IMPROVEMENT OF QUANTITATIVE AND QUALITATIVE EGGS PRODUCTION ISSUED FROM LAYING HENS, UNDER THERMAL STRESS CONDITIONS. A NUTRITIONAL APPROACH

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Abstract

The present study aimed to evaluate the effects of sodium bicarbonate and ascorbic acid feeding utilization in fighting the undesired thermal stress effects onto the quality of the eggs produced by commercial hybrids at the end of the laying cycle. The trial was conducted at the Animal Husbandry Faculty's Experimental Farm in Iasi, Romania, during a period of 4 weeks. A total of 90 hens, 57 week old ISA Brown layers were allocated to a completely randomized experimental design with three treatments (C- Control group, L1+250 mg ascorbic acids, L2+1% sodium bicarbonate), with 30 birds each. Although the usage of feed additives generated supplemental feeding expenses, (+13.4% in L1 group, +10.4% in L2 group respectively), compared with C group, the beneficial effects induced by these additives on the quantitative and qualitative eggs production produced slightly higher revenues in experimental treatments than in the control one (0.14% in L1 group and +1.02% in L2 group).

Key words: sodium bicarbonate, ascorbic acid, thermal stress, laying hens performance

INTRODUCTION

When laying hens approach the end of lay cycle and are raised intensively, at +20-28°C temperatures, it is difficult to distinguish between age-induced effects on eggs production and those generated by environmental temperature. However, temperatures exceeding 28°C trigger heat stress, manifested by decreased egg weight and changes in the proportion of eggs components. In this situation, the albumen / yolk ratio is less affected, but significantly decreases the proportion of mineral shell. When birds are exposed to a long period of time at temperatures exceeding 28°C, egg white/yolk ratio changes, involving reduction of the yolk weight, comparing to the white one[10].

Nutritional factors could be optimized, in order to reduce the influence of other factors on the decrease of eggs quality, such as: fowl age, non adequate husbandry conditions, handling and storage.

This experiment aimed to establish the effect issued from the usage of certain feed additives in heat stressed laying hens feeding.

MATERIAL AND METHOD

The experiment was set up within the Animal Husbandry Micro Experimental Farm in Iasi, during 30 days (14 June-15 July), corresponding to the 57-61 weeks of the birds' age.

The biological material was represented by 90 hens, ISA-Brown laying hybrid, 57 weeks old, accommodated in 3 levels pyramidal type batteries, two hens per each coop.

The fowl were divided in three treatment groups: control, L1 and L2. The Control group (C) included 30 hens which received a diet based on a corn-soymeal mixture. L1 group (30 hens), received a 1% *sodium bicarbonate* supplementation of the basal diet. A *250 mg ascorbic acid* was added to the L2 group (30 hens) feed.

The environment temperature of the poultry house, measured with a thermometer hung above the cages, ranged between 26°C and 32°C during the period of experiment.

The parameters assessed in our study included: hens' living weight, feed intake and laying intensity dynamics – as productive features; egg weight, glair weight, yolk weight, eggshell weight, eggshell thickness, shell ratio

participation in the whole egg eight, shell index, morphologic anomalies – as eggshell quality parameters; Haugh index – as eggs' internal quality property. Finally, an economic reliability calculation was done for the usage of such feed additives in laying hens diet.

The eggs' quality parameters were assessed weekly, on 10 eggs harvested from each group, randomize selected.

Data concerning the entire amount of eggs produced the amount of broken, cracked, rough, pale or deformed eggs were recorded on a daily base.

Economic efficacy computation for the usage of the studied feed additive was based on the quantification of expenses with fowl diet, of incomes from eggs selling, issuing the net revenue. Other costs were not considered (biological material, husbandry, medicine, wages etc.), knowing they were identical in both groups throughout the entire experimental period.

The experimental values were statistically processed and then the comparisons between means were applied, using a single factor ANOVA algorithm, included within the MsExcel software package.

RESULTS AND DISCUSSIONS

Production performances

The results achieved, concerning the yield performances, showed improved values in both experimental groups. Thus, the average amount of eggs produced per period increased and, as a consequence, the laying intensity was also improved, while the feed intake decreased (table 1).

Table 1. Effects of +250 mg ascorbic and acids 1% $NaHCO_3$ usage in laying hens feed supplementation on their production performances

Studied character		Exp. period (week)	Groups					
			Control		L1 (+250 mg ascorbic acids)		L2 (+1% $NaHCO_3$)	
			$\overline{X}$	$\pm s_{\overline{X}}$	$\overline{X}$	$\pm s_{\overline{X}}$	$\overline{X}$	$\pm s_{\overline{X}}$
Initial hens' body weight (kg/hen)		-	1.95	0.031	1.98	0.031	2.01	0.029
Final hens' body weight (kg/hen)		-	1.90	0.034	2.09	0.025	2.15	0.030
Average daily feed intake (g/hen/day)		4	101.60		101.92		104.70	
Egg production(eggs/day/group)		4	23.61		24.57		24.71	
Laying intensity (Mean values)(%)		4	78.7	1.06	81.9	1.04	82.4	1.01
Egg-mass production	(g/hen/day)	4	47.65	1.61	51.45	0.25	53.21	1.85
	% (C=100)		100.00		107.97		111.67	
Feed conversion	(kg feed/kg egg mass)	4	2.13		1.99		1.97	
	% (C=100)		100.00		93.43		92.49	

The best results were achieved by the L2 group, with an egg mass yield of 53.21 g/hen/day, with an average intake of only 1.970 kg feed to obtain 1 kg egg mass. However, the differences found between control and experimental groups were statistically insignificant.

The situation observed in other studies confirmed the results communicated [2], [5], which showed beneficial action of certain additives (ascorbic acid and sodiu mbicarbonate) on feed intake under heat stress, knowing that temperatures above the thermal comfort edge reduce feed intake level.

Egg production quality

The experimental data concerning the quality of the eggs issued from the laying hens belonging to the three used groups are presented in table 2.

Table 2 Effects of +250 mg ascorbic and acids 1% $NaHCO_3$ usage in laying hens feed supplementation on egg quality

Studied character	Exp. period (week)	Groups					
		Control		L1 (+250 mg ascorbic acids)		L2 (+1% $NaHCO_3$)	
		$\overline{X}$	$\pm s_{\overline{X}}$	$\overline{X}$	$\pm s_{\overline{X}}$	$\overline{X}$	$\pm s_{\overline{X}}$
Egg weight (grams)	4	62.15	1.44	63.76	0.95	64.31	0.71
(%) (C=100)		100.00		102.59		103.47	
Eggshell weight (grams)	4	5.86	0.16	6.09	0.15	6.29	0.08
(%) (C=100)		100.00		103.92		107.33	
Glair weight (grams)	4	40,06	1,14	41,24	0,82	41,57	0,53
(%) (C=100)	4	100		102,94		103,77	
Yolk weight (grams)	4	16,23	0,40	16,44	0,27	16,45	0,32
(%) (C=100)	4	100		101,29		101,35	
Shell thickness(mm)	4	0.353	0.007	0.367	0.007	0.375	0.005
(%) (C=100)		100.00		104.58		106.01	
Shell index	4	7.89	0.13	8.12	0.18	8.37	0.10
(%) (C=100)		100.00		102.91		106.08	
Haugh Index (UH)	4	87.60	1.76	87.70	1.69	87.89	1.62
(%) (C=100)		100.00		100.10		100.33	

Average egg weight was found, during the entire period, between 62.15 g (group C) and 64.31 g values (group L2), the differences between treatments being insignificant.

Yolk weight ranged from average values of 16.23 g in group C and 16.45 g in group L2 (table 2). Lower values (-1,3%) for this trait were observed in control group, compared to experimental ones. However, the differences were not statistically significant.

Average weight of the eggshell was higher in the eggs laid by hens whose feed was supplemented with ascorbic acid (+3.9%) and sodium bicarbonate (+7.3%), compared to that measured in control group eggs.

The results were partially consistent with other studies carried out previously [6], which showed no significant effects on egg production, egg weight and shell weight, when Leghorn hens, aged 47-67 weeks were dietary supplemented with 100 mg ascorbic acid / kg feed. In two other investigations, performed on Leghorn hens aged 76 and 96 weeks after the onset of the experience, feed supplementation with ascorbic acid (3 g / kg), under conditions of heat stress, increased egg weight, specific gravity, and also serum calcium level. The authors concluded that ascorbic acid given in high doses may interfere with calcium metabolism in laying hens at the end of the laying, when eggshell quality is generally lower than at the onset of laying birds [5].

Results on the introduction of ascorbic acid (44-88 mg / kg feed) in feed of laying hens kept in hot tropical climate conditions (T max = 45°C) [1] showed improvements in egg production, feed intake and conversion, while other research [7] have shown similar effects at inclusion doses of ascorbic acid of 50 and 100 mg / kg feed.

The results in terms of skin thickness revealed improved values of this parameter in the experimental group compared to control group. Thus, 4.6% to 6% higher values are observed for the eggs produced by birds whose diet was supplemented with ascorbic acid and sodium bicarbonate (table 2). The values obtained (0.353 ± 0.007 mm … 0.375 ±0.005 mm) (table 2) were within the range specified in the literature [8], [11].

According to the literature, Haugh index changes depending on many factors, so that as hens flock turns old, this parameter decreases in value, respectively 1.5 to 2 UH for each lay month [3]. Haugh unit value decreases with a relatively constant value, of 0.0458 UH /day of laying [4].

Haugh index showed close mean values for all three groups (C = 87.60±1.76 UH; L1 = 87.70 ± 1.79 UH; L2 = 87.79 ± 1.62 UH), which shows that the addition ofascorbic acid and NaHCO3 in laying birds feed in this case had no influence on the character studied (Table 2). Determined values for this index falls within the limits shown in the literature [11].

Incidence of morphological abnormalities of the shell

Shell appearance and integrity are important factors which in particular determine the buyer's initial perception on the quality of the egg. However, imperfections in the shell leads to increased susceptibility of internal egg content contamination by germs and thus to increase health risks for consumers.

Table 3. Numeric egg production of the control and experimental groups

Notice		Groups		
		Control	L1 (+250 mg ascorbic acid)	L2 (+1% $NaHCO_3$)
Whole yielded eggs, from which:		661	688	692
* cracked eggshell	eggs	21	18	10
	% from whole yield	3.2	2.6	1.4
* broken eggshell	eggs	7	8	9
	% from whole yield	1.1	1.2	1.3
* rough eggshell	eggs	8	8	9
	% from whole yield	1.2	1.2	1.3
* soft shell or shell less	eggs	9	6	7
	% from whole yield	1.4	0.9	1.0
* deformed eggshell	eggs	12	6	7
	% from whole yield	1.8	0.9	1.0
Total amount eggs with faulty:	eggs	57	46	42
	% from whole yield	8.6	6.7	6.1

The results reveal that the proportion of eggs with shell defects from the total production ranged between 6.1% (group L2) and 8.6% (control group) (table 3). Compared with values in the control group, the proportion of eggs with non-compliances was reduced by 28.4% for the group that received feed supplemented with 250 mg ascorbic acid / kg, and by 40.1% in hens that received in feed 1% sodium bicarbonate (Table 3).

This improvement in shell quality, based mainly on reducing the incidence of eggs with cracked shell, of those with deformed shell, or even of the eggs soft shelled, was due to an increase of eggshell proportion in whole egg and of its thickness, in the experimental groups, compared to control.

In some previous researches [12] there have been observed the beneficial effects of the introduction ascorbic acid in feeding of laying hens exploited under heat stress. The results provided by these authors have specified the improvement of productive parameters, namely: fowl liveability sustainability, feed intake, eggs laying intensity and their quality. Productive responses most spectacular occurred at rates of inclusion of 250-400 mg ascorbic acid / kg feed. The explanation offered for the effect of vitamin C was the synergistic relationship between ascorbic acid and adrenal cortical function in the fight against stress. With regard to improving the quality of the shell, it is assumed that vitamin C interferes calcium metabolism in general and particularly in eggshell de novo synthesis.

Also, another way to improve would be the avoidance, if possible, to decrease carbon dioxide gas or bicarbonate content in blood serum, knowing the physiological importance of these chemical compounds in the mineral shell uterine calcification [8]. However, it was observed that the addition of NaHCO3 in poultry diets has proven to be ineffective [9] or produced the same effects that were induced by fowl maintenance under normal temperature conditions [6]. In other research, it was observed that if the pullets whose feed was added with NaHCO3 0.3% (and 0.05% NaCl), the mount of rough shell eggs was lower compared to that produced by birds that have received NaCl (0.25%) diet only [9].

Economic efficiency of ascorbic acid and sodium bicarbonate usage in the diet of laying hens

Several elements have been included in calculation of the economic efficiency, namely: feed costs (including costs arising from the introduction of used feed additives), the income generated from the sale of egg production and revenue results (table 4).

Table 4. Economic efficiency of the ascorbic acid and of sodium bicarbonate usage in laying hens feeding, under thermal stress conditions

Group / Notice	Control	L1 (+250 mg ascorbic acid*)	L2 (+1% $NaHCO_3$**)
Price/kg feed (RON)	1.00	1.10	1.10
Price/kg feed (EUR***)	0.28	0.31	0.31
Feed intake (kg)	85.34	85.61	87.95
Yielded eggs (pcs.)	661	688	692
Eggs for selling (buc.)	604	642	650
Feeding expenses (RON)	85.34	94.17	96.75
Feeding expenses (EUR)	24.17	26.67	27.40
Income**** (RON)	151.00	160.50	162.50
Revenue (RON)	65.66	66.33	65.76
Income (EUR)	42.77	45.46	46.02
Revenue (EUR)	18.60	18.79	18.62
Difference compared to control group (%)	-	+1.02	+0.14

* 100g ascorbic acid = 40 RON

** 100 g $NaHCO_3$ = 1 RON

*** according to RNB exchange rate during the experiment, 1 EUR = 3,5309 RON

**** incoming was calculated at selling price of 0.25 RON/egg

Although the addition of feed additives in studied poultry diets increased the feed costs (+10.37% in group L1, respectively +13.37% in group L2), the beneficial effects exerted by these additives on the quantitative and qualitative eggs production generated an improved income, a revenue slightly higher in experimental groups compared to control group (+1.02%for L1 group, +0.14% for L2 group) (Table 4).

Dietary usage of ascorbic acid and sodium bicarbonate in heat stressed hens at the end of laying increased the number of marketable eggs, leading to direct impact on economic profitability.

CONCLUSIONS

Addition of ascorbic acid 250 mg / kg (L1) and 1% NaHCO3 (L2) in the feed of hens at the end of laying cycle and reared under heat stress conditions has resulted in improvements of many parameters, such as:

* production traits (changes in body weight, feed intake, egg production, laying intensity, feed conversion);

* the quality indices of eggs (egg weight, egg weight components, shell thickness, the shape index, Haugh index);

* economic indices.

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