
Calcium	3.49	3.67	3.84
Phosphorus (total)	0.54	0.57	0.60
Methionine	0.38	0.41	0.43
Methionine + cystine	0.67	0.71	0.74
Lysine	0.87	0.93	0.99
Linoleic acid	1.29	3.01	4.71
Energy (kcal ME/kg)	2,783	2,936	3,089

1 - Supplied per kilogram of diet: biotin 0.2 mg; choline, 500 mg; ethoxyquin, 65 mg; folic acid, 1 mg; niacin, 60 mg; pantothenic acid, 15 mg; pyridoxine, 5 mg; riboflavin, 5 mg; thiamin, 3 mg; vitamin A, 8,000 IU; vitamin B12, 0.02 mg; cholecalciferol, 2,200 IU; vitamin K, 2 mg; vitamin E, 20 mg. 2 - Supplied per kilogram of diet; copper: 10 mg; ethoxyquin, 65 mg; iodine, 2 mg; iron, 60 mg; manganese, 90 mg; selenium, 0.2 mg; zinc, 80 mg. 3 - Contains 18.5% P and 21% Ca. 4 - Amino acid content is based on analysis of corn and soybean meal. Other nutrients were based on NRC (1994) values.

Table 2 - Egg production, egg mass and energy per gram egg mass when hens fed diets with different levels of corn oil.

Dietary Treatment Pre-Experimental	Experimental	Egg Production	Egg Mass	Energy/ Egg Mass
(% Corn Oil[1])		(%)	(g)	(kcal/g)
0	0	88.6[a]	52.7[b]	5.10[a]
6	6	89.9[a]	55.8[a]	5.02[a]
6	3	90.3[a]	55.6[a]	4.89[b]
6	0	89.2[a]	53.7[b]	4.74[b]

1 - Percentage of corn oil in pre-experimental and experimental diets. a-b - Means within a column with different superscripts differ significantly ($p < 0.05$).

Hens on the 6-6 and 6-3 treatments produced an egg mass (EM) that was significantly heavier than EM from hens on the other two treatments (Table 2).

Besides, there was no significant difference in EM between the hens on the control and the 6-0 treatment. The difference in EM among treatments was primarily due to differences in EW. The EM was significantly higher in the cool house (57.3 *vs* 51.6g). Treatment *x* weeks interaction was not significant (P = 0.30).

Egg weight (EW) from hens fed the 6-6 or 6-3 treatments was significantly higher than EW from hens on the other two treatments (Table 3). There was a gradual increase in EW during the last three weeks of the experiment. This resulted in a significant week *x* treatment interaction. Egg weight was significantly higher (61.9 vs 59.7g) in the cool house.

Table 3 - Egg weights from hens fed diets with different levels of corn oil.

Dietary Treatment Pre-experimental	Experimental (% Corn Oil[1])	Week 1	2	3	4	5	6	Av
		(g)						
0	0	58.6	59.1	59.5	59.2	59.7	60.1	59.4[c]
6	6	60.8	61.6	62.4	62.2	63.1	62.2	62.1[a]
6	3	60.9	61.2	61.6	61.5	61.9	62.2	61.6[a]
6	0	60.8	59.7	59.1	60.2	60.1	60.7	60.1[b]
Average		60.3[b]	60.4[b]	60.7[ab]	60.8[ab]	61.2[a]	61.3[a]	

1 - Percentage of corn oil in pre-experimental and experimental diets. a,b - Means within a column or row with different superscripts differ significantly (p > 0.05).

Feed consumption (FC) was significantly greater for hens on the control treatment than for hens on the other three treatments (Table 4). The hens on the 6-6 treatment consumed significantly less feed than hens on the 6-3 treatment, and FC for hens on the 6-0 treatment was not significantly different from either of these. FC was significantly higher in the cool house (91.1 vs 86.7g). The interaction of treatment *x* week was significant (P = 0.002). This was a result of decrease in FC during the first two weeks followed by an increase in FC for the 6-3 treatment. Furthermore, FC was extremely low during the first four weeks followed by a large increase during weeks 5 and 6 for treatment 6-0.

Energy intake (EI) for hens fed the 6-6 treatment was significantly greater than the EI for the hens receiving the other three treatments (Table 5). There was no difference in EI for hens fed the control diet and the 6-3 treatment. The hens receiving the 6-0 treatment had the lowest EI. The interaction between treatment and weeks was significant (P = 0.0029). This was a result of decreases in energy intake during the first two weeks for hens on the 6-3 and 6-0 treatments. This decrease was followed by an increase in EI during the next four weeks for hens on the 6-3 treatment and an increase in EI for hens on the 6-0 treatment at weeks 5 and 6. The EI was essentially the same throughout the experiment for hens on the control, significantly different from groups 6-0 and 6-6 (Table 5). Energy intake was significantly higher for hens in the cool house than for hens in the warm house (287 *vs* 251 kcal ME).

Table 4 - Feed consumption of hens fed diets with different levels of corn oil.

Dietary Treatment Pre-experimental	Experimental (% Corn Oil[1])	Week 1 - 2	3 – 4	5 – 6	Average
		(g/h/d)			
0	0	97.0	95.6	97.4	96.7[a]
6	6	91.0	90.0	89.7	90.2[c]
6	3	90.6	93.0	93.3	92.3[b]
6	0	89.8	88.8	96.3	91.6[bc]
Average		92.1[b]	91.9[b]	94.2[a]	

1 - Percentage of corn oil in pre-experimental and experimental diets. a,c - Means within a row or column with different superscripts differ significantly (p < 0.05).

Table 5 - Energy intake of hens fed diets with different levels of corn oil.

Dietary Treatment Pre-experimental	Experimental (% Corn Oil[1])	Week 1 - 2	3 – 4	5 – 6	Average
		(kcal ME/h/d)			
0	0	270	266	271	269[b]
6	6	281	278	281	280[a]
6	3	266	273	274	271[b]
6	0	250	247	268	255[c]
Average		267[b]	266[b]	274[a]	

1 - Percentage of corn oil in pre-experimental and experimental diets. a,c - Means within a row or column with different superscripts differ significantly (p < 0.05).

Hens fed the 6-3 and 6-0 treatments produced one g of EM with less ME/hen/day than hens on the other two treatments. (Table 2). There was no difference in energy per g EM between the 6-3 and 6-0 treatments. There was no difference in energy per g EM for hens on the 0-0 and 6-6 treatments.

The hens in the present experiment did not adjust feed intake when energy was reduced from 3,089 (6% corn oil) to 2,783 (control) kcal ME/kg. This resulted in EW being reduced from 61.6 to 59.7 g by the end of the second week after the corn oil diet was changed to the control diet. Reduction in energy intake when corn oil was removed from the feed indicates the lack of the ability to adjust for energy needs. In a previous experiment (Harms *et al.*, 2000), EW was not different for hens fed the low- and medium-energy diet. However, EW from hens fed the high-energy diet, containing corn oil, was significantly heavier than the EW from the other two groups. Energy intake was not significantly different for hens fed the low- and medium-energy diet. However, the energy intake was significantly higher for hens fed the higher energy diet. This indicates that hens were able to adjust for the decrease in dietary energy from 2,798 to 2,519 kcal ME/kg. However, they did not adjust energy intake when the energy was increased from 2,798 to 3,089 kcal ME/kg.

CONCLUSIONS

Feeding a diet with 6% corn oil produced a 2.7 g increase in egg weight. The increased egg weight is a result of the hen not adjusting feed intake when the energy of the diet is increased. Hence, hens fed diets containing higher energy levels increased energy consumption.

Removal of corn oil from the diet resulted in a decrease in energy intake and a decreased egg weight.

The hens in the 6-0 and 6-3 treatments gradually increased feed intake, which was equal to hens fed control treatment at the end of four weeks. Previous studies have shown that corn oil can be added to the diet to increase egg weight. Present data indicate that when eggs are too heavy, corn oil can be removed from the diet and egg weight will be reduced.

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