Exploiting the Maximum Productive Potential of Spent Laying Hens with Various Metabolizable Energy and Protein Levels after Induced Molting

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강제환우시킨 산란노계에서 생산성 제고를 위한 대사에너지와 단백질 수준의 탐색

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ABSTRACT

This experiment was conducted to investigate the influence of different levels of metabolizable energy (ME) and crude protein (CP) on post-molt performance and egg quality of spent laying hens. Four hundred and thirty two, ISA Brown hens at sixty six weeks of age after molt induction were fed six experimental diets containing three ME (2,750, 2,800, 2,850 kcal/kg) with two CP (15, 17%) levels in a factorial design. The influence of ME and CP were evaluated on egg production, egg weight and feed intake throughout 24 weeks of production. Egg mass and feed conversion ratio (FCR) were measured during the experimental period. Haugh unit, yolk color and eggshell breaking strength were measured at 5%, 50%, peak, post peak and end stage of egg production. The hens fed 2800 kcal/kg diet along with 15% CP recorded the highest outcome of egg production ($P<0.05$). The egg weight has been shown to increase with hens receiving 2,800 kcal/kg ME. Daily egg mass tended to increase in hens fed with 15% CP and 2,800 kcal/kg ME. Feed intake decreased significantly with the level of ME and CP in the diet increased ($P<0.05$). Yolk color was improved significantly in eggs laid by the hens receiving 17% CP than 15% diet. It also tended to be higher in 17% CP with 2,800 or 2,850 kcal/kg ME diet treatments. Egg shell breaking strength increased with hens receiving diets of 15% CP and 2,800 kcal/kg. From this experiment it can be concluded that the ME level of 2,800 kcal/kg coupled with 15% CP could be used to achieve the higher egg production and better eggshell strength in induced molting hens.

(Key words : Induced molting, Laying hens, Egg production, CP, ME)

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I . INTRODUCTION

Induced molting is an effective way of bringing a recovery in both the egg quality and production. Also it is a managerial practice usually employed on spent hens to enhance profit, to avoid the cost of replacing pullets, and to increase the subsequent egg production (Akram et al., 1998a). Revitalizing the spent layer flocks has been more convenient and economical than annual replacement because of ever increasing prices of chicks, feed, vaccine and medicines (Akram et al., 1998b). During molting, 15 day fasting followed by alternate day feeding led to higher egg production than 5 or 10 day fasting with daily feeding (Akram et al., 2000). Post-molt production performance has also been found to be influenced by the post-fast dietary regimes (Akram et al., 2001). Different protein and energy levels have been manipulated during the post-fast pre-lay phase to maximize the subsequent post-molt production and to improve the egg quality. However, the nutritional requirements of post-molt hens are not yet described. Therefore, the present study was conducted to investigate the influence of different dietary ME and CP levels on the post-molt performance of spent laying hens.

II . MATERIALS AND METHODS

Four hundred and thirty two ISA Brown spent hens were induced to molt followed by the method of Akram et al. (2001), and randomly divided into 24 experimental units having 18 hens each. These units were divided into 6 experimental groups fed with three different levels of ME (2,750, 2,800, 2,850 kcal/kg) and

two CP (15, 17%) levels in a factorial design with four replicates of each. Diets containing 0.92% Ca and 0.26% P were fed during the post-fast and pre-lay phase and then elevated up to 3.75 and 0.40% respectively during the post-molt phase and the same levels were kept until the end of this experiment. Ingredient and chemical composition of the experimental diets are given in Table 1. The influence of different levels of ME and CP were measured on the post-molt production performance and the egg quality of laying hens.

1. Egg production, egg weight, feed intake, egg mass, feed conversion

The hen day egg production (%), egg weight (g) and feed intake (g) were recorded daily throughout the 24 weeks of production. Based upon these data egg mass and feed conversion per bird were calculated.

2. Haugh unit, yolk color, eggshell breaking strength

Six eggs were randomly selected per pen at 5%, 50%, peak, post-peak and at the end phase of egg production to measure the haugh units, yolk color and eggshell breaking strength (kg/cm², FHK, Tokyo, Japan).

3. Statistical analysis

The data collected on production performance and egg quality parameters in post-molt laying hens were analyzed by two way ANOVA with GLM procedure(SAS Institute, 1997).

Table 1. Ingredients and nutrients of post-molt laying hens diets

	Diets					
	1	2	3	4	5	6
Ingredients						
Corn	60.1	60.9	61.5	59.9	62	61.5
Wheat	3.9	3.8	4.0	0.3	0.3	-
Wheat bran	8.68	7.3	5.7	6.45	3.95	3.7
Rapeseed meal	0.20	-	-	0.1	-	-
Soybean meal	16.6	17.1	17.5	22.9	23.4	25.35
Corn gluten meal (60%)	-	-	-	-	-	0.15
Calcium carbonate	8.9	8.9	8.9	8.9	8.9	8.9
Tri calcium phosphate	0.9	0.9	0.9	0.9	0.9	0.9
Lysine	0.17	0.15	0.15	0.02	0.02	0.02
DL-methionine	0.11	0.11	0.11	0.09	0.09	0.09
Vitamin premix ¹⁾	0.15	0.15	0.15	0.15	0.15	0.15
Mineral premix ²⁾	0.15	0.15	0.15	0.15	0.15	0.15
Soybean oil	-	0.4	0.80	-	-	0.08
Sodium chloride	0.14	0.14	0.14	0.14	0.14	0.14
Nutrients						
Crude protein (%)	15	15	15	17	17	17
Metabolizable energy (Kcal./ kg)	2750	2800	2850	2750	2800	2850
Calcium (%)	3.75	3.75	3.75	3.75	3.75	3.75
Phosphorus (%)	0.4	0.4	0.4	0.4	0.4	0.4
Lysine (%)	0.83	0.83	0.83	0.83	0.83	0.83
Methionine (%)	0.35	0.35	0.35	0.35	0.35	0.35

¹⁾ Provided per kilogram of diet : vit A, 5,500 IU; vit D₃, 1,100 ICU; vit E, 11 IU; vit B₁₂, 0.0066mg; riboflavin, 4.4mg; pantothenic acid, 11mg (Ca-pantothenate: 11.96mg); cholin, 190.96 mg (choline chloride 220mg); menadione, 1.1mg (menadione sodium bisulfite complex 3.33mg); folic acid, 0.55mg; pyridoxine, 2.2mg(pyridoxine hydrochloride, 2.67mg); biotin, 0.11mg; thiamin, 2.2mg (thiamin mononitrate 2.40mg); ethoxyquin, 125mg;

²⁾ Provided per kilogram of diet : Mn, 120; Zn, 100; Fe, 60; Cu, 10; I, 0.46 and Ca, min:150, max:180.

III. RESULTS AND DISCUSSION

1. Egg production, egg weight, feed intake, feed conversion

The diet containing 15% CP coupled with 2,800 kcal/kg ME increased the post-molt egg production. These results are supported by the findings of Grimes et al. (1994) that demonstrated the feeding of low protein post-molt diet

Table 2. Post-molt egg production and egg weight (Mean $\pm$ SE) during 66 to 90 weeks of age influenced by dietary ME and CP levels in ISA Brown hens

ME (Kcal/Kg)	CP (%)	Egg production (%)		Egg weight (g)		
		15	17	Mean	15	17
2750		62.5 $\pm$ 3.0 ^{ab}	65.8 $\pm$ 3.3 ^{ab}	64.2 $\pm$ 2.2	62.5 $\pm$ 0.5 ^{ab}	62.7 $\pm$ 0.5 ^{ab}
2800		70.4 $\pm$ 2.3 ^a	60.5 $\pm$ 3.5 ^b	65.5 $\pm$ 2.4	63.5 $\pm$ 0.6 ^{ab}	64.2 $\pm$ 0.7 ^a
2850		60.1 $\pm$ 2.6 ^b	62.0 $\pm$ 3.6 ^{ab}	61.1 $\pm$ 2.2	61.4 $\pm$ 1.1 ^b	61.9 $\pm$ 0.8 ^b
Mean		64.4 $\pm$ 1.7	62.8 $\pm$ 2.0		62.5 $\pm$ 0.5	62.9 $\pm$ 0.4

^{a,b} Means with the different superscripts differ significantly ($P < 0.05$).

resulted in higher rate of egg production than the feeding of high protein diet. Similarly, in another study high energy and protein post-fast diet failed to produce more number of eggs (Zia-ul-hussan et al. 2000). However, ME and CP alone did not influence the daily egg production of the hens in the present study.

The egg weight increased in hens fed 2,800 kcal/kg ME independently or with 17% CP, whereas the magnitude of difference was not significant. Limited effect of molt diets on egg weight has already been observed by Bell and Kuney (1992). Feed intake was significantly influenced by the different levels of ME and CP in post-molt diets ($P < 0.05$). Feed intake was the highest in hens with 2,750 kcal/kg and the lowest with the group fed diets with 2,850 kcal/kg ME, developing an inverse relationship as the ME level increased (Table 3). The protein level in the diet also manifested the similar trend of decrement in feed intake with the increasing level of protein. The feed intake pattern of the current study is partially supported by Castanon et al. (1990) that reported the significantly higher feed intake

when 15.32% CP and 2,650 kcal/kg ME were applied to the molt diet, but this trend did not last till the end of experiment since the post-molt diets were used during early post-molt period only for a short duration. The low nutrient diet increased the feed intake probably to satisfy the daily requirements of nutrients. The diets containing high energy and high protein furnished bird's requirements with low feed intake.

Daily egg mass was not influenced significantly either by ME or CP alone. However, egg mass somewhat increased in hens receiving the diet containing 15% CP and 2,800 kcal/kg. The results of the present study are partially agreed to another study (Bhatia and Sharma, 1989) that the lowest level of CP in post-molt diet yielded the highest egg mass. Another study of comparing diverse molt diets revealed that feeding 16% CP corn-soybean meal molt diet yielded higher egg mass than the diets containing feather meal or corn gluten meal with or without lysine and methionine supplementation (Koelkebeck et al., 1999). As the above mentioned studies are based on CP alone, so it

Table 3. Post-molt feed intake, egg mass and FCR (Mean $\pm$ SE) during 66 to 90 weeks of age influenced by dietary ME and CP levels in ISA Brown hens

ME (Kcal/Kg)	CP (%)	Feed intake/day (g)			Egg mass/day (g)	
		15	17	Mean	15	17
2750		122 $\pm$ 2.0 ^a	116 $\pm$ 2.0 ^{ab}	119 $\pm$ 1.5 ^a	39.11 $\pm$ 1.6 ^{ab}	42.14 $\pm$ 2.2 ^{ab}
2800		120 $\pm$ 2.0 ^a	113 $\pm$ 2.3 ^b	117 $\pm$ 1.7 ^b	44.94 $\pm$ 1.3 ^a	39.64 $\pm$ 2.4 ^{ab}
2850		117 $\pm$ 1.9 ^{ab}	110 $\pm$ 2.0 ^c	113 $\pm$ 1.5 ^c	37.80 $\pm$ 1.6 ^b	39.58 $\pm$ 2.4 ^{ab}
Mean		119 $\pm$ 1.20 ^a	113 $\pm$ 1.3 ^b		40.60 $\pm$ 1.0	40.47 $\pm$ 1.3

ME (Kcal/Kg)	CP (%)	Egg mass/day(g)	FCR (g/egg)		
		Mean	15	17	Mean
2750		40.60 $\pm$ 1.4	199 $\pm$ 11.7	180 $\pm$ 10.8	189 $\pm$ 8.3
2800		42.32 $\pm$ 1.4	173 $\pm$ 8.3	194 $\pm$ 14.9	183 $\pm$ 9.2
2850		38.69 $\pm$ 1.4	197 $\pm$ 9.9	183 $\pm$ 13.3	190 $\pm$ 8.1
Mean			189 $\pm$ 5.8	186 $\pm$ 7.5	

^{a,b} Means with the different superscripts differ significantly (P<0.05).

is difficult to draw the final conclusion. Whereas, the current study indicated egg mass output from 2,800 kcal/kg ME and 15% CP interaction. Feed conversion did not show significant differences either by different levels of ME and CP or their interaction. Feeding the different levels of ME and CP did not result in significant differences and their interaction also might not have much effect at all on feed conversion.

2. Haugh unit, yolk color, egg shell breaking strength

Experimental diets with different levels of ME and CP independently or in combination did not show significant differences in Haugh unit of

eggs laid during the post-molt period (Table 4). The limited effect of molt diets on albumen quality has been observed by some researchers that used corn, wheat in 12 and 16% CP for molt diet (Nordstrom, 1980), ground corn, 10 % guar meal or pullet developer (Zimmerman et al., 1987), layer mash or starter (Zimmerman and Andrew, 1990), cracked Milo or layer mash (Bell and Kuney, 1992) as molt diets failed to impart any significant difference in haugh unit scores. Yolk color was statistically affected by CP levels alone and in combination with ME in molt diets (P<0.05). Significantly better yolk color was noted in eggs laid by the hens receiving 17% than 15% CP molt diet. Diets containing 17% CP coupled with 2,800 or 2,850 kcal/kg ME produced better yolk color in eggs.

Table 4. Post-molt haugh unit, Yolk colour and eggshell breaking strength (Mean $\pm$ SE) during 66 to 90 weeks of age influenced by dietary ME and CP levels in ISA Brown hens

ME (Kcal/Kg)	CP (%)	Haugh unit		Yolk color	
		15	17	Mean	
2750		78.73 $\pm$ 2.29	76.40 $\pm$ 1.98	77.57 $\pm$ 1.49	7.04 $\pm$ 0.14 ^b
2800		76.13 $\pm$ 1.87	77.68 $\pm$ 1.58	76.91 $\pm$ 1.21	7.15 $\pm$ 0.14 ^{ab}
2850		78.22 $\pm$ 2.29	74.71 $\pm$ 2.24	76.47 $\pm$ 1.62	7.32 $\pm$ 0.14 ^{ab}
Mean		77.69 $\pm$ 1.22	76.26 $\pm$ 1.11		7.17 $\pm$ 0.08 ^b

ME (Kcal/Kg)	CP (%)	Yolk color	Shell strength (kg/ cm ²)		
		Mean	15	17	Mean
2750		7.22 $\pm$ 0.09	3.43 $\pm$ 0.17 ^{ab}	3.22 $\pm$ 0.16 ^{ab}	3.32 $\pm$ 0.11
2800		7.33 $\pm$ 0.09	3.51 $\pm$ 0.11 ^a	2.98 $\pm$ 0.17 ^b	3.25 $\pm$ 0.11
2850		7.41 $\pm$ 0.09	2.99 $\pm$ 0.10 ^b	3.17 $\pm$ 0.11 ^{ab}	3.08 $\pm$ 0.07
Mean			3.31 $\pm$ 0.08	3.13 $\pm$ 0.08	

^{a,b} Means with the different superscripts within a column differ significantly (P<0.05).

Yolk color showed improvement in relation to increasing energy and protein content. As the nutrient contents in the diet were elevated the yolk color tended to increase the intensity. However, the lack of information prohibits the full explanation of this intensification of the yolk color by diet. Different levels of ME and CP independently in diets could not influence the egg shell breaking strength. However, the strength increased with the hens receiving diets with the combination of 15% CP and 2,800 kcal/kg. These results are partially confirmed by some other reports that use of various molt diets including ground corn or pullet grower (Brake and Thaxton, 1977; Brake et al., 1979), 16 verses 8% CP diet (Harms, 1983; Christmas and Harms, 1983), ground corn, layer mash or

starter (Zimmerman and Andrew, 1990) and 10, 13 or 16% CP molt diets (Koelkebeck et al., 1991) which reported no significant effect of various molt diet differentiation on egg shell quality during the post-molt lay.

The diet containing 15% CP coupled with 2,800 kcal/kg ME has shown to increase the post-molt egg production. Feed intake decreased significantly with the increasing level of ME and CP in post-molt diets. Egg shell breaking strength tended to increase in the hens receiving diet with 15% CP and 2,800 kcal/kg ME. It can be concluded from the results of this experiment that 2,800 kcal/kg ME can be used to obtain higher egg production and egg shell breaking strength with 15% CP in induced molting hens.

IV. 요약

본 연구는 대사에너지(ME)와 조단백질(CP) 수준이 강제환우를 실행한 산란노계의 생산성과 난품질에 미치는 영향을 구명하고자 실시하였다. 강제환우를 실시한 66주령의 이사브라운 산란계 432수 ME 3 수준(2,750, 2,800, 2,850 kcal/kg)과 CP 2수준(15, 17%)의 전체 6 종류 실험사료를 급여하였다. 조사항목으로 ME와 CP의 수준에 따른 산란율과 난중, 사료섭취량을 24주간 측정하였으며, 1일 산란량과 사료요구율을 조사하였다. 난품질은 산란시기별로 5, 50%, 산란피크, 피크 후기, 실험 종료시에 각각 Haugh unit과 난황색, 과각강도를 측정하였다. 산란율은 ME 2,800 kcal/kg과 CP 15%를 급여한 처리구에서 다른 처리구에 비하여 현저하게 높았다($P<0.05$). 난중은 ME 2,800 kcal/kg을 급여한 닭에서 증가하는 경향을 나타냈다. 1일 산란량은 CP 15%와 ME 2,800 kcal/kg을 섭취한 처리구에서 높은 경향을 나타냈다. 사료섭취량은 ME와 CP의 수준이 증가할수록 현저하게 감소하였다 ($P<0.05$). 난황색은 CP 17%를 급여한 처리구에서 CP 15% 처리구에 비하여 현저히 개선되었으며, CP 17%와 ME 2,800 또는 2,850 kcal/kg 급여구에서 높은 경향을 나타냈다. 과각강도는 CP 15%와 ME 2,800 kcal/kg을 급여한 닭에서 증가하였다. 본 연구의 결과 강제 환우계에서 산란율과 난품질을 극대화 할 수 있는 사료내 최적의 ME와 CP는 15%와 2,800 kcal/kg 수준으로 사료된다.

(색인 : 강제환우, 산란노계, 산란율, 조단백질, 대사에너지, 난품질)

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