DIGITONIN AND EGG QUALITY CHARACTERISTICS*

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The aim of the present study was to describe the effect of digitonin on egg quality. There were 3 groups in the experiment. Group 1 was fed by the control feed mixture with 16.54% crude protein and 11.61 MJ ME. Group 2 got the control feed mixture with 0.01% digitonin and the supplement of digitonin in group 3 was 0.025%. There was a negative correlation between the group and egg weight or yolk weight. Digitonin in the amount 0.025% significantly ($P \leq 0.05$) reduced egg weight from 65.07 g in the control group to 61.44 g in group 3, white weight (41.21 g vs. 37.96 g). Most of the eggshell quality characteristics were not influenced by the digitonin. Digitonin significantly ($P \leq 0.05$) increased eggshell share in groups 2 and 3 in comparison with the control group.

laying hen; digitonin; egg weight; albumen quality characteristics; yolk quality characteristics

INTRODUCTION

The avian egg is a highly integrated biological system, the structure and characteristics of which are interlinked. Therefore, any abnormality in the physical character of the egg can lead to a breakdown in the interactions of these parameters and, as a consequence, a collapse in its main physiological function to provide the best conditions for the developing embryo. The technological value of eggs, egg weight and eggshell quality influences the processing of eggs and their price. One of the most important indicators of egg performance is egg weight, because there is a highly positive correlation between the egg weight and the weight of different parts of the egg – especially between the egg yolk and albumen.

Egg quality characteristics are affected by many factors. It is a well known fact that with hen age, the egg weight increases but eggshell quality decreases and also as the number of eggs increases, egg weight decreases. The effect of a housing system on egg quality is described by Roland et al. (1997), Moorthy et al. (2000) and Tůmová, Ebeid (2003) who concluded that eggshell thickness, shape index, Haugh units and yolk index were higher in birds housed in cages than in birds on deep litter.

One of the most important factors influencing egg quality is nutrition. The emphasis is on metabolizable energy, crude protein, amino acids and mineral elements in feed mixtures. The effect of metabolizable energy on egg weight was revealed by Rossa et al. (1996), Harms et al. (2000) or Tůmová et al. (2002) – and methionine by Waldroup, Hellwig (1995) and Tůmová et al. (2002).

Recently, there has been an interest in the specific substances used in the feeding of laying hens, which can influence human health status. Digitonin is one of them. Digitonin is known as a substance, which decreases cholesterol level in blood plasma and has an effect on leucocytes and enzyme activity. Digitonin is a plant steroid which is placed to steroid sapogenin, C_{27}-steroid. Fisher, Griminger (1967) and Sim, Bragg (1978) found out that plant sterols decreased plasma cholesterol in laying hens. In the literature, the opposite effect of plant sterols on egg yolk cholesterol is described. Clarenburg et al. (1971) stated that 4% of sitosterol lowered egg yolk cholesterol. However, Bartov et al. (1971) found no effect of soybean sterols upon the cholesterol level of egg yolk. The effect of plant sterols on egg quality has not been described in the available literature.

The objectives of the present study were to determine the effect of digitonin and its level on egg weight and egg quality traits.

MATERIALS AND METHODS

The experiment was carried out with 24 Hisex brown laying hens. The hens were divided into 3 groups (8 laying hens per group) according to the digitonin concentration in the feed mixture. Group 1 was fed by the control feed mixture, group 2 got the control feed mixture with 0.01% digitonin and the feed mixture for group 3 was supplemented with 0.025% digitonin. The composition of the feed mixture is given in Table 1.

The experiment took 16 weeks, from weeks 28 to 44. The laying hens were kept individually in 3-floor conventional cages: Big Dutchman Eurovent. There was a floor space of 1000 cm^2 per hen, 10 cm feeding space and 2 available drinkers. The environmental conditions corresponded with laying hen requirements. Feeding and watering were ad libitum. The daily photoperiod con-

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sisted of 15 h of light and 9 h of darkness and light intensity was 10 lx.

Eggs for measuring the egg quality were sampled every 14 days, 2 days in each collection period (12 eggs for each collection period in the group). Egg weight, yolk weight, white weight, shell weight, and shell strength were determined. Albumen height and Haugh units were evaluated by QCD device (TSS England). Using the individual weight of each egg and the weight of its components, the percentages of the yolk, albumen and shell were determined. From the measurement of the egg, the albumen and yolk length and height, the index of the egg, the albumen and the yolk were counted. Eggshell strength was measured by nondestructive deformation by Columbus M- instrument (Simeonová et al. 1992).

Data were analysed by Anova using SAS programme. Duncan's multiple range test was used to differentiate group means. Differences were considered significant at $P \leq 0.05$. Statistically significant differences are in tables denoted by various letters.

Table 1. Composition of feed mixture

Components	%
Wheat	49.87
Maize	17.00
Fish meal	1.5
Rapeseed meal	4.00
Alfalfa meal	2.00
Soybean meal	14.00
Rapeseed oil	1.5
Limestone	5.50
Salt	0.25
Eggshells	3.0
Bolifor MCP-F	0.83
DL-methionine	0.05
Aminovitan SK-C1	0.50
Content of nutrient	
Dry matter	87.36
Crude protein	16.54
Metabolizable energy (MJ)	11.16
Fat	4.09
Fibre	3.48
Ca	3.56
P	0.57

Composition of Aminovitan SK per 1 kg of premix: vitamin A 1 600 000 iu., vitamin D_3 450 000 iu., a-tokoferol 3000 mg, vitamin K_3 300 mg, vitamin B_1 300 mg, vitamin B_2 800 mg, vitamin B_6 400 mg, vitamin B_{12} 2 mg, niacin 4000 mg, pantothenan Ca 1200 mg, cholin 50 000 mg, biotin 12 mg, folic acid 80 mg, betaine 10 000 mg, DL-methionine 60 g, Co 60 mg, Cu 1200 mg, Fe 6000 mg, I 140 mg, Mn 12 000 mg, Zn 10 000 mg, Se 40 mg, butylhydroxytoluen 3000 mg, etoxyquin 2000 mg, butylhydroxyanisol 400 mg, wheat meal ad 1 kg

RESULTS AND DISCUSSION

The results (Table 2) show the effect of digitonin on egg quality characteristics. There was a significantly ($P \leq 0.05$) lower egg weight in group 3 with 0.025% digitonin in feed mixture in comparison with the control group and the group with 0.01% digitonin. The differences between the control group and group 3 were more than 3.5 g. These findings confirm the negative correlation between group and egg weight (–0.312). The egg weight is an important measurement in egg quality because there is a high correlation between egg weight and the weight of albumen, yolk and eggshell (Izat et al., 1985; Skřivan, 1990). We found a slightly negative

Table 2. Egg quality characteristics

Measurement	Group		
	I	II	III
	control	0.01% digitonin	0.025% digitonin
Egg weight (g)	65.07^{a}	65.94^{a}	61.44^{b}
Egg shape index (%)	74.09^{b}	76.64^{a}	75.12^{b}
Albumen weight (%)	41.21^{a}	41.49^{a}	37.96^{b}
Albumen (%)	63.27^{a}	62.93^{a}	61.80^{b}
Haugh units	83.15^{b}	87.71^{a}	79.49^{c}
Albumen index (%)	9.65^{b}	10.89^{a}	8.64^{c}
Yolk weight (g)	16.64	16.77	16.34
Yolk (%)	25.58^{b}	25.39^{b}	26.59^{a}
Yolk index	47.51	47.63	46.45
Shell weight (g)	7.22^{b}	7.69^{a}	7.14^{b}
Shell (%)	11.15^{b}	11.68^{a}	11.62^{a}
Shell thickness (mm)	0.36	0.37	0.36
Shell strength (N)	31.72	34.67	32.30

^{a,b,c} $P \leq 0.05$

correlation between the group and yolk weight (–0.071). In the experiment yolk share and eggshell share were significantly ($P \leq 0.05$) higher in group 3 where egg weight was the lowest. The digitonin level 0.025% significantly reduced albumen share. These results are in contrast with findings of Halaj, Arpášová (1997), Cotterrill, Geiger (1977), Ledvinka et al. (1997) or Ledvinka et al. (2002) who stated that with egg weight the share of albumen, yolk and eggshell changes equally. The results show that digitonin has an effect on egg weight and the relationship between the different parts of the eggs.

Albumen quality was measured by albumen index and Haugh units. A positive effect of digitonin was found in the second group with 0.01%. Both albumen characteristics were significantly higher ($P \leq 0.05$) in comparison with the control group. In contrast, in group 3 with the higher digitonin level 0.025%, the albumen index and Haugh units were significantly ($P \leq 0.05$) lower than in the control group and the group with 0.01% of digitonin. Yolk quality, expressed by the yolk index, was not affected by the digitonin. According to the results of the yolk and albumen quality it seems that digitonin might influence albumen characteristics more than yolk quality.

One of the most important egg quality characteristics is eggshell measurement – of eggshell share, eggshell thickness and eggshell strength – because these influence eggshell integrity which is the primary condition contributing to the natural defense system of the egg. Digitonin significantly ($P \leq 0.05$) increased eggshell share in groups 2 and 3 in comparison with the control group. Harms et al. (1994) described the close relationship between eggshell share and other eggshell characteristics. In our experiment there were no differences among the groups in eggshell thickness and eggshell strength – but digitonin increased eggshell share.

Based on the results of the present study, it can be concluded that digitonin might have an effect on egg quality characteristics. Digitonin influenced mainly egg weight and albumen measurements. We found a small positive effect on yolk percentage. However, digitonin particularly affected lipid metabolism which confirmed our previous study Ledvinka et al. (2000) where we observed a negative correlation between digitonin concentration and serum HDL cholesterol (–0.250) and egg cholesterol (–0.301).

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Digitonin a kvalita vajec.

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Kvalita vajec vyjádřená jejich hmotností, podílem jednotlivých částí a kvalitou skořápky má význam i pro ekonomiku produkce, protože je spojena s cenou. Kvalita je ovlivněna řadou faktorů, z nichž je poměrně velmi málo známo o vlivu sterolů. Cílem pokusu bylo posoudit vliv digitoninu na kvalitu vajec. Digitonin je rostlinný sterol zařazovaný jako steroid sapogenin. Pokus byl realizován s 24 nosnicemi Hisex hnědý, které byly individuálně ustájené v konvenční kleci Big Dutchman Eurovent. Pokus byl rozdělen do tří skupin (8 ks ve skupině). Skupina 1 byla krmena kontrolní krmnou směsí s 16,54 % N-látek a 11,61 MJ ME, skupina 2 dostávala kontrolní směs s 0,01 % digitoninu a v krmné směsi pro skupinu 3 bylo 0,025 % digitoninu. Vejce pro rozbory byla sbírána ve 14denním intervalu, dva dny v každém období (12 vajec ze skupiny v každém období). Digitonin v množství 0,025 % průkazně ($P \leq 0,05$) snížil hmotnost vajec (z 65,07 g v kontrolní skupině na 61,44 g ve skupině 3) a hmotnost bílku (41,21 g vs 37,96 g), dále Haughovy jednotky ve vztahu nejen ke kontrolní skupině, ale i ke skupině s 0,01 % digitoninu. Většina ukazatelů kvality skořápky nebyla digitoninem ovlivněna. Digitonin signifikantně ($P \leq 0,05$) zvýšil podíl skořápky z vejce ve skupinách 2 a 3 ve srovnání s kontrolní skupinou, ale neměl vliv na pevnost skořápky. Z výsledků je zřejmé, že digitonin může ovlivnit kvalitu vajec, jeho působení je však rozdílné ve vztahu k jednotlivým částem vejce.

slepice; nosný typ; digitonin; hmotnost vajec; charakteristiky kvality bílku; charakteristiky kvality žloutku

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