

CHANGES IN EGG WEIGHT, EGG SHELL WEIGHT AND QUALITY IN HENS WITH SPONTANEOUS AND EXPERIMENTAL ALOPECIA

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Summary

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In layer hens with spontaneous and experimental alopecia (provoked via administration of dried thyroid glands), a reduced egg and egg shell weights were observed. The levels of calcium, phosphate and magnesium in both blood serum and egg shell were decreased. The blood alkaline phosphatase activity was elevated.

Key words: alopecia, calcium, egg shells, hens, magnesium, phosphate

INTRODUCTION

The egg dimensions are an individual feature for each hen but they change under the influence of selection and depend on the age, nutrition and housing of birds (Djader, 1982; Jiang & Sim, 1991; Altan *et al.*, 1998).

During the last years, in poultry industry there is a tendency towards reduction in egg shell strength especially at the end of egg-laying (Linn, 1988), determined by the conditions of feeding and housing of hens and their heredity (Guo, 1988; Linn, 1988).

The egg shell strength depends on its thickness, weight and structure. The mineral content of diet influences those parameters more than the breed does (Lennards *et al.*, 1981; Junqueira *et al.*, 1984; Clunies & Leeson, 1995). It is established that via various means (food and water deprivation, sodium chloride, administration of thyroxin), alopecia could be induced and consequently, the egg weight and egg shell weight and quality was ele-

vated (Abu-Serewa & Karunajeewa, 1985). Data about the effect of spontaneous alopecia (SA) upon egg weight, egg shell and its quality are missing.

This motivated our study on egg and egg shell weight as well as on its qualitative changes in hens with spontaneous and experimental alopecia (EA).

MATERIALS AND METHODS

The experiments were performed on 40 Hissex laying hens fed a standard compound forage. Ten hens exhibited visible signs of SA and served as experimental group whereas another ten hens without such signs (healthy) – as controls. The day of allotment of hens into groups was accepted as initial day of the observations.

The experimental model of alopecia included 2 groups: one experimental (10 birds) that was treated once orally with 15 g dried calf thyroid gland tissue and one

control (untreated) group. At predetermined intervals after the start of observation in SA or after provocation of EA, the following egg and blood parameters were examined: the egg weights and egg shell weights by days 1–5 (mean values for the period), 30 and 60; blood plasma calcium, inorganic phosphate, magnesium and alkaline phosphatase levels by days 1, 30 and 60 for SA and days 1 and 30 for EA; the content of the mentioned macroelements in egg shells – by days 1 and 30.

The egg and egg shell weights were determined with a balance after removing the egg content. Then, the egg shells were mineralized in an oven. The ash was dissolved in 100 mL 0.1N HCl and calcium, phosphorus and magnesium contents were determined by atomic absorption spectrophotometry (AAS).

The data were statistically processed by the Student-Fischer test and presented as mean \pm SEM.

RESULTS

The egg weights in healthy hens and hens with SA and EA are presented on Fig. 1. Egg weights measured after the beginning of the observation in SA birds varied between 53.8 ± 1.56 g (at days 1–5) and 59.0 ± 0.5 g (at day 60) whereas in EA hens – from 51.2 ± 0.65 (at days 1–5) to 60.4 ± 0.57 g (at day 30). The differences between experimental and control groups were statistically significant only by days 1–5 in EA birds ($P < 0.01$). The egg-laying stopped completely 5 days after the start of EA and afterwards, was gradually restored after the 30th day.

The egg shell weights (Fig. 2) in SA controls varied between 6.03 ± 0.06 g (at day 60) and 6.15 ± 0.07 g (at day 30); in SA hens – between 5.63 ± 0.18 g (at days 1–5) and 6.04 ± 0.08 g (at day 60). A statistically significant difference vs controls was found by days 1–5 ($P < 0.05$). In the groups with EA egg shells weighed

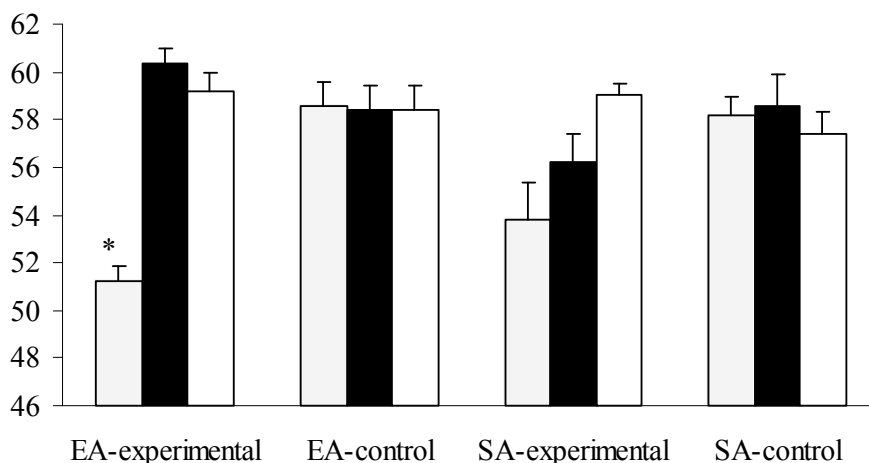


Fig. 1. Changes in egg weight in healthy hens (controls) and hens with spontaneous (SA) and experimental (EA) alopecia by days 1 (dotted bars), 30 (black bars) and 60 (white bars) after provocation of the disease in EA group, mean \pm SEM, * $P < 0.01$.

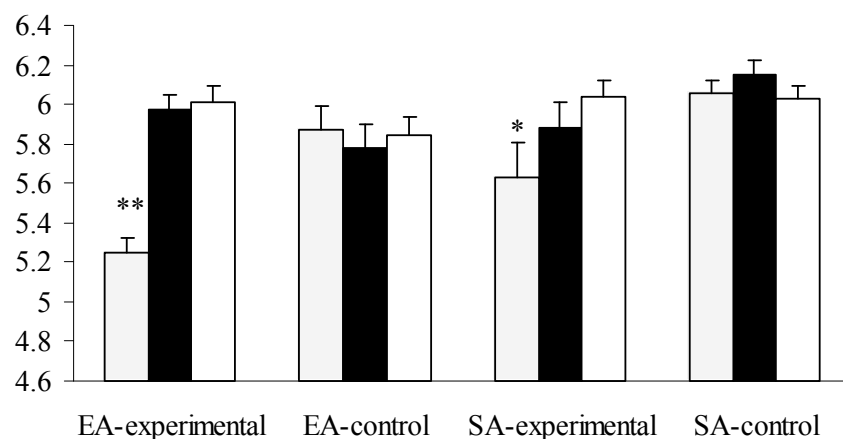


Fig. 2. Changes in egg shell weight in healthy hens (controls) and hens with spontaneous (SA) and experimental (EA) alopecia by days 1 (dotted bars), 30 (black bars) and 60 (white bars) after provocation of the disease in EA group, mean \pm SEM, * $P < 0.05$, ** $P < 0.01$.

Table 1. Calcium, phosphorus and magnesium content (mean \pm SEM) in egg shells in hens with spontaneous (SA) or experimental (EA) alopecia by days 1 and 30 after the start of observations in SA or after provocation of EA

Period of study	Groups	n	Calcium, mmol/L	Phosphorus, mmol/L	Magnesium, mmol/L
<i>Spontaneous alopecia</i>					
Day 1	Experimental	8	29016.28 \pm 1685.95	65.06 \pm 11.84*	2528.16 \pm 137.88
	Control	12	33293.72 \pm 1619.75	127.79 \pm 17.90	2550.20 \pm 110.09
Day 30	Experimental	8	33615.19 \pm 1302.30	95.09 \pm 10.36	2501.53 \pm 120.33
	Control	12	32055.85 \pm 2207.56	102.60 \pm 11.43	2491.00 \pm 122.95
<i>Experimental alopecia</i>					
Day 1	Experimental	5	27764.91 \pm 1442.11	63.03 \pm 7.81	2433.17 \pm 137.65
	Control	8	35236.92 \pm 1896.09	107.32 \pm 4.39	2436.08 \pm 76.39
Day 30	Experimental	5	40693.80 \pm 1655.80	109.53 \pm 7.22	2467.47 \pm 60.83
	Control	8	32353.73 \pm 1362.47	102.44 \pm 7.31	2457.93 \pm 48.92

* $P < 0.05$ vs controls.

5.78 \pm 0.12 g (at days 1–5) – 5.87 \pm 0.12 g (at day 30) and 5.25 \pm 0.07 g – 6.01 \pm 0.08 g (at day 60) in untreated and treated hens respectively. A significantly lower weight

vs the respective control group was observed by days 1–5 in SA ($P < 0.05$).

The content of macroelements in egg shell of hens with SA and EA is presented in Table 1. At the beginning of the study,

the shell calcium content in the SA group was insignificantly lower than in controls (29016.28 ± 1685.28 mmol/L). By day 30 it was insignificantly higher compared to both baseline and controls (33615.19 ± 1302.30 mmol/L). In EA hens, egg shell calcium content was 27764.91 ± 1442.11 mmol/L by day 1 and did not change considerably 30 days later.

The phosphorus content in SA egg shells at the beginning was significantly lower ($p < 0.05$) vs controls. The differences by day 30 were similar but statistically insignificant. In EA hens the values by day 1 and by day 30 were 63.03 ± 7.81 mmol/L and 109.53 ± 7.22 mmol/L respectively, also statistically insignificant vs controls.

The magnesium levels in both experimental groups were not statistically significantly different during the entire period of the study (Table 1).

The changes in blood plasma calcium, inorganic phosphate, magnesium and alkaline phosphatase in SA and EA groups are presented in Table 2. Calcium concentrations in SA hens at the beginning (3.23 ± 0.08 mmol/L) were significantly lower than healthy hens ($P < 0.001$). They went up to 5.76 ± 0.48 mmol/L by day 60 but the differences vs baseline and the respective controls were not significant. EA hens had considerably lower calcium values than controls by day 1 after the treatment with dried thyroid gland tissue ($p < 0.001$). By day 30, there was an opposite correlation but without statistical significance.

The blood phosphate levels in both experimental groups did not reveal significant variations throughout the experimental period, except for the significantly lower values ($P < 0.05$) for the SA group by day 30.

Table 2. Blood calcium, inorganic phosphate, magnesium and alkaline phosphatase levels (mean \pm SEM) in hens with spontaneous (SA) by days 1, 30 and 60 or experimental (EA) alopecia by days 1 and 30 after the start of observations in SA or after provocation of EA

Period of study	Groups	n	Calcium, mmol/L	Inorganic phosphate, mmol/L	Magnesium, mmol/L	Alkaline phosphatase, U/L
<i>Spontaneous alopecia</i>						
Day 1	experimental	8	$3.23 \pm 0.08^{***}$	0.99 ± 0.06	1.77 ± 0.06	$78.40 \pm 15.65^{**}$
	control	5	5.16 ± 0.19	1.69 ± 0.35	1.78 ± 0.11	28.80 ± 4.60
Day 30	experimental	7	4.39 ± 0.21	$1.63 \pm 0.13^*$	1.74 ± 0.08	65.20 ± 12.14
	control	7	5.36 ± 0.45	2.09 ± 0.15	1.85 ± 0.02	30.10 ± 5.73
Day 60	experimental	6	5.76 ± 0.48	2.12 ± 0.26	2.03 ± 0.09	$50.26 \pm 5.34^*$
	control	5	5.23 ± 0.26	1.89 ± 0.22	1.92 ± 0.12	30.70 ± 5.21
<i>Experimental alopecia</i>						
Day 1	experimental	5	$4.13 \pm 0.14^{***}$	1.76 ± 0.27	2.18 ± 0.21	$85.30 \pm 9.40^{**}$
	control	5	5.46 ± 0.25	2.08 ± 0.22	2.35 ± 0.27	32.10 ± 7.21
Day 30	experimental	5	6.22 ± 0.19	1.92 ± 0.20	2.26 ± 0.22	50.22 ± 5.62
	control	5	5.84 ± 0.27	2.19 ± 0.11	2.26 ± 0.09	35.00 ± 6.15

* $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$ vs controls.

Blood magnesium levels in experimental and control hens varied within a very narrow range. Such variations were observed in egg shell magnesium content too. Alkaline phosphatase activity in all experimental birds had higher values vs respective controls that were significantly different only at the beginning and by day 60 in SA birds.

DISCUSSION

The feeding of laying hens is among the primary factors responsible for the manifestation of the genetic potential related to high productivity. Our data showed that despite the regulated feeding of laying hens with standard ratios, the onset of SA is still possible. By day 5 after the appearance of alopecia in EA hens, the egg-laying stopped and was slowly restored after the 30th day. The lower egg weights in both SA and EA birds, compared to controls (at the beginning of trials on the average by 7.4 g) increased up to the 60th day when it was higher than that in controls. This fact does not correspond to the opinion of some authors (Djader, 1982; Altan *et al.*, 1998), that the feeding regimen and the age are determining the weight of eggs. We assume that the fact was due to the enhanced metabolism following the higher T₃ and T₄ levels (Tsokova, 2002). Some authors (Fisinin *et al.*, 1990) attribute the higher T₃ and T₄ concentrations to age.

It is known that egg shell is a relatively constant proportion of egg weight (Djader, 1982). According to our results, this feature was also valid in alopecia as well.

The strength and constitution of egg shells are influenced not only by bird's age (Clunies & Leeson, 1995) and the dietary mineral, but possibly by other factors influencing mineral metabolism in-

cluding distress (Fisinin *et al.*, 1990). Our data support this assumption.

The EA model is a strong stressor as evidenced also by others (Hart & Blair, 1989), resulting in reduced egg and egg shell weights. The significant decrease in calcium levels in both experimental groups, together with blood calcium concentrations, corresponded to data of Abu-Serewa & Karunajeewa (1985). At the same time, it correlated with elevated alkaline phosphatase activity reported also by Singh *et al.* (1983) and Filipov (1996) whereas magnesium levels were almost comparable vs controls.

The low plasma calcium concentrations were probably due to the fact, that birds use blood minerals primarily for formation of a strong shell and then, for mineral bone deposit (Halaj, 1987). In our experiments, the stores were probably deficient and that was why the shell content of those macroelements decreased vs the control groups and caused the lesser strength of egg shell.

CONCLUSIONS

In spontaneous and experimental alopecia, the egg weight and egg shell weight decreased up to day 40–50 and then, were higher than those in controls.

Egg shell strength decreased in SA and EA. The low blood calcium, phosphate and magnesium content correlated with the low levels of those elements in egg shells and with the elevated alkaline phosphatase activity.

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