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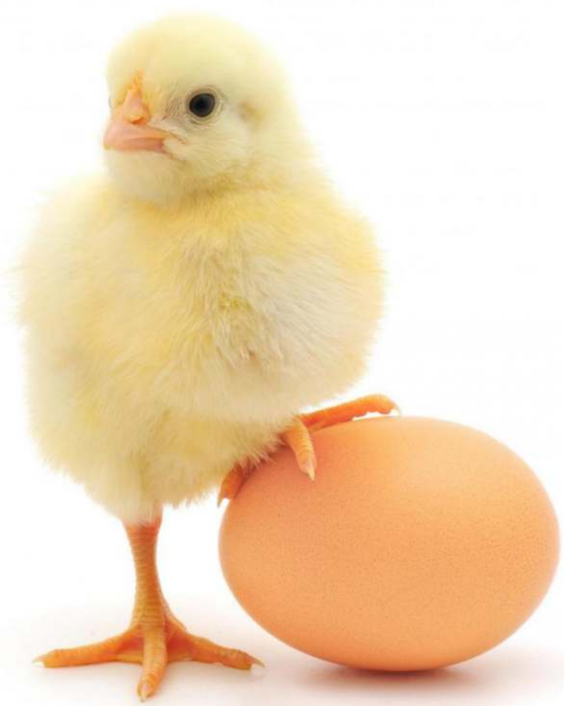

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Effects of Protein and Supplemental Fat on Performance of Laying Hens

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Abstract: A 2 × 2 factorial experiment of two protein levels (17.0 and 15.9%) with and without supplemental fat was conducted to determine the effect of supplemental fat on performance of commercial Hy-line W-36 at different protein levels from 47 to 55 week of age. Hens at 47 week of age were randomly assigned into 4 treatments (6 replicates of 15 birds per treatment). There were no significant interactions between protein and supplemental fat in feed intake, egg production, egg weight, egg mass, feed conversion, egg specific gravity, and body weight. Protein had significant effects on egg production, egg mass, and feed conversion, but had no effect on feed intake, egg weight, egg specific gravity, and body weight. With increasing protein level, egg production and egg mass significantly increased and feed conversion significantly decreased. Supplemental fat had no effect on egg production, egg weight, egg mass, and body weight. Supplemental fat significantly reduced feed intake and improved feed conversion at both protein levels. Supplementing fat in diets can improve performance of commercial Hy-line W-36.

Key words: Supplemental fat, protein, feed conversion, egg weight

Introduction

Many studies have been conducted to determine the effect of protein and supplemental fat on egg weight. Increasing protein significantly increased egg weight (Liu *et al.*, 2005; Wu *et al.*, 2005a). There are inconsistent results in effect of supplemental fat or dietary energy on egg weight. Many researchers (Keshavarz, 1995; Keshavarz and Nakajima, 1995; Harms *et al.*, 2000; Bohnsack *et al.*, 2002; Sohail *et al.*, 2003; Bryant *et al.*, 2005; Wu *et al.*, 2005C) reported that the addition of supplemental fat increased early egg weight. However, Summers and Leeson (1983) reported that supplementing fat in diets had no effect on egg weight.

Protein significantly affected egg production (Liu *et al.*, 2005). There are contradicted results about the effect of supplemental fat on egg production. The addition of fat had no effect on egg production (Harms *et al.*, 2000; Bohnsack *et al.*, 2002; Sohail *et al.*, 2003; Bryant *et al.*, 2005). In contrast, Grobas *et al.* (1999) reported that the addition of supplemental fat significantly increased egg production from 38 to 61 wk of age.

Regulating dietary energy is believed to be one of the most effective ways to adjust feed intake of laying hens. Several studies (Grobas *et al.*, 1999; Harms *et al.*, 2000, Bryant *et al.*, 2005) showed that increasing dietary energy or supplementing fat decreased feed intake and improved feed conversion of laying hens (Bryant *et al.*, 2005; Wu *et al.*, 2005b,C). In different protein levels, the effect of supplemental fat on feed intake or feed conversion may be different. Sohail *et al.* (2003) reported that there were interactions between protein and supplemental fat in feed consumption and feed conversion.

The cost of diets may be easily decreased by regulating protein and supplemental fat. Many egg producers do not use supplemental fat because of inadequate storing and mixing facilities (Sohail *et al.*, 2003). It is necessary to understand the effect of supplemental fat on performance of laying hens at different protein levels to optimize the use of supplemental fat. The objective of this experiment was to determine the effect of supplemental fat on performance of commercial Hy-line W-36 at different protein levels from 47 to 55 week of age.

Materials and Methods

This study was a 2 × 2 factorial arrangement of two protein levels (17.0 and 15.9%) with and without supplemental fat. Ingredients and nutrient composition of experimental diets were showed in Table 1.

In this experiment, 360 Hy-line W-36 hens at 47 week of age were randomly assigned into 4 treatments (6 replicates of 15 birds per treatment). The experiment lasted 8 weeks. Three hens were housed in a 42 × 46 cm^2 cage and five adjoining cages consisted of a replicate. Birds in each replicate shared a feed trough and had access to drinking cups. Hens were kept in a windowless house with tunnel ventilation. A standard lighting program (16 hour light:8 hour dark) was used. Feed consumption was obtained weekly by subtracting the ending feed weight in trough from the beginning feed weight. Egg production was recorded weekly. Egg weights were determined weekly using all eggs

Table 1: Ingredients and nutrient composition of experimental diets

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4
Corn (%)	63.60	60.00	66.37	62.78
Soybean meal (%)	24.85	25.43	22.08	22.66
$CaCO_3$ (%)	5.11	5.11	5.12	5.11
Hardshell[1] (%)	4.00	4.00	4.00	4.00
Dicalcium phosphate (%)	1.49	1.50	1.50	1.52
Poultry oil (%)	0.00	3.00	0.00	3.00
NaCl (%)	0.36	0.36	0.36	0.36
Vitamin premix[1] (%)	0.25	0.25	0.25	0.25
Mineral premix[2] (%)	0.25	0.25	0.25	0.25
DL-Methionine (%)	0.10	0.11	0.06	0.07
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Crude protein (%)	17.0	17.0	15.9	15.9
ME (kcal/kg)	2737	2889	2762	2915
Ca (%)	4.00	4.00	4.00	4.00
Available phosphorus (%)	0.38	0.38	0.38	0.38
Methionine (%)	0.38	0.38	0.33	0.33
Methionine + Cystine (%)	0.67	0.67	0.61	0.61
Lysine (%)	0.90	0.90	0.83	0.83

[1]Provided per kilogram of diet: vitamin A, 8,500 IU; cholecalciferol, 2,200 IU; vitamin E, 8 IU; vitamin B_{12}, 0.02 mg; riboflavin, 5.5 mg; D-calcium pantothenic acid, 15 mg; niacin, 36 mg; choline, 500 mg; folic acid, 0.5 mg; vitamin B_1, 1 mg; pyridoxine, 2.2 mg; biotin, 0.05 mg; vitamin K, 2 mg. [2]Provided per kilogram of diet: manganese, 66 mg; iodine, 1 mg; iron, 55 mg; copper, 6 mg; zinc, 57 mg; selenium, 0.3 mg.

collected for two consecutive days. Egg specific gravity was determined monthly using all eggs collected for two consecutive days (Holder and Bradford, 1979). Mortality was determined daily. Body weight was obtained by weighting hens at the end of experiment.

Data were analyzed by proc mixed procedures of Statistical Analysis System (SAS Institute, 2000) for a randomized complete block with a factorial treatment design. Supplemental fat and protein were fixed, while blocks were random. The factorial treatment arrangement consisted of two supplemental fat levels and two protein levels. The following model used to analyze data was as follows:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + P_k + \epsilon_{ijk}$$

Where Y_{ijk} = individual observation, μ = experimental mean, α_i = supplemental fat effect, β_j = protein effect, $(\alpha\beta)_{ij}$ = interaction between fat and protein, P_k = effect of block, ϵ_{ijk} = error component.

If differences in treatment means were detected by ANOVA, Duncan's Multiple Range Test was applied to separate means. A significance level of $P \leq 0.05$ was used during analysis.

Results and Discussion

Protein had no significant effect on feed intake (Table 2). Feed intake of hens fed the diets supplemented with fat was significantly lower than that of hens fed the diets without fat at two protein levels. This result was in agreement with that of Grobas *et al.* (1999) and Bryant *et al.* (2005), who reported that supplemental fat had a significant effect on feed intake. There was no significant interaction between protein and supplemental fat in feed intake. However, Sohail *et al.* (2003) reported that fat decreased feed intake at high protein level but had no effect on feed intake at low protein level. The differences between this experiment and Sohail *et al.* (2003) might be due to the difference in the amount of fat supplemented in the diets. Sohail *et al.* (2003) supplemented 1.75% fat in low protein level and 4.24% fat in high protein level, while the same amount of fat (3%) was added at high and low protein levels in this experiment.

Hens fed the diets containing 17.0% protein had higher egg production than hens fed the diets containing 15.9% protein (Table 2). Similarly, Liu *et al.* (2005) and Wu *et al.* (2005a) reported that increasing protein improved egg production. Supplemental fat had no significant effect on egg production. This result was consistent with that of Harms *et al.* (2000), Bryant *et al.* (2005), and Wu *et al.* (2005b,C), who reported that egg production was not affected by supplemental fat or dietary energy.

Protein had no significant effect on egg weight (Table 2). This result was inconsistent with that of Liu *et al.* (2005) and Wu *et al.* (2005a), who reported with increasing protein egg weight increased. No response of egg weight to protein might be due to over-consumption of feed of hens fed low protein level. As protein decreased, feed consumption decreased (Liu *et al.*, 2005; Wu *et al.*, 2005a). However, hens fed the diets containing 15.9% protein had the same feed consumption as hens fed the

Table 2: Influence of protein and supplemental fat on performance of Hy-line W-36 from 47 to 55 wk of age

Factor		Feed intake (g/hen per day)	Egg production (%)	Egg weight (g)	Egg mass (g egg/hen per d)	Feed conversion (g of feed/of g egg)	Egg specific gravity (unit)	Body weight (kg)
Protein (%)								
15.9		96.0	83.2[b]	60.90	50.67[b]	1.90[a]	1.0809	1.57
17.0		95.8	86.4[a]	60.98	52.69[a]	1.82[b]	1.0814	1.67
Supplemental fat								
-		97.5[a]	83.9	60.97	51.15	1.91[a]	1.0815[a]	1.58
+		94.4[b]	85.7	60.91	52.20	1.81[b]	1.0808[b]	1.67
Protein (%)	Fat							
15.9	-	97.6	83.0	61.01	50.62	1.93	1.0810	1.53
15.9	+	94.4	83.4	60.80	50.71	1.86	1.0807	1.62
17.0	-	97.4	84.8	60.93	51.68	1.89	1.0819	1.63
17.0	+	94.3	88.0	61.03	53.70	1.76	1.0808	1.72
Pooled SEM		0.91	1.39	0.45	1.32	0.03	0.0003	0.06
		---------- Probability ----------						
Main effects and interactions								
Protein		NS	*	NS	*	*	NS	NS
Supplemental fat		*	NS	NS	NS	*	*	NS
Protein × Fat		NS	NS	NS	NS	NS	NS	NS

[a-b]Means within a column and under each main effect with no common superscripts differ significantly. *Significantly different ($P \leq 0.05$).

diets containing 17.0% protein. Supplemental fat had no significant effect on egg weight. This result was similar to that of Summers and Leeson (1983), who reported that egg weight was not affected by supplemental fat, but egg weight was affected by body weight. In this experiment, there was no significant difference in body weight between hens fed the diets with fat and hens fed the diets without fat. However, the addition of supplemental fat increased early egg weight (Keshavarz, 1995; Keshavarz and Nakajima, 1995; Harms *et al*., 2000; Bohnsack *et al*., 2002; Sohail *et al*., 2003; Bryant *et al*., 2005). The differences among researchers might be due to strain difference and composition difference of fat.

As protein increased, egg mass significantly increased (Table 2). Supplemental fat had no significant effect on egg mass. Feed conversion was affected by both protein and supplemental fat. Hens fed high protein level had better feed conversion than hens fed low protein level. This result was in agreement with that of Liu *et al*. (2005) and Wu *et al*. (2005a), who reported increasing protein improved feed conversion. Feed conversion of hens fed the diets supplemented with fat was significantly lower than that of hens fed the diets without fat. Similarly, Bryant *et al*. (2005) and Wu *et al*. (2005b,C) reported that supplementing fat or increasing dietary energy decreased feed conversion. There was no significant interaction between protein and supplemental fat in feed conversion.

Protein had no effect on egg specific gravity. Hens fed the diets supplemented with fat had lower egg specific gravity than hens fed the diets without fat possibly because hens fed the diets supplemented with fat had less calcium intake than hens fed the diets without fat. Decreased feed intake caused less calcium intake of hens fed the diets supplemented with fat. Either protein or supplemental fat had no effect on body weight and mortality. The total mortality rate is 0.3%.

In conclusion, there were no significant interactions between protein and supplemental fat in feed intake, egg production, egg weight, egg mass, feed conversion, egg specific gravity, and body weight. Protein had significant effects on egg production, egg mass, and feed conversion. Supplemental fat significantly reduced feed intake and improved feed conversion at low and high protein levels. Supplementing fat in diets can improve performance of commercial Hy-line W-36.

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