THE EFFECTS OF DUAL PROTEIN FEEDINGS ON THE EGG QUALITY OF LAYING HENS

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Abstract

The objective of the study was to investigate the effect of dual protein feedings of isocalory feed on the egg quality of laying hens. Sixty Lohmann Brown hens 24 weeks of age were randomly divided into four group of 15 hens each and individual hen as a replication. The hens were given ad libitum access of feeds during feeding time. Morning feeding time was given during 08.00-12.00 (AM) whereas afternoon feeding time was given during 12.00-18.00 (PM). The treatments were, treatment A, hens were fed both AM and PM with 16% crude protein (CP) (16/16); Treatment B, hens fed 13% CP during AM and 16% CP during PM (13/16); Treatment C, hens fed 16% CP during AM and 13% CP during PM (16/13), and the last treatment D, hens fed both AM and PM with 13% CP (13/13). The treatments were ended when hens reached 36 weeks of age. Data collected were the egg components of the last three days of 28 days cycles of egg production. The data collected were analysed by analysis variance and DMRT was applied to evaluate the differences. Correlation analyses were used to know the link between protein consumption either in the morning or in the afternoon and totally protein consumption in each of egg component. Results showed that dual protein feedings affected the weight of egg and albumen and the percentages of yolk, shell, albumen and the shell thickness too ($P \leq 0.01$). Egg and albumen weight and the percentage of albumen of treatment A and B were higher than treatment C and D ($P \leq 0.01$). The yolk: albumen ratio, percentage of yolk and the shell thickness decreased by increasing egg weight. Afternoon protein consumption significantly correlated ($P \leq 0.01$) with the weight of egg, albumen and the percentage of albumen with coefficient correlation r = 0.485; 0.432; and -0.263 respectively. Total protein consumption significantly correlated with weight of egg and albumen ($P \leq .01$) with coefficient correlation r = 0.379 and 0.343 respectively. Low protein feeding in the morning followed by high protein in the afternoon can increase the weight of egg especially albumen weight.

Key words: Laying hens, Dual protein feedings, Egg quality

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Introduction

Time of feeding of the low- and high-protein diets to be main factor in using low-protein diets successfully in laying rations. Cave (1981) reported that feeding low protein (11.4 or 13.5% CP) at the first feeding of the day and high protein (17 or 18.9% CP) feed at subsequent feeding time had no significant effect on HDA but egg weight was significant greater than control (15.1% CP). Penz and Jensen (1991) reported that when hens were fed low protein (13%) in the morning and high protein in the afternoon (16%) resulted HDA and weight of egg with no difference compared by hens with single fed 16%. The result was in accordance with result of Sri-Sudaryati (2001), low protein feeds (13%) and high protein feeds (16%) resulted no difference to single feed (16%).

Morning feed consumption was lower than afternoon feed consumption, as shown by Sri-Sudaryati (2001) that morning feed consumption and afternoon feed consumption were 44% and 56% respectively, while Keshavarz (1998a) reported 40%: 60% and Keshavarz (1998b) 50%: 50% for morning and afternoon feed consumption. Mongin *et al.* (1978) cited by Sykes (1983) reported that, although feeding takes place mainly in the light, about one third of the consumption is consumed during the intervening dark period. No food is consumed during either the second or the longer dark phase, which is this physiologically speaking, the true night. Cave (1981) said that the use of low-and high protein feeds, was due to a favourable coincidence of feeding times with diurnal metabolic rhythms. Given up to 74 % of dietary protein at the later feeding times would benefit broiler breeder enterprises.

The lipoproteins of the yolks are continuously synthesized in the liver and accumulated in the ovum until ovulation takes place, while the protein of albumen are synthesized in the oviduct and must be deposit on the ovulated ovum during a time period of 3 to 3.5 h while the ovum is in the magnum (Etches, 1996). On hens with highly egg production, oviposition happened in the morning, 30 minutes later ovulation take place so albumen secretion occurred in the morning too and then predicted that the requirement of protein in the morning increased. It was postulated that nutrients would be more efficiently, thereby improving the hens performance if nutrient were supplied at time that correspond more closely to their demand by the tissue.

The percentage of albumen and yolk is important to the egg breaking industry, with the yolk being more valuables. The proportion of yolk is reported to be less in small egg than in larger ones. Therefore, the yolk size increases proportionally with egg size. Ahn *et al.* (1997) said that Yolk: albumen ratio depends upon hen age and egg size. Yolk: albumen ratio was lowest when hen age 28 week and highest when 55-78 week and intermediate from 97 week. The percentage difference in yolk: albumen ratio between the highest and the lowest approximately 10%. Yolk: albumen ratio was the greatest in medium egg and this ratio decrease gradually as egg size increased. The percentages of egg yolk gradually decreased and that of egg albumen increased as the weight of egg increased. Larger eggs always have lower yolk: albumen ratio than smaller egg in all age groups. These findings suggest that the use of smallest eggs for whole liquid egg preparation and larger eggs for table egg use will be most beneficial for egg producers and processors.

The experiments were conducted to determine whether the daily requirement of laying hens for protein can be reduced by providing them with diets containing adequate levels of protein during the time of the day when the physiological protein need during egg formation, reduced protein consumption without disturb the quality of the egg.

Materials and Method

Sixty Lohmann Brown hens 24 weeks of age were placed in individual battery cage and furnished with an individual drinker and two individual feeders. The hens were randomly divided into four group of 15 hens each and individual hen as a replication. The hens were given ad libitum access of feeds during feeding time. The experimental diets were shown on Table 1. Morning feeding time was given during 08.00-12.00 (AM) whereas afternoon feeding time was given during 12.00-18.00 (PM). The treatments were, treatment A, hens were fed both AM and PM with 16% crude protein (CP) (16/16); Treatment B, hens fed 13% CP during AM and 16% CP during PM (13/16); Treatment C, hens fed 16% CP during AM and 13% CP during PM (16/13), and the last treatment D, hens fed both AM and PM with 13% CP (13/13). The treatments ended when hens reach 36 weeks of age or three cycles of 28 days of egg production.

Data collected were all egg of the last three days of 28 days cycles of egg production. Egg were weighed individually and broken onto a flat surface of glass where the height of the inner thick albumen was twice measured with depth micrometer. The yolk then was separated from the albumen and weighed. The shell was dried at room temperature a week and weighed. The weight of albumen was calculated as the difference between the weight of the egg and the weight of the yolk plus shell. Yolk colour fan from Roche was used to measure the colour of the yolk. Data collected were analysed by analysis variance and DMRT was used to know the differences. Correlation analyses were used to know the link between protein consumption either in the morning or in the afternoon and totally protein consumption with each of egg component.

Table 1. Composition of experimental diets

Ingredient and analysis	13 % protein	16% protein
	%	
Yellow corn	60.00	56.50
Rice bran	10.00	7.50
Soybean meal, dehulled	8.50	12.50
Poultry meat meal	5.00	8.00
Palm oil	4.00	4.00
Limestone	8.00	7.55
Mineral mix*	1.20	0.70
Salt	0.30	0.30
Vitamin mix**	0.50	0.50
Sand	2.50	0.70
Total	100.00	100.00
Calculated analysis		
ME, kcal/kg	2863.00	2862.60
Protein, %	13.06	16.03
Ca, %	3.59	3.46
P (available), %	0.45	0.45

* Mineral mix per 100 g: 18% Ca, 21% P, 4.82% CP, 213 kcal
** Vitamin mix 1000 g: 1,200,000 IU vitamin A, 200,000 IU vitamin D_3, 800 IU vitamin E, 200 IU vitamin B_1, 500 mg vitamin B_2, 50 mg vitamin B_6, 1.200 mg vitamin B_{12}, 200 mg vitamin K, 2.500 mg vitamin C, 600 mg Ca-D-Pantotenat, 4.000 mg Niacin, 1.000 mg Santoquine, 1.000 mg Choline-Chloride, 3.000 mg Methionine, 3.000 mg Lysine, 12.000 mg Manganese, 2.000 mg Iron, 20 mg Iodine, 10.000 mg Zinc, 20 mg Cobalt, 400 mg Copper, 2.100 mg Zinc Bacitracine.

Results and Discussions

The result of the present study showed that feeding with two levels of protein affected egg component in absolute weight, and as percentage of egg weight (Table 2), and correlation between morning-afternoon protein consumption's and total protein consumption (Table 3). Egg weight of treatment A was not different to B, as well as C to D, even though egg weight of A and B were heavier compared to C and D ($P \leq 0.01$). Those were caused by different protein consumption, especially during afternoon (Table 4). Sri-Sudaryati (2001) found morning protein consumption A and C were here higher compare to B and D ($P \leq 0.01$). For all treatments, afternoon protein consumption was higher to morning protein consumption, except morning protein consumption A and afternoon protein consumption of C ($P \leq 0.01$). Totally, the highest of protein consumption occurred at treatment A and the lowest protein consumption occurred at the treatment D ($P \leq 0.05$). The correlation between afternoon protein consumption with egg component has higher then the correlation between total protein consumption with egg component. Coefficient correlation

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between egg weight and afternoon protein consumption compared to coefficient correlation between egg weight with total protein consumption were r = 0.485 and r = 0.379 respectively ($P \leq 0.01$). Those results indicated that differences of egg weight were not only affected by level of protein consumption, but also by when the hens were fed. On B and C treatments, total protein consumption was not different, but egg weight in B was heavier to C, caused by afternoon protein consumption of B was higher to C ($P \leq 0.01$). This result was in line with Cave (1981), where the use of low- followed by high-protein feeds, was due to a favourable coincidence of feeding times with diurnal metabolic rhythms.

Afternoon protein consumption was more efficient, as shown also by Cave (1981), that given up to 74% of dietary protein at the later feeding times would benefit for egg performance of broiler breeder hens. Besides that Sri-Sudaryati (2001); Penz and Jensen (1991) reported that feeding low protein in the morning followed by high protein at the afternoon resulted HDA and egg weight with no difference compared to single high protein. Etches (1996), said that higher efficient protein use at the afternoon has correlation with locomotors activity, where in the night motoric activity was decreasing. In the absence of movement, the utilization of feed for maintenance is reduced and therefore the efficiency of feed utilization increases.

Table 2. The egg components of dual protein feeding program

Egg components	A	B	C	D	Mean
	16/16	13/16	16/13	13/13	
Egg, g	56.06^{b}	55.25^{b}	50.60^{a}	49.61^{a}	52.88
Yolk, g	12.82	13.49	13.35	13.37	13.26
Albumen, g	37.73^{b}	36.28^{b}	31.74^{a}	31.20^{a}	34.24
Shell, g	5.51^{b}	5.49^{b}	5.51^{b}	5.05^{a}	5.34
Yolk, %	22.88^{a}	24.44^{a}	26.46^{b}	27.00^{b}	25.19
Albumen, %	67.28^{b}	65.63^{b}	62.64^{a}	62.81^{a}	64.59
Shell, %	9.84^{a}	9.34^{a}	10.90^{b}	10.18^{a}	10.21
Yolk: albumen, %	34.12^{b}	37.33^{b}	42.54^{b}	43.14^{b}	39.28
Yolk colour	8.72	8.80	8.86	8.70	8.77
HU	101.59	100.25	100.63	101.17	100.91
Shell thickness, mm 10^{-2}	31.36^{a}	31.88^{a}	33.51^{ab}	35.44^{b}	33.04

Mean within rows with no common superscript differ significantly ($P \leq 0.01$)

Table 3. The correlation coefficient (r) between protein consumption and egg components

Egg components	Protein consumption		
	Morning	Afternoon	Total
Egg, g	0.022	0.485**	0.379**
Yolk, g	-0.075	0.071	0.010
Albumen, g	0.029	0.432**	0.343**
Shell, g	0.129	0.176	0.208
Yolk, %	-0.080	-0.263**	0.233
Albumen, %	0.025	0.299	0.240
Shell, %	0.114	-0.287	-0.150
Yolk: albumen, %	-0.042	-0.0286*	-0.0240
Yolk colour	0.014	-0.078	- 0.050
HU	0.185	0.015	0.119
Shell thickness, mm 10^{-2}	0.131	-0.177	-0.057

* Correlated (P≤0.05)
** Correlated (P≤0.01)

In the present study, egg weight increased because of increasing albumen weight (P≤0.01). Absolute weight and percentage against to egg weight of albumen on treatments of A and B were higher compare to C and D. Coefficient correlation between albumen weight with afternoon protein consumption was r = 0.432, higher compare to total protein consumption and albumen weight (r = 0.343). In contrary yolk weight and afternoon protein consumption have negative coefficient correlation (r = -0.263). Keshavarz (1998ab) predicted that protein requirement increased significance when ovum on magnum for 3 to 3.5 h and occurred at the morning. On the other hand, the yolk protein are continuously synthesized in the liver and accumulated in the ovum until ovulation takes place. Edward (1978) cited by Solomom (1983) found that from 4 to 24 h after oviposition the protein content of the magnum increase steadily taking 20 – 23 h to synthesis the albumen protein for single egg. Etches (1996) also explained that the secretory cells of the epithelium of the magnum do not release all of the preformed granules as the yolk passes through the magnum and may contain sufficient protein for deposition on two eggs just before an egg enter the magnum. Albumen weight and albumen percentage on the heavier egg in accordance with results of Scott and Silversides (2000) that the correlation coefficient between eggs weights and yolk and shell weight were lower than egg and albumen weights.

Table 4. Average protein consumption of dual protein feeding program

	A (16/16)		B (13/16)		C (16/13)		D (13/13)	
	AM	PM	AM	PM	AM	PM	AM	PM
Consumption **	6.57^{bc}	8.55^{e}	5.22^{a}	8.56^{e}	6.38^{b}	6.82^{c}	5.47^{a}	7.23^{d}
Total*	15.12^{c}		13.78^{b}		13.20^{ab}		12.70^{a}	

Values followed by different letters within rows are different
* ($P \leq 0.05$)
** ($P \leq 0.01$)

Yolk weight was not affected by treatments, but by increasing of albumen weight and yolk weight caused yolk percentage decreased by increasing egg weight. This result was in line with Ahn *et al.* (1997) that the percentage of egg yolk gradually decreased as that of egg albumen increased as the weight of egg increased, as shown on the coefficient correlation between afternoon protein consumption and yolk percentage ($r = -0.263$, $P \leq 0.01$). Because of changes in egg weight and albumen that was not followed changes on yolk weight, caused yolk: albumen ratio on A and B treatments were lower compared to C and D ($P \leq 0.01$). Yolk: albumen ratio decreased by increasing egg albumen, this was in line with Ahn *et al.* (1997) that explained larger eggs always have lower yolk: albumen ratio than smaller egg.

Shell weight on D treatment was the lowest compared to A, B, and C treatments, even though on C shell weight increased without increasing egg weight. The reason of this result was unclear. Shell thickness on A and B treatments was lower compared to C and D, this was in line with the percentage of eggshell. The lower percentage of eggshell, because the lower shell thickness was in agreement with the study of Scott and Silversides (2000), where the correlation coefficients between egg weight and yolk and also shell weight were lower than egg and albumen weights. It was concluded that treatments did not affect either HU or yolk colour.

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