Acta Veterinaria (Beograd), Vol. 53. No. 1, 35-40, 2003.

UDK 619:636.5.084.524

IMPROVING EGGSHELL QUALITY BY REPLACEMENT OF PULVERISED LIMESTONE BY GRANULAR LIMESTONE IN THE HEN DIET

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(Received 22. December 2002)

Eggshell quality was studied in a total of 108 Hissex hens from 58 to 62 weeks of age. All hens received a basal diet of the same composition. The differences between the three equal groups were in the replacement percent of fine pulverised limestone by granular limestone, of larger particle size. The first group (control) received the basal diet with only pulverised limestone as a calcium supplement. In the diet of the second group, 60 % of the pulverised limestone was replaced with granular limestone and in the third group percent 80 %. Significantly higher breaking force (3.6 kg), shell mass (8.2 g), shell thickness (36 x 0.01 mm) and lower deformation (20.4 μ) were found for eggs from the third group of hens than for eggs from the first group (3.4 kg; 8.0 g; 35 x 0.01 mm; 21.4 μ; respectively). Also, these eggshell characteristics were more favourable in the second group than in the first group, but the difference was significant ($p<0.05$) only for breaking force (3.5 kg versus 3.4 kg). The results obtained in our investigation showed some possibilities of eggshell quality improvement using limestone of larger particle size as a Ca supplemente in the hen diet. Replacing 60-80 % of pulverised limestone by larger particle size limestone had positive effects on eggshell quality.

Key words: eggshell, limestone, particle size, hens

INTRODUCTION

The content of the egg is protected by a highly ordered calcareous eggshell that needs to be as strong as possible to maximize the number of eggs reaching the market. Egg breakage produces a large economic loss to the poultry industry. It was estimated that 13-20 % of total eggs produced are cracked or lost before reaching the consumers (Roland, 1988). Many factors influence eggshell quality, including the age of hens, strain of bird, nutrition, ambiental conditions and diseases (Washburn, 1982; Woolford, 1994; Vitorović *et al*., 1995). About 95 % of the dry eggshell is calcium carbonate and, because of that, laying hens have a high dietary calcium requirement for shell calcification. The main source of calcium in hen diets is pulverised limestone. However, eggshell formation usually occurs at night when the hen is not eating, and satisfaction of needs is not adequate. It has been suggested that calcium absorption might be more sustained if the hen is given access to particulate calcium which might persist for longer in the gut after eating ceases (Guinote and Nys, 1991; Roberts and Nolan, 1997). Larger particle size of limestone led to an increase in gizzard and duodenal soluble Ca at the end of eggshell calcification in laying hens (Kermanchoi *et al*., 1991; Guinote at al., 1995; Zhang and Coon, 1997). Replacing 50 % of ground limestone by large particle size limestone was found to be quite adequate in order to optimize eggshell quality (Roland and Bryant, 1999). Our previous article (Pavlovski *et al*., 2000) presented the positive effects on eggshell quality in hens receiving a diet in which 60 % of pulverised limestone was replaced by two granular forms of limestone.

The aim of the present study was to compare the effects on eggshell quality using diets with different amounts of the pulverised limestone replaced by granular limestone.

MATERIALS AND METHODS

A total of 108 Hissex hens were divided into three groups (36 birds per group) and housed in cages (four birds per cage) from 58 to 62 weeks of age. Hens were provided with feed and water *ad libitum*. All groups received a basal diet (Table 1) of the same composition. The differences between the groups were in the replacement percent of fine pulverised limestone by granular limestone of larger particle size. The first group (control) received the basal diet with only pulverised limestone as a calcium supplement. In the diet of the second group, 60 % of pulverised limestone was replaced with granular limestone and in the third group 80 %. The calcium content of the limestone was 36 %.

Table 1. Composition of the basal diet

Ingredients	Composition (%)
Maize	62.7
Soybean meal (44%)	17.6
Sunflower meal	5.5
Fish meal (44%)	3.0
Dicalcium phosphate	1.8
Limestone pulverised *	8.2
Salt	0.2
Vitamin.-mineral mixture	1.0
Calculated composition	
ME, MJ/kg	11.10
Crude proteins, %	16.53
Calcium %	3.61
Phosphorus total %	0.73
Phosphorus available %	0.35

During the experimental period, from the starting age (58 weeks) eggs were collected at the end of every week. The following parameters were determined: egg mass (g); shell deformation on Marius Instrument loaded with 500 g (μm); shell breaking force, on »IS-96« Instrument at 2 mm/s rate of force applied at the equator (kg); shell thickness without membrane, using a micrometer at five random locations on the shell (0,01 mm); shell mass (g). Data for all weekly periods and for the whole experimental period (total of 540 eggs) were subjected to analysis of variance. Differences between measurements were tested by the t-test.

RESULTS AND DISCUSION

The results obtained for weekly intervals during the experimental period are shown in table 2.

Table 2. Eggshell characteristics influenced by the relative amount of larger particle size dietary limestone in hens from 58 to 62 weeks of age (grups 1, 2 and 3)

	Age of hens (weeks)				
	58	59	60	61	62
			Egg mass (g)		
1	59.4 ± 3.39	58.8 ± 3.39	58.7 ± 3.12	60.3 ± 4.66	59.9 ± 3.87
2	60.4 ± 4.64	61.1 ± 3.51	60.7 ± 3.98*	60.1 ± 5.73	62.8 ± 4.63*
3	60.0 ± 4.68	60.2 ± 3.38	61.0 ± 5.64*	59.5 ± 5.50	60.8 ± 4.69
			Deformation (*μ*)		
1	24.5 ± 4.31	19.6 ± 3.96	21.2 ± 4.42	20.8 ± 3.64	21.5 ± 4.32
2	23.5 ± 3.59	19.2 ± 3.75	20.3 ± 3.81	20.4 ± 3.63	19.8 ± 2.51
3	23.7 ± 5,03	18.9 ± 3.36	19.3 ± 3.40	21.4 ± 3.12	19.3 ± 2.68*
			Breaking force (kg)		
1	3.3 ± 0.59	3.5 ± 0.58	3.4 ± 0.63	3.5 ± 0.52	3.1 ± 0.80
2	3.2 ± 0.47	3.6 ± 0,63	3.6 ± 0.56	3.6 ± 0.69	3.6 ± 0.75**
3	3.5 ± 0.66	3.7 ± 0.57	3.6 ± 0.58	3.4 ± 0.56	3.7 ± 0.71**
			Shell mass (g)		
1	7.9 ± 0.80	8.1 ± 0.74	7.7 ± 0.69	8.2 ± 0.75	8.0 ± 0.71
2	8.1 ± 0.80	8.2 ± 0.94	8.0 ± 0.73	8.0 ± 0.84	8.3 ± 0.86
3	8.4 ± 1,14*	8.5 ± 0,91	8.1 ± 0.85	7.9 ± 0.59	8.3 ± 0.77
			Shell thickness without membrane (0,01 mm)		
1	35.0 ± 3.17	35.9 ± 2.87	34.6 ± 2.91	35.9 ± 2.94	34.8 ± 3.56
2	35.7 ± 2.46	36.0 ± 3.23	35.2 ± 2.43	36.6 ± 3.59	36.1 ± 2.50*
3	35.8 ± 2.61	36.3 ± 2.51	35.6 ± 2.37	35.7 ± 2.20	36.5 ± 2.26*

Means and standard deviation
Significant differences: * $p < 0.05$; ** $p < 0.01$

Hens which received granular limestone in the diet eggs of better shell quality than hens given only pulverised limestone as a Ca source, but the differences between treatments were not significant at all weekly intervals. The most significant differences were obtained at the end of the last week (62 weeks of age). Deformation (19.3 μ) was significantly ($p<0.05$) lower in eggs from the third group (80 % pulverised limestone replaced by granular limestone) than in those from the first group (21.5 μ) fed a diet without (0 %) granular limestone. Also, significantly ($p<0.01$) higher breaking forces were observed in eggs from the second (3.6 kg) and third group (3.7 kg) than from the first group (3.1 kg). Differences in shell mass were not significant. Shell thicknesses of eggs laid by hens of the second group and the third group were significantly higher ($p<0.05$) than for the first group at 62 weeks of age.

Because of the relatively small number of eggs (34 - 35 eggs/group/week) examined in individual weekly periods, for better analysis all eggs (180 eggs/group making total of 540 eggs) during the whole experimental period were included. The results obtained are shown in table 3.

Table 3. Mean eggshell characteristics influenced by the relative amount of larger particle size dietary limestone in hens from 58 to 62 weeks of age

Characteristics	Group of hens		
	1	2	3
Egg mass (g)	59.4 ± 3.73	61.0 ± 4,66	60.3 ± 5,17
Deformation (μ)	21.4 ± 4.35	20.6 ± 3.77	20.4 ± 4.03*
Breaking force (kg)	3.4 ± 0.64	3.5 ± 0.63*	3.6 ± 0.63**
Shell mass (g)	8.0 ± 0.75	8.1 ± 0.83	8.2 ± 0.88**
Shell thickness (0.01 mm)	35.3 ± 3.09	35.9 ± 2.66	36.0 ± 2.40*

Means and standard deviation
Significant differences: * $p < 0.05$; ** $p < 0.01$

A significantly higher mean breaking force (3.6 kg), shell mass (8.2 g) shell thickness (3.5 x 0.01 mm) and lower deformation (20.4 μ) occured in eggs from the third group of hens than in eggs from the first group (3.4 kg; 8.0 g; 35 x 0.01 mm; 21.4 μ; respectively). Also, these eggshell characteristics were more favourable in the second group of hens than in the first group, but the difference was significant ($p<0.05$) only for breaking force (3.5 kg v.s. 3.4 kg).

The results obtained in our investigation showed the possibilities of improving eggshell quality using limestone of larger particle size as a Ca source in diets for hens, and are in agreement with those reported earlier (Guinote and Nus, 1991, Roberts and Nolan, 1997). Larger particle size limestone led to an increase in gizzard and duodenal soluble Ca at the end of eggshell calcification in laying hens (Kermanchoi *et al*., 1991; Guinote at al., 1995; Zhang and Coon, 1997). In our previous article (Pavlovski *et al*., 2000) we presented the positive effects on eggshell quality in hens given a diet in which 60 % of pulverised limestone was replaced by granular forms of limestone. Roland and Bryant (1999) suggested that replacing 50 % of ground limestone by large particle size limestone is quite adequate to optimize eggshell quality. In our investigation it was observed that replacing 60-80 % of pulverised limestone by larger particle size limestone had positive effects on eggshell quality.

CONCLUSION

The results obtained in our investigation showed the possibilities of eggshell quality improvement using limestone of larger particle size as a Ca source in the hen diet. Replacing 60-80 % of pulverised limestone by larger particle size limestone had positive effects on eggshell quality. Significantly higher breaking force (3.6 kg), shell mass (8.2 g) shell thickness (3.5 x 0.01 mm) and lower deformation (20.4 μm) occured in eggs from the third group of hens than in eggs from the first group (3.4 kg; 8.0 g; 35 x 0.01 mm; 21.4 μm respectively). Also, these eggshell characteristics were more favourable in the second group of hens than in the first group, but the difference was significant ($p<0.05$) only for breaking force (3.5 kg vs 3.4 kg).

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POBOLJŠANJE KVALITETA LJUSKE JAJA ZAMENOM SITNO MLEVENOG KREČNJAKA SA MERMEROM KRUPNIJIH ČESTICA U OBROCIMA ZA NOSILJE

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SADRŽAJ

Ispitivanja su obavljena na 108 Hissex nosilja u uzrastu od 58 do 62 nedelje, podeljenih u tri grupe. Sve grupe su za ishranu dobijale smeše istog sastava a razlike su bile samo u procentu zamene krede, u obroku, sa mermerom krupnijih čestica. Grupa 1. (kontrola) je dobijala smešu u koji je osnovni izvor kalcijuma bila stočna kreda. U obroku grupe 2, 60% krede je bilo zamenjeno sa mermerom krupnijih čestica, dok je u obroku grupe 3 taj procenat zamene iznosio 80 %. Jaja su sakupljana po nedeljnim intervalima u cilju određivanja osobina kvaliteta ljuske. Ustanovljeno je da je najbolje rezultate dala ishrana nosilja grupe 3. Zamena 80 % krede sa mermerom krupnijih čestica, doprinela je statistički značajnom poboljšanju kvaliteta ljuske u odnosu na grupu 1. Na jajima nosilja grupe 3, ustanovljena je sila loma ljuske od 3,6 kg, deformacija ljuske 20,4 μm, masa ljuske od 8,2 g i debljina ljuske od 36 x 0,01 mm. Vrednosti ovih osobina na jajima nosilja gupe 1 su iznosile: 3,4 kg, 21,4 μ, 8,0 g i 35 x 0,01mm. Efekat poboljšanja kvaliteta ljuske jaja ispoljen je i kod nosilja grupe 2, ali je statistička značajnost ustanovljena samo za vrednost sile loma ljuske (3,5 kg).