PRODUCTIVE RESPONSE OF THE LAYING HENS SUBJECTED TO THERMAL STRESS IN CONVENTIONAL CAGES SYSTEM

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Abstract

The researches organized in 2009, aimed to assess the productive response of the laying hens, accommodated in conventional pyramidal cages within standard temperature and thermal stress (overheat) conditions, due to inappropriate technical endorsements in small size farms. There were used 1000 Lohmann Brown laying hens, during the peak period of the laying cycle (age 25-28 weeks). The flock was divided into two groups: standard temperature group (ST), which comprised 500 hens, kept at 17-18°C and overheated microclimate group (OH) – 500 hens, kept at 27-29°C temperatures. Quantitative and qualitative production traits have been analyzed: eggs yield and laying intensity throughout the 4 weeks period, shell thickness and proportion of eggs with normal/abnormal shell. Shell quality was studied on 100 eggs/group weekly. The results indicated performance levels close to the hybrid management guide specifications, for the fowl accommodated at normal temperature (92.03% laying intensity, 0.392 mm shell thickness, 99.21% eggs with intact eggshell), while the hens subjected to higher temperatures presented lower laying levels (89.72%), thinner eggshell (0.367 mm), consequently more eggs with shell unconformities (rough and cracked shell, shell less eggs – 4.40%). It is suggested to improve microclimate conditions, though an increase of ventilation rate and to use a feed additive (sodium bicarbonate or vitamins), in order to protect hens against heat stress and regain production levels.

Key words: hens, heat stress, eggs, yield, shell, quality

INTRODUCTION

Since the 20th century there have been found certain correlations between ambient temperatures in poultry shelters and the significant decrease of mineral eggshell quality [10]. Blood flow in uterus is 30-40% reduced, due to high environment temperatures, which produces peripheral vessels dilatations [12]. The most obvious effect of hyperthermia in fowl is the onset of a polipneic respiration and of the respiratory alkalosis. Blood inner content for carbonate decreases then the bicarbonate ions excretion is intensified through kidneys, in order to maintain blood pH at its normal value. This regulation mechanism exerts limitations on the bicarbonate quantity available for buffering the released protons for shell synthesis [10] and explains why the increase of environmental temperature is followed by a decrease of carbonate quantity deposed in shell.

Another reason of shell quality depreciation is given by the decrease of dietary calcium intake, as whole feed intake reduces per se. Most of the authors agree that calcium blood serum level reduces after fowl maintenance under high temperature environment [10].

Certain studies [11] showed that the effects of too high temperature on various productive parameters are produced by direct ways and less on a decrease in feed consumption; just laying percentage decrease is due to reduced feed intake. Eggshell thinning appears to be related to direct action of the heat on the fowl body of birds [10].

But it is clear that a deficient management, nutritional problems and poor microclimate conditions contribute greatly to the downgrading of a large quantity of eggs. On the other hand, it was observed that there are some practical solutions, but unfortunately they can not fully remove the

shell quality problems, but it attenuates the severity [1], [3].

This experiment aimed to establish the effect exerted by the heat stress (environmental overheating) on the quantitative and qualitative production parameters of the laying hens accommodated in conventional husbandry systems (cage batteries), within familial farms.

MATERIAL AND METHOD

The experiment was run throughout 2009 year, in certain small size (familial) farms for laying hens husbandry, in order to encourage the revival of animal production in the population, to provide subsistence activities and even to onset small businesses for family income.

There have been used, as biological material, 1000 laying hens, Lohmann Brown hybrid, aged 25-28 weeks (theoretic laying peak). The fowl were accommodated in conventional multilevel pyramidal battery, specific for such poultry category. The flock was divided into two groups, relatively to the microclimate provided to hens: a group reared in standard temperature conditions (ST group)=17-18°C, 500 hens and the group accommodated into a compartment whose temperature within varied between 27-29°C (OH group), 500 hens.

Hens diet was provided in accordance to hybrid producer recommendation for the laying period: 2800 Kcal Metabolisable energy, 18.0 % Crude protein, 0.40% digestible Methionine, 0.60% digestible Methionine+Cystine, 0.66% digestible Lysine, 3.50% Calcium, 0.40% available Phosphorus and 2% Lioleic acid. Lighting schedule was also provided in accordance with the management guide (14 hours light:10 hours dark).

Eggs yield has been assessed daily then laying intensity was calculated, while 100 eggs were sampled every week from each group and certain traits have been investigated: shell thickness and proportion of eggs with normal/abnormal shell. Laying intensity was calculated as ratio between laid eggs and accommodated flock size. Shell thickness was measured with a micrometric device, on shell particles sampled from round pole, sharp pole and equatorial area of the eggs. Prior to measurements, shell fragments were cleaned with distilled water, matrix membrane was removed and they were dried at 105°C, throughout 24 h. The eggs with shell unconformities were also recorded and reported to the whole amount o eggs laid without shell integrity problems, resulting total % unconformities.

The data were collected, input in a database and statistically processed, including for the analysis of variance, in order to test the significance of the differences between the performances of the heat stressed and normal accommodated hens.

RESULTS AND DISCUSSIONS

From the analysis of quantitative eggs production, it was found that throughout the 4 weeks studied period, daily yield varied between 447.14-453.71 eggs for the hens accommodated under standard climate conditions (ST group), while the production of the hens maintained at higher temperatures (OH group, 27-29°C) ranged within the 435.43-438.71 eggs/day/group (tab. 1). Therefore, heat stress influenced, numeric eggs production, resulting 2.7%..3.4% less eggs in the hens kept under inappropriate environmental conditions. The data from table 1 also reveals higher weekly casualties in OH group, compared to ST one. Laying intensity progressively augmented till the last week of study, when maximum of production was reached, as the performance guide states. However, the acquired performance was lower than the theoretical specifications. Thus, intensity of lay ranged from 89.43% (wk 25) till 92.03% (wk 28) in ST group hens, while the fowl in overheated group achieved just 87.09-89.72% laying (tab. 1), (fig. 1).

Table 1 Eggs yield and laying intensity throughout the 25-28 week fowl age period

Fowl age	ST Group (Lohmann Brown hens kept at 17-18°C)			OH group (Lohmann Brown hens, heat stress:27-29°C)		
	Flock size (hens)	Laid eggs (daily average yield)	% laying	Flock size (hens)	Laid eggs (daily average yield)	% laying
week 25	500	447.14	89.43	500	435.43	87.09
week 26	497	449.71	90.49	494	438.71	88.81
week 27	495	452.43	91.40	491	437.29	89.06
week 28	493	453.71	92.03	488	437.86	89.72

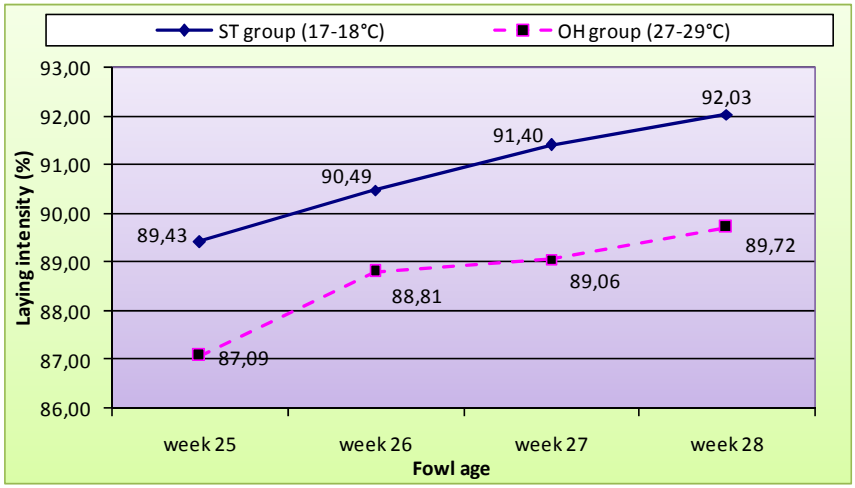


Fig. 1 Dynamics of laying intensity during laying peak period (weeks25-28) in the hens accommodated under normal temperature and heat stress conditions

The standard performance for laying peak (wk 28) should be 92-94%. In both situations, the achieved values were lower, while the most compliant group was ST. It is possible that yield was influenced, especially in OH group, by lower feed intake values, due to heat stress, knowing that other researches reported so [7], [9]. Fig. 1 shows how the production level was influenced by over heat environment. Although the hens in experimental group tried to follow the trend of a normal laying curve, it was obvious the lower level achieved in reality.

Qualitative assessment of the eggshell revealed certain interesting data related to shell thickness dynamics (tab.2, fig. 2).

Table 2 Shell thickness dynamics, under the influence of the environmental conditions provided to the hens in both groups

Fowl age	ST Group shell thickness (n=100 eggs) (Lohmann Brown hens, kept at 17-18°C)		OH group shell thickness (n=100 eggs) (Lohmann Brown hens, heat stress:27-29°C)	
	$\bar{X} \pm S_{\bar{x}}$ (mm)	V%	$\bar{X} \pm S_{\bar{x}}$ (mm)	V%
week 25	0.419±0.017	40.57	0.408±0.019	46.57
week 26	0.407±0.015	36.86	0.395±0.017	43.04
week 27	0.403^{a}±0.013	32.26	0.381^{c}±0.016	41.99
week 28	0.392^{a}±0.012	30.61	0.367^{d}±0.013	35.42

ANOVA test: ^{ac,} ^{ad}different superscripts within the same row= distinguished significant (Fcomp.=18.77>Fα.0.01=11.26) or highly significant (Fcomp.=47.26>Fα.0.001=25.41) differences between analyzed means

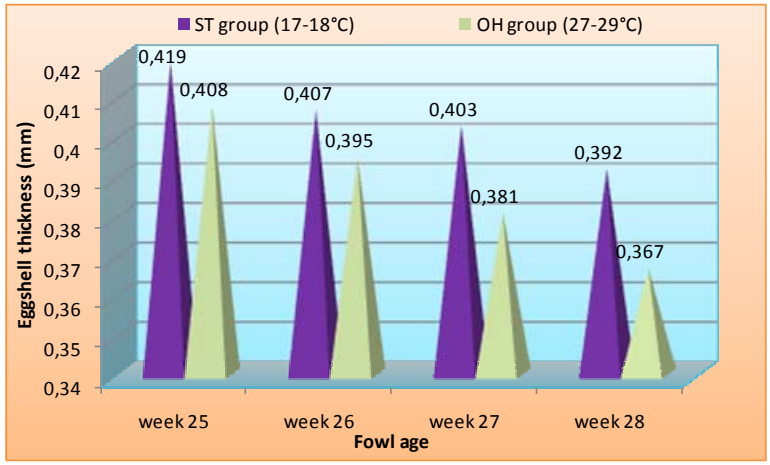


Fig. 2 Shell thickness throughout the 4 weeks of study,
under the influence of the environmental conditions provided to the hens in both groups

Thus, it was found that shell thickness values presented in table 2, calculated on a basis of 2x100 measurements multiplied by 3 (3 points of measurement for every studied egg) decreased slightly from 25th toward 28th week of fowl age, situation considered as physiological, due to egg volume enlargement as fowl turn old. In ST group, the measured parameter varied from 0.419±0.017 mm (wk 25) till 0.392±0.012 mm (wk 28). In OH group hens, the same parameter ranged between 0.408±0.019 mm (study onset) and 0.367±0.013 mm (experiment ceasing). The thinner eggshell in OH group eggs could be explained through both troubles in dietary calcium absorption and in its usage in uterine eggshell formation, as other researches similarly suggested [6], [8]. Moreover, statistical significant differences occurred between the two analyzed groups, especially after two weeks of exposition to overheated environment. Thus, the differences between the means calculated for weeks 27 and 28 were distinguished (Fcomp.=18.77>Fα0.01=11.26) and highly significant (Fcomp. = 47.26 > Fα.0.001 =25.41).

Uniformity of the flock for the shell thickness trait became better as hens approached the laying peak. However, higher values for variability coefficient were calculated in OH group.

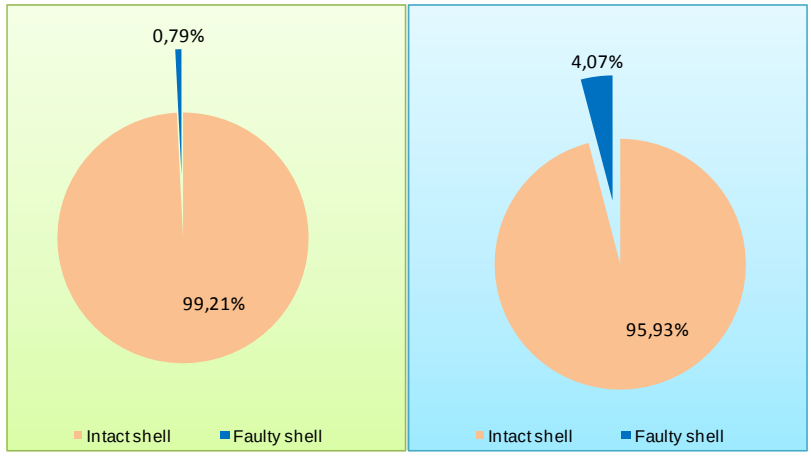
Despite the fact that numeric egg production and shell thickness decreased, a better depiction of heat stress influence on eggs quality is given by the data presented in tab. 3 and fig. 1. Eggs yield is presented entirely.

Table 3 Ratio between intact shell eggs and faulty shell eggs, under the influence of heat stress

Fowl age	ST Group (Lohmann Brown hens kept at 17-18°C)					OH group (Lohmann Brown hens, heat stress: 27-29°C)				
	Yielded eggs	Shell quality balance				Yielded eggs	Shell quality balance			
		Intact shell	%	Faulty shell	%		Intact shell	%	Faulty shell	%
week 25	3130	3094	98.85	36	1.15	3048	2931	96.16	117	3.84
week 26	3148	3127	99.33	21	0.67	3071	2951	96.09	120	3.91
week 27	3167	3143	99.24	24	0.76	3061	2935	95.88	126	4.12
week 28	3176	3158	99.43	18	0.57	3065	2930	95.60	135	4.40
Mean values:			99.21^{a}		0.79^{d}			95.93^{a}		4.07^{d}

ANOVA test: ^{ad}different superscripts within the same row=highly significant differences between analyzed means (Fcomp.=331.62>Fα.0.001=35.51)

It could be noticed again higher yield levels in ST group, compared to OH group, every week. Thus, in the 25th week of fowl life, the hens in ST group laid 3130 eggs, from which 98.85% (3094 pcs.) were marketable, while 1.15% (36 pcs.) presented shell faults and were not used for sale. The situation improved as hens approached the peak of production (28 wks old), when from the total 3158 laid eggs, only 0.57% presented shell unconformities. Overall the entire study, it resulted that the hens in ST group produced 99.21% marketable eggs, while losses reached 0.79% only, from whole production (fig. 3).



ST group (17-18°C) OH group (27-29°C)

Fig. 3 Proportion of faulty shell eggs from whole eggs yield, as related to hens exposure to normal temperatures or heat stress

In those hens kept under heat stress conditions (27-29°C environmental temperature), throughout 4 experimental weeks there were observed increases of shell faulted eggs. Thus, from 3.84% eggs with non-conformities, produced during the 25th week, the looses raised to 4.40% from whole yield (3065 eggs) in week 28. The overall average of shell faulted eggs reached 4.07% in OH group. The statistical differences between ST and OH hens performance was calculated as highly significant ($F_{comp.}=331.62>F_{\alpha.0.001}=35.51$), revealing thus the importance of a well balanced environment onto egg numeric and qualitative production. The proportion of eggs with faults would be surely increased if the heat stress would have been kept at the same level or increased, as other researches [2], [4] also previously specified decreases of shell thickness, shell specific gravity and values up to 12-15% faults from whole production till laying ceasing and fowl exhausting.

In order to fight the heat stress issues in laying hens, there are multiple possible approaches: if possible, to keep the environmental conditions at standard recommended levels; if not possible to comply, it is recommended to use, single or combined, certain dietary heat protectors, such as vitamins C and E or sodium bicarbonate [2], [5], [10].

CONCLUSIONS

Several production parameters, qualitatively and quantitatively speaking, were affected by exposure of hens to heat stress conditions, as following:

- laying percentage decreased at 89.72%, instead of 92-94% during production peak;
- shell became 6.8% thinner than normal for the studied period.

- proportion of shell faults from whole eggs yield reached 4.40%, trending to increase weekly.

In order to avoid the unpleasant effects given by heat stress exposure it is recommended to adjust microclimate parameters and add some dietary protectors (vitamins and carbonates) to hens feed or drinking water .

REFERENCES

[1] Coutts J. A., Wilson G. C., Fernández S., Rosales E., Weber G., Hernández J.M., Optimum Egg Quality - A Practical Approach, Sheffield: 5M Publishing, 2007

[2] Ghorbani M. R., Fayazi J.: Effects of Dietary Sodium Bicarbonate and Rearing System on Laying Hens Performance, Egg Quality and Plasma Cations Reared Under Chronic Heat Stress, Biological Sciences Research Journal, 2009, 4 (5): 562-565

[3] Grieve D., Heat Stress in Commercial Layers and Breeders, Hy-Line technical bulletin, 2007.

[4] Hughes R. J., Inter-relationships between egg shell quality, blood acid-base balance and dietary electrolytes, World's Poultry Science Journal, 1988, 44: 30-40

[5] Kkoelkebeck' K.W., Harrison P.C., Parsons C.M., Carbonated Drinking Water for Improvement of Eggshell Quality of Laying Hens During Summertime Months, J. appl. Poultr. Res, 1992, 1:194-199

[6] Lin H., Mertens K., Kemps B., Govaerts T., Der Ketelaere B., De Baerdemaeker J., Decuypere E., Buyse J., New approach of testing the effect of heat stress on eggshell quality: mechanical and material properties of eggshell and membrane, 2004, British Poult. Sci. J. 45(4):476-82.

[7] Mashaly M. M., Hendricks G. L., Abbas A. O., Patterson P. H., Effect of Heat Stress on Production Parameters and Immune Responses of Commercial Laying Hens, Poultry Science J., 2004, 83:889–894.

[8] Melesse A., Maak S., Vvon Lengerken G., Effect of long-term heat stress on egg quality traits of Ethiopian naked neck chickens and their F1 crosses with Lohmann White and New Hampshire chicken breeds, Livestock Research for Rural Development, 2010, 22 (4).

[9] Sahin K., Sahin N., Onderci M., Vitamin E supplementation can alleviate negative effects of heat stress on egg production, egg quality, digestibility of nutrients and egg yolk mineral concentrations of Japanese quails, Res. Vet. Sci., 2002, 73(3):307-312.

[10] Sauveur B., Ajustements technico-économiques possibilités d'alimentation des volailles dans les pays chauds, Production animales INRA, 1993, 6 (2).

[11] Smith A. H., Changes in the average weight and shell thickness of eggs produced by hens exposed to high environmental temperatures, Tropical Animal Health and Production, 1974, 6 (4):237-244.

[12] Waldroup P. W., Influence of environmental temperature on protein and amino acid needs of poultry. Fed. Proc., 1982, 41 (11):2821-2823.