Effects of reducing dietary methionine, linoleic acid, choline and increasing energy on performance and eggshell quality in aged laying hens

M.YOUSEFI[1]* M. SHIVAZAD[2] and I. SOHRABI-HAGHDOOST[3]

[1]Faculty of Agriculture, Islamic Azad University-Saveh Branch, 39187-366, [2]Faculty of Agriculture, University of Tehran, [3]Faculty of Veterinary, Islamic Azad University-Science and Research Branch, Iran.
***e-mail: yosefius@yahoo.com**

An experiment was conducted to determine whether egg quality during the late stage of egg production can be improved by using diets that are effective in reducing egg size. The experiment was conducted in completely randomized design with six treatment groups and four replicates each with ten hens from 94 to 106 wk of age. Three 28-d periods used for different dietary factors including: 1) Control (C); 2) Control with low (0.24%) methionine (LM); 3) Control with low (0.42%) linoleic acid (LLA); 4) Control with high (3000Kcal/kg) energy (HE); 5) Control with low (0.2, 0.42%, no supplement) methionine, linoleic acid, choline and high energy (3000Kcal/kg) (LM-LLA-LCH-HE) and 6) Control with low (no supplement) choline (LCH). The data were analyzed using the General Linear Model procedure of SAS software (1992). Overall feed intake was significantly ($P<0.05$) lower for the hens fed HE diets compared to the control. Overall egg weight and albumin weight was significantly ($P<0.05$) lower for the hens fed LM and LM-LLA-LCH-HE compared to the control. Overall egg mass, egg production and eggshell thickness was not affected by treatments. The results indicate that certain manipulations of methionine, choline, linoleic acid, energy or the combination of these nutrients have the potential to reduce egg weight without affecting egg mass, egg production and eggshell thickness during the latter stage of the egg production cycle.

Key words: methionine; linoleic acid; choline; energy; egg quality

Introduction

As hens get older, the nutrient requirements decrease. If the nutrient content of diets fed to old hens is the same as that of diets fed to young hens, some of nutrients may be increase. It is important for commercial leghorn industry to know the nutritional requirements of laying hens at different ages (Wu et al., 2005b). A number of factors may influence a hens requirement for choline, for instance age, feed intake and dietary crude protein or methionine levels. It is generally accepted that dietary requirement declines with age, possibly associated with an increasing feed intake (Workel et al., 2002). Methionine is the first limiting amino acid for egg production and, given the common function with choline in methyl group donation, interactions between the two nutrients may be anticipated. The levels and balance of amino acids in the diets are all important nutritional variables that affect the economic efficiency of an egg laying enterprise (Al-Saffar and Rose, 2002). Eggshell thickness and eggshell weight reduces with increase in egg size (Roland, 1988; Jackson et al., 1987).

Researchers have been interested in reducing egg size during the late stages of the egg production cycle by dietary manipulation of nutrients for increasing eggshell quality (Keshavarz, 2003). Objective of this experiment was to determine the influence of dietary level of methionine, linoleic acid, choline, energy or the combination of these nutrients on performance and eggshell quality in aged laying hens.

Materials and Methods

Two hundered and fourty Hy-line W-36 hens were used in this experiment, which were 94 weeks of age, and continued for three 28-d periods. Ten hens were grouped house and shared a common feed trough between them, forming one experimental unit. There were 4 experimental units for each of the 6 treatment groups. Diets were formulated to meet the nutrient requirements for poultry (NRC, 1994) (Table 1). The diets were: 1) Control (C); 2) Control with low (0.24%) methionine (LM); 3) Control with low (0.42%) linoleic acid (LLA); 4) Control with high (3000Kcal/kg) energy (HE); 5) Control with low (0.2,0.42%,no supplement) methionine, linoleic acid, choline and high (3000Kcal/kg) energy (LM-LLA-LCH-HE) and 6) Control with low (no supplement) choline (LCH).

Egg production was recorded daily and expressed monthly as eggs produced per hen per day. On the last 2 d of each 28-d period, eggs were collected to measure egg weight, albumin weight and eggshell thickness. Feed intake was determined at the end of each 28-d period.

The experiment was a completely randomized design, and the experimental unit was the replicate consisting of five adjacently caged birds fed as one group. Data were analyzed using the General Linear

Model procedure of SAS software (1992). Mean values were compared by a multiple range test (Duncan). The level of significance was $p<0.05$.

Table 1 Diet composition (%)

Ingredients	Diet1	Diet2	Diet3	Diet4	Diet5	Diet6
Corn	64.91	64.82	-----	57.1	-----	64.91
Wheat	-----	-----	69.39	-----	61.54	-----
Soybean meal	21.57	21.72	15.51	23.03	18.09	21.57
Dicalcium phosphate	1	1	1.02	1.01	1.02	1
Vegetable oil	1.65	1.69	-----	7.99	-----	1.65
Tallow	-----	-----	3	-----	8.59	-----
Calcium carbonate	7.9	7.9	7.88	7.89	7.87	7.9
Oyster shell	2	2	2	2	2	2
Salt	0.37	0.37	0.34	0.37	0.34	0.37
DL-methionine	0.1	-----	0.14	0.11	-----	0.1
Lysine Hcl	-----	-----	0.22	-----	0.04	-----
Vitamin premix	0.25	0.25	0.25	0.25	0.25*	0.25*
Mineral premix	0.25	0.25	0.25	0.25	0.25	0.25
Enzyme**	-----	-----	0.05	-----	0.05	-----
Calculated analysis						
ME (Kcal/Kg)	2750	2750	2750	3000	3000	2750
CP (%)	14.59	14.59	14.59	14.59	14.59	14.59
Ca (%)	3.89	3.89	3.89	3.89	3.89	3.89
AP (%)	0.29	0.29	0.29	0.29	0.29	0.29
Methionine (%)	0.34	0.24	0.34	0.34	0.2	0.34
Lysine (%)	0.72	0.72	0.72	0.72	0.72	0.72
Linoleic acid (%)	2.35	2.37	0.42	5.42	0.42	2.35

*Vitamin premix without choline; **Vetazyme X

Results and Discussion

As dietary energy increased from 2750 to 3000 Kcal/kg, feed intake decreased from 101.6 to 91.6, resulting a 10% decrease in feed intake (Table 2). This result was in agreement with that of Grobas et al. (1999), Harms et al. (2000), Bryant et al. (2005), and Zou and Wu (2005), who reported that increasing dietary energy or supplementing fat had a significant effect on feed intake.

Egg mass and egg production were not significantly different among treatments (Table 2). In the other words, nutrients deficiency including: methionine, linoleic acid and choline, and also increasing dietary energy can not be causes of large different of egg production among treatments. This result was consistent with that of Harms et al. (2000), Bohnsack et al. (2002), Wu et al. (2005a), and Zou and Wu (2005), who reported that egg mass and egg production were not affected by supplemental fat or dietary energy. Egg mass and egg production can not be affected by reducing dietary methionine, choline (Keshavarz, 2003), and linoleic acid (Mannion et al., 1992).

Egg weight and albumin weight were significantly ($p<0.05$) lower for 2^{th} and 5^{th} treatments compared to the control (Table 2). Reducing dietary methionine with or without choline caused decrease of egg weight. This result was in agreement with the previous report that egg weight was significantly affected by methionine and choline (Keshavarz, 2003). The increasing dietary energy level from 2750 to 3000 Kcal/kg had no influence on egg weight (Table 2). This result was in agreement with that of Summers and Leeson (1983), and Wu et al. (2005a), who observed that egg weight was not changed by increasing dietary energy or supplementing with fat. Because nutrients contents except energy in all six diets were the same, nutrients such as protein, methionine and lysine used to produce one gram egg decreased. The decrease of nutrient intake might explain why increasing dietary energy levels from 2750 to 3000 Kcal/kg had no effect on egg weight. Eggshell thickness was not affected by treatments (Table 2).

The results indicate that certain manipulations of methionine, choline, linoleic acid, energy or the combination of these nutrients have the potential to reduce egg weight without affecting egg mass, egg production and eggshell thickness during the latter stage of the egg production cycle.

Table 2 Treatment effects on performance and eggshell quality.

	Diet1	Diet2	Diet3	Diet4	Diet5	Diet6	SEM
Feed consumption(g/hen/day)	101.6^{bc}	95.3^{ab}	106^{c}	91.6^{a}	97.7^{abc}	103.6^{bc}	1.42
Egg production(%)	68.01	63.27	63.1	66.8	65.72	69.7	1.33
Egg mass(g egg/h/d)	43.53	39.02	44.03	42.94	40.01	43.6	0.96
Egg weight(g)	65.43^{c}	59.31^{a}	65.57^{c}	65.46^{c}	61.34^{ab}	63.33^{bc}	0.59
Albumin weight(g)	39.14^{c}	34.48^{a}	38.76^{c}	39.52^{c}	35.13^{ab}	37.85^{bc}	0.49
Eggshell thickness(mm)	41.38	41.25	41.5	41.75	40.87	41.63	0.46

$^{a-c}$ Means within a row with no common superscript different significantly($P<0.05$)

References

AL-SAFFAR, A.A. and ROSE, S.P. (2002) The response of laying hens to dietary amino acids. World's Poult. Sci **58**: 209-234.

BOHNSACK, C.R., HARMS, R.H. MERKEL, W.D. and RUSSELL, G.B. (2002) Performance of commercial layers when fed diets with four contents of corn oil or poultry fat. J. Appl. Poult. Res **11**: 68-76.

BRYANT, M., WU, G. and ROLAND, DA, SR. (2005) Optimizing dietary energy for profits and performance of two strains of white leghorns. Page 23 in: International Poultry Scientific Forum Abstracts, Atlanta, GA, USA.

GROBAS, S., MENDEZ, J. DEBLAS, C. and MATEOS, G.G. (1999) Laying hen productivity as affected by energy, supplemental fat, and linoleic acid of the diet. Poult. Sci **78**:1542-1551.

HARMS, R.H., RUSSELL, G.B. and SLOAN, D.K. (2000) Performance of four strains of commercial layers with major changes in dietary energy. J. Appl. Poult. Res **9**: 535-541.

JACKSON, M.E., HELLWIG, H.M. and WALDROUP, P.W. (1987) Shell quality potential for improvement by dietary means and relationship with egg size. Poult. Sci **66**: 1702-1713.

KESHAVARZ, K. (2003) Effects of reducing dietary protein, methionine, choline, folic acid, and vitamin B12 during the late stages of the egg production cycle on performance and eggshell quality. Poult. Sci **82**: 1407-1414.

MANNION, P.F., NEIL, A.R. and BREWSTER, M. (1992) Egg weight responses of laying hens fed different concentrations of vegetable oil and linoleic acid. Aust. J. Agri. Res **43**: 389-397.

National Research Council. (1994) Nutrient Requirements of Poultry. 9th rev. ed. National Academy Press, Washington, DC.

ROLAND, DA, SR. (1988) Egg shell problems: Estimates of incidence and economic impact. Poult. Sci **67**: 1801-1803.

SAS Institue. (1992) Users Guide: Statistics. SAS Institue Inc., Cary, NC.

SUMMERS, J.D. and LEESON, S. (1983) Factors influencing early egg size. Poult. Sci **62**: 1155-1159.

WORKEL, H.A., KELLER, T. REEVE, A. and LAUWAERTS, A. (2002) Choline-the rediscovered vitamin for poultry. Feed Additive in Poultry.

WU, G., BRYANT, M.M. VOITLE, R.A. and ROLAND, DA, SR. (2005a) Effect of dietary energy on performance and egg composition of Bovans white and Dekalb white hens during phase I. Poult. Sci **84**: 1610-1615.

WU, G., LIU, Z. and ROLAND, DA, SR. (2005b) Performance comparison and nutritional requirements of five commercial layers strains in phase IV. Int. J. Poult. Sci **4**: 182-186.

ZOU, S.G. and WU, Y.Z. (2005) Effects of supplemental fat on performance of laying hens. Int. J. Poult. Sci **4**: 998-1000.