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IMPROVEMENT OF PRODUCTIVITY AND EGG QUALITY WITH CALCIUM LEVELS BASED UPON FEEDING TIME SCHEDULE ON LAYERS

Sri Sudaryati

Faculty of Animal Sciences, University of Gadjah Mada. Karangmalang Yogyakarta 55281 Indonesia

ABSTRACT

The study was conducted to investigate the productivity and egg quality on layer which given different calcium levels based upon time feeding schedule. Combination of calcium morning (AM) and afternoon (PM) of Isocalory-nitrogen feed were fed to serve calcium and other nutrients needed as physiological egg formation especially shell egg as an effort to improve egg quality and production. Three levels of calcium (2.0; 3.5; and 5.0 %) were fed for 3 months during egg production. Sixty three layers 70 weeks of egg were divided into 7 treatments; every treatment was repeated 3 times with each 3 layers. Those treatment were T1 (3.5 AM and 3.5 PM), T2 (2.0 AM and 5.0 PM), T3 (5.0 AM and 2.0 PM), T4 (3.5 AM and 2.0 PM), T5 (2.0 AM and 3.0 PM), T6 (3.5 AM and 5.0 PM), and T7 (5.0 AM and 3.5 PM). Data were analyzed with one-way ANOVA, followed by Duncan's Multiple Range Test. The result of the study showed that, isocalory-nitrogen feed with different calcium levels on AM and PM feeding time affected on egg production (P< .05), calcium consumption, weight and percentage of shell egg and also on egg shell index (P< .01). It was concluded that the patterns of morning and afternoon feed intake had little changes, morning feed intake increased when morning Ca feed was low and afternoon feed intake reduced when Ca feed was high and vice versa. Increasing intake of dietary Ca significantly improved performance of laying hens, absolute weight and percentage of eggshell, and improved shell index, but over consumption of Ca intake reduced that performance. Dietary Ca requirement for laying hens from 70 to 82 weeks of age was 4.72 g per hen daily.
(Keywords: *Calcium, Feeding Time, Layers*)

INTRODUCTION

Calcium is one of the key elements required for maintenance and production of laying hens. It is generally accepted that the decrease in egg production rates and increase in egg size, without concurrent and equal increase in shell weight is the reason for the decrease in shell quality as the hen ages (Clunies, *et al.*, 1992; Etches, 1996; Roland *et al.,* 1996). Eggshell quality also changes in accordance with level of production and age of layer. As age advances also, shell thickness and shell strength decrease as age advances (Camerius *et al.*, 1996).

It is widely acknowledged that eggshell quality is affected by many factors, such as diseases, nutritional status of the flock, heat stress and age (Roberts, 2004), genetic (Al-Batshan *et al.,* 1994, Franco-Jimenez D.J. and M.M. Beck. 2005) . Economic losses

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because of poor shell quality around the world are estimated at approximately $500 million per year (Etches, 1996). The increase in egg size that age brings along with insufficient calcium carbonate secretion consequently results in a reduced thickness of the eggshell (Etches, 1996). Among the various nutritional factors that are necessary for proper eggshell formation adequacy of Ca intake probably, plays the important role, because Ca make up about 40% of the eggshell investigation of the Ca requirement of laying hens have been the subject of numerous reports. The shell deposition and shell quality are directly related to the calcium level in the diet. The value of 3.75 g Ca per hen per day or greater was determined to be necessary for optimum shell and bone formation (Clunies *et al.*, 1992).

The element a composition of eggshell has been reported to be about 98.2% calcium, 0.9% magnesium and 0.9% phosphorus (present in shell as phosphate). Inadequate Ca significantly decreased egg production, egg weight, egg specific gravity, feed consumption, and bone density and strength (Roland *et al.*, 1996). On the other hand excess Ca significantly reduced egg weight, egg production, and feed consumption (Harms and Waldroup, 1971)

A number of studies have been conducted to investigate Ca requirement for laying hens. However, the results for Ca requirement ranging from 3.25 to 5.57 g hen per d are inconsistent among researchers (Roland *et al.*,1996; Ahmad *et al.*, 2003). Eggshell Ca concentration of the ration with 3.5 -4.10 % was significantly greater than when the chicken given more than that concentration (Canan Bölükbasi *et al* 2005). Dietary Ca requirement for White Laying Hens from 46 – 62 weeks of age was 3.56% in the diet or 4.0 g per hen daily with average ambient temperature 21.65°C. Increasing dietary Ca from 028% to 0.42% had a quadratic effect in egg production, egg mass, feed intake, feed conversion and egg weight (Narváez-Solarte *et al.*, 2006). Various indices of shell quality were not improved when must paths of the daily Ca need was fed during the afternoon and evening and were not reduced when most parts of the daily Ca need was fed during the morning. Regardless of dietary Ca level, bird consumed about 40% during the morning and about 60% of their daily feed intake during the afternoon (Kesavarz, 1998)

MATERIALS AND METHODS

Hens and treatment

Sixty and three layers 70 weeks old Lohmann laying hens were used in this experiment. Combination of three levels of calcium (2.0; 3.5; and 5.0 %) isocalory-nitrogen feed was fed as morning feed (AM) and afternoon feed (Table 1). The feed were fed for three months to serve calcium and other nutrients needed as physiological egg formation especially shell egg as an effort to improve egg quality and production. The laying hens were divided into 7 treatments; every treatment was repeated 3 times with each 3 layers. Those treatment were T1 (3.5 AM and 3.5 PM), T2 (2.0 AM and 5.0 PM), T3 (5.0 AM and 2.0 PM), T4 (3.5 AM and 2.0 PM), T5 (2.0 AM and 3.0 PM), T6 (3.5 AM and 5.0 PM), and T7 (5.0 AM and 3.5 PM). Each hen was housed individually.

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Production and egg quality.

Feed intake, feed conversion were recorded weekly and egg production was charted daily. Egg weight and egg quality were recorded 3 days of the end of 4 weeks period. The surface area of eggs for determining shell weight per unit surface area (SWUSA) was calculated according to the method of Izat *et al* (1985). SWUSA= {shell weight (g) x 1000}/egg surface area. Egg surface area = 3.9782 x egg weight$^{0.7056}$. For eggshell quality, specific gravity (SG) and Haugh Unit were determined too. Specific gravity (SG) is a non-invasive method to determine eggshell thickness as well as eggshell quality. The SG of an egg is equal to the egg's density relative to water. To perform the SG determination, the eggs were immersed in a series of increasingly concentrated salt solutions until the eggs floated on the surface of one of the solutions. The saline solutions with a SG ranging from 1.064 to 1.100 in increasing of 0.05 were used following the floatation method described by Hamilton (1982). Data were analyzed with one-way ANOVA, followed by Duncan's Multiple Range Test, if there were differences.

RESULTS AND DISCUSSION

The total daily feed intake were not influenced by Ca feed morning and afternoon. The results of daily feed intake was not due to an increased appetite for Ca during the afternoon hours for shell formation but it depend on the patterns of feed intake that morning feed intake about 40% and 60% in the afternoon and the combination of Ca morning and afternoon made small changes.
Morning feed intake were increasing in the morning when afternoon Ca was higher and the contrary, morning feed intake were reducing when Ca feed in the afternoon was lower. This is in agreement with that of Keshavarz 1998 and Sri Sudaryati, 2001.

Table 1: Ingredients and Calculated Nutrient Composition of Experimental Diets

	2.0 % Ca	3.5 % Ca	5.0 % Ca
Ingredients			
Broiler concentrate, %	27.00	27.00	27.00
Corn, %	47.00	47.00	47.00
Rice bran, %	10.00	10.00	10.00
Palm oil, %	4.00	4.00	4.00
Mineral mix	0.50	0.50	0.50
Vitamin premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
$CaCO_3$	3.00	6.50	10.50
Sand/filler	8.00	4.50	0.50
calculated Analysis			
Crude Protein, %	16.03	16.03	16.03
ME, Kcal/kg	2849.00	2849.00	2849.0
P, %	0.49	0.49	0 0.49

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Table 2. Feed and Calcium Intake During Morning and Afternoon Feeding

	Ca level		Feed intake			Calcium intake		
	Morning[1]	Afternoon[1]	Morning	Afternoon	Total	Morning	Afternoon	Total
	—%—		—g/hen/day—			—g/hen/day—		
T1	3.5	3.5	44.76[ab]	70.03[bc]	114.79	1.57[b]	2.45[b]	4.02[D]
T2	2.0	5.0	47.24[cd]	65.85[a]	113.09	0.94[a]	3.29[b]	4.24[E]
T3	5.0	2.0	42.81[a]	72.06[c]	114.87	2.14[c]	1.44[a]	3.58[C]
T4	3.5	2.0	44.11[ab]	70.60[bc]	114.71	1.54[a]	1.41[a]	2.96[A]
T5	2.0	3.5	47.50[d]	67.59[ab]	115.09	0.95[a]	2.37[a]	3.32[B]
T6	3.5	5.0	47.16[cd]	67.97[bc]	115.13	1.65[b]	4.40[c]	5.05[G]
T7	5.0	3.5	44.73[ab]	70.87[bc]	115.60	2.24[d]	2.48[b]	4.72[F]
SEM			0.44	0.71	0.765	0.01	0.02	0.03

[a-f]Means within columns with no common superscript differ significantly (P,0.05)
[A-F]Means within columns with no common superscript differ significantly (P,0.01)
[1] Morning feeds were fed from 06.00 to 13.00 h and afternoon feeds were fed from 13.00 to 18.00 h

Table 3. The Effect of Calcium Feed Regimens on Hen Day Average, Egg Weight, Egg Mass and Feed Conversion Ratio

	Ca level		Hen Day Average	Egg Weight	Egg Mass	Feed Conversion Ratio
	Morning[1]	Afternoon[1]	—%—	—g/egg—	—g/day—	
	—%—					
T1	3.6	3.5	76.71[a]	66.07	50.80	2.27
T2	2.0	5.0	78.11[a]	63.11	49.42	2.34
T3	5.0	2.0	75.96[a]	61.45	47.17	2.47
T4	3.5	2.0	78.69[ab]	64.78	51.03	2.25
T5	2.0	3.5	78.99[ab]	63.04	50.34	2.26
T6	3.5	5.0	74.69[a]	66.96	49.57	2.30
T7	5.0	3.5	84.75[b]	62.46	52.71	2.17
SEM			1.97	1.35	1.24	0.06

[a-f]Means within columns with no common superscript differ significantly (P,0.05)
[1] Morning feeds were fed from 06.00 to 13.00 h and afternoon feeds were fed from 13.00 to 18.00 h

When Ca morning was low (T2, T5), hens feed intake morning was increased to reach much Ca intake but it was limited by morning feed intake about 40% due to isocalory-nitrogen feed, and other hand afternoon feed intake was decreased. Feed intake morning on moderate Ca (T1, T4, and T6) it was depend on Ca feed afternoon, T1 and T4 were similar but T6 was similar to T2 and T5. Feed intake on high Ca in the morning (T3, T7) it depend on Ca in the afternoon, morning feed intake was the lowest when afternoon Ca the lowest too and the feed intake was the highest when the Ca afternoon was moderate.

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Table 3. The Effect of Calcium Feed Regimens on Egg Quality

	Weight of				Percentage of			Shell	Egg	
	Whole Egg	Egg Yolk	Egg White	Egg Shell	Egg Yolk	Egg White	Egg Shell	Index (SWUSA)	Egg Specific Gravity	Haugh Unit
	g				%			–mg/cm^2–	(SG)	
T1	66.07	16.67	43.50	5.90^B	25.23	65.84	8.93^{BC}	77.09^{BC}	1.0545	86.19
T2	63.11	16.95	40.06	6.10^B	26.86	63.48	9.67^C	82.32^C	1.0501	74.60
T3	61.45	16.74	39.56	5.15^A	27.24	64.38	8.38^{AB}	70.82^A	1.0576	89.10
T4	64.78	17.24	42.19	5.35^A	26.61	65.13	8.26^{AB}	70.88^A	1.0603	90.51
T5	63.04	16.64	41.02	5.38^A	26.40	65.07	8.53^{AB}	72.66^{AB}	1.0501	84.69
T6	66.96	17.28	44.55	5.13^A	25.81	66.53	7.66^A	66.39^A	1.0522	85.11
T7	62.46	16.62	39.99	5.85^B	26.61	64.02	9.37^{AB}	79.52^{AB}	1.0580	89.80
		1.42	1.20	0.32	1.31	0.62	2.12	1.295	0.0000	1.07

$^{A-F}$Means within columns with no common superscript differ significantly (P,0.01)
[1] Morning feeds were fed from 06.00 to 13.00 h and afternoon feeds were fed from 13.00 to 18.00 h

Daily Ca intake affected HDA (P<.05) but did not affect on egg weight, egg mass, and FCR. Calcium intake from 2.96 to 4.24 g/day (T1, T2, T3, T4, and T5) had no significant effect on egg production and increasing Ca intake 4.72 (T6) increased the egg production but increased Ca 5.05 g/day (T6) reduced egg production (Table 3). This result was similar to Harms and Waldroup (1971), they reported that excess Ca significantly reduced egg weight, egg production, and feed consumption and Narváez-Solarte et al (2006) reported that the increase of Ca feed level had a quadratic effect on egg production, dietary Ca level increased from 2.6 to 3.8% increased egg production but increased dietary Ca until 4.2% decreased egg production. This value is close to that of Roland *et al.* (1996), who reported that the requirement of dietary Ca ranged from 3.6 to 4.2 g per hen daily at 32 wk of age and Narváez-Solarte et al (2006) that Ca requirement of white laying hens from 46 to 62 wk of age was 4.02 g per hen daily, also Clunies *et al.*, (1992) reported that the value of 3.75 g Ca per hen per day or greater was determined to be necessary for optimum shell and bone formation.

Shell weight on T1, T2, and T7 was heavier eggshell weight compared to T3, T4, T5, and T6 (P<.01). Increasing intake of Ca increased the weight of egg shell, but on T6, increasing Ca intake decreased egg shell weight, percentage of eggshell, egg shell index, and egg production. Eggshell weight on T6 the diet containing 3.8% had the highest egg shell weight (7.16 g). Increased egg shell weight with increasing dietary Ca level agreed with those of Roland *et al.* (1996), who reported that increasing dietary Ca level improved egg shell quality, afternoon Ca feed was higher than morning Ca

The results of this experiment along with others (Roland *et al*, 1996; Clunies *et al.*, 1992; and Narváez-Solarte et al, 2006) increasing daily Ca intake from 2.96 to 4.72 g/day significantly improved performance of laying hens but excessively daily Ca intake (5.05 g/day) decreasing performance (Harms and Waldroup, 1971; Narváez-Solarte et al, 2006). The total daily feed intake were not influenced by Ca feed morning and afternoon similar to Keshavarz, (1998) but opposite to the results of Harms et al (1996).

In conclusion, daily feed intake was not due to an increased appetite for Ca during the afternoon hours for shell formation but it depended on the patterns of feed intake that morning feed intake about 40% and 60% in the afternoon, but the patterns of morning and afternoon feed intake had little changes, morning feed intake increased

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when morning Ca feed was low and afternoon feed intake reduced when Ca feed was high and vice versa. Increasing intake of dietary Ca significantly improved performance of laying hens absolute weight and percentage of eggshell, and improve shell index, but over consumption of Ca intake reduced that performance. Dietary Ca requirement for laying hens from 70 to 82 weeks of age was 4.72 g per hen daily.

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