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SEASONAL VARIATION OF EGG SIZE AND EGGSHELL QUALITY CHARACTERISTICS IN LAYERS

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An analysis of eggs' quality parameters (egg weight, eggshell strength, eggshell thickness and egg index) was performed in two Lohman Brown flocks of commercial laying hens at advanced age. Two farms equipped with battery cages were the places where the experiment was performed. The first farm (F1) was small, family-owned farm equipped with moderately efficient ventilation, and in the second farm (F2) a highly efficient tunnel ventilation with water pads cooling equipment was installed. Egg weight and eggshell strength were analyzed in the laboratory for testing egg quality, using Egg Multi Tester EMT 5200 and Eggshell Gauge (Robotmation Co. Ltd., Tokyo, Japan), computerized equipment that gives unbiased values, while shell thickness and egg index were measured using a micrometer. No significant differences in the average values of egg size (63.09; 63.33 g), shell thickness (0.38; 0.38 mm) and egg index (75.49; 76.56) were registered between F1 and F2 farms, respectively. Average shell strength values revealed that layers kept on F2 farm produce eggs with stronger eggshell (3,434.16 g/cm^2) compared to the farm F1 (3,344.82 g/cm^2), mainly due to the fact that the drop of the eggshell quality in the first farm in the hot summer period (July) was drastic (2,914.00 g/cm^2). The other explanation of this situation could be the significant drop of egg size in the farm equipped with cooling pads at the beginning of the hot season (May–June) which most probably helps the layers in maintaining their Ca reserves that later help their metabolism maintain its shell-forming capacities. The conclusion is that high summer temperatures influence the eggshell strength resulting in lower strength, but the cooling equipment mitigates this negative effect.

Key words: egg weight; eggshell strength; eggshell thickness; egg index; layers

СЕЗОНСКИ ВАРИЈАЦИИ НА ГОЛЕМИНАТА НА ЈАЈЦАТА И КВАЛИТЕТОТ НА ЈАЈЦЕВАТА ЛУШПА КАЈ НЕСИЛКИТЕ

Анализа на параметрите за квалитет на јајцевата лушпа (тежина на јајцето, цврстина на јајцевата лушпа, дебелина на јајцевата лушпа и индекс на обликот на јајцето) беше направена кај две јата комерцијални несилки од хибридот Lohman Brown во напредната возраст. Двете фарми каде е направен експериментот беа опремени со батериски кафези. Првата фарма (F1) беше мала, фамилијарна, опремена со умерено ефективна вентилација, додека во втората фарма (F2) беше инсталирана високоефективна тунелска вентилација со водно ладење. Тежината на јајцата и цврстината на јајцевата лушпа беа анализирани во лабораторијата за тестирање на квалитетот на јајцата, каде се користеа мултинаменскиот тестер за јајца и инструментот за мерење на цврстината на лушпата на јајцата (Robotmation Co. Ltd., Tokyo, Japan), компјутеризирана опрема која дава непристрасни вредности, додека дебелината на лушпата и индексот на обликот на јајцата беа мерени со микрометар (0.01 mm) и дигитален шублер. Не беа забележени значајни разлики во просечните вредности на големината на јајцата (63,09; 63,33 g), дебелината на јајцевата лушпа (0,38; 0,38 mm) и индексот на обликот на јајцата (75,49; 76,56 %) помеѓу двете јата. Просечните вредности на цврстината на јајцевата лушпа на јајцата произведени на фармата F2 покажаа дека, тамошните несилки произведуваат јајца со поцврста јајцева лушпа (3.434,16 g/cm^2) споредено со оние во фармата F1 (3.344,82 g/cm^2), што главно се должи на фактот дека падот на квалитетот на јајцевата лушпа во фармата F1за време на топлиот летен период (јули) бил драстичен (2.914,00 g/cm^2). Второто објаснување на ваквата состојба би можело да биде значајното опаѓање на големината на јајцата во фармата опремена со умерено ефективно ладење на почетокот на летниот период (мај–јуни) кое нешто најверојатно им помага на несилките за одржување на нивните резерви на Ca (калциум), што подоцна му помагаат на организмот во капацитетот на формирање јајца. Заклучокот е дека високите летни температури влијаат на цврстината на јајцата, што резултира со помала цврстина, но опремата и ладењето го ублажуваат овој негативен ефект.

Клучни зборови: тежина на јајце; цврстина на јајцевата лушпа; дебелина на јајцевата лушпа; индекс на обликот на јајцето; несилки

INTRODUCTION

The ambient temperature and relative humidity, equipment in farms, the way of ventilation in the building, are part of the important elements for achieving good results in the production of eggs. A solidly built object with good internal and external isolation, with strong ventilation and air flow, as well as an appropriately balanced diet of poultry depending on its needs, are factors that can be easily overcome problems caused by variations in temperatures during the seasons. It is very important to maintain optimum microclimate for layers to give maximum production. The zone of thermal neutrality for adult birds has been reported to be in the range of 14 to 26°C. High temperature (above 26°C) depresses production and adversely affects shell quality and egg size. Relative humidity of 40 to 60% is preferred (Stadelman, 1995).

Egg production and egg quality are affected by season. High temperature has an adverse effect on egg production. The egg quality depends on physical make up and chemical composition of its constituent which, however, ultimately depend upon breed and type, age, nutrition, stocking density of the laying bird, environmental factors and season of the year (Nesheim et al., 1979).

Egg quality is one of the most important contributing factors in marketing eggs, which generally influences the price of the egg and its acceptability to the consumers. Breed, feed, housing and possibly other factors, like season, stocking density and group size have also profound influence on the quality of eggs (Yeasmin, 1987).

Nikolova and Kocevski (2004) found that the high temperatures, which on average exceeded 25ºC and reached 35–40ºC, contributed to a decrease in the weight of eggs of 2.16 g from the average weight of a total 877 examined eggs. In the summer months, layers were losing their appetite, the consumption was smaller and could not bring in all the necessary nutrients in general, and this deficit caused the layng of smaller egg. Deaton et al. (1982), in their research found a reduction in egg masses of 1–2 g in the summer season at constant temperatures of 15–35ºC

Nikolova and Kocevski (2004), Nikolova et al. (2008) and Kocevski et al. (2011) reported differences in egg weight and quality strength of eggshell due to genotypes and also as influenced by season (high summer temperature).

Most authors are agreed that shape cannot be considered in isolation from the effect of, for example thickness, porosity and chemical composition. They believe that the factor shape should always be included when discussing the strength of eggshells. The whole of avian eggs are typical oval shaped, however, they are different in dependence of bird species and race (Nikolova and Kocevski, 2006). The hen's eggs are some elongated with more sharpen peak usually abreast with eggs of other bird species. It was conclusion that egg shape is important factor about packing eggs intended for market, incubation of fertile eggs and hatching the chicks (Romanoff and Romanoff, 1949).

MATERIAL AND METHODS

An analysis of egg quality parameters (egg weight, eggshell strength, eggshell thickness and egg shape index) was performed in two Lohman Brown flocks of commercial laying hens at advanced age.

Two farms equipped with battery cages were the places where the experiment was performed. The first farm (F1) was small, family-owned farm equipped with moderately efficient ventilation, and in the second farm (F2) highly efficient tunnel ventilation with water pads cooling equipment was installed. Thirty eggs were collected and examined per month from each flock for the period from March to October, or a total of 480 eggs were analyzed. The research period covered three seasons (spring, summer and autumn).

Egg quality was measured in terms of egg weight, egg shape index, eggshell strength and eggshell thickness. Egg weight and eggshell strength were analyzed in the laboratory for testing egg quality, using Egg Multi Tester EMT 5200 and Eggshell Gauge (Robotmation Co. Ltd., Tokyo, Japan), computerized equipment that gives unbiased values, while eggshell thickness and egg shape index were measured using a micrometer and digital caliper.

The egg shape index was calculated for each egg from the width and length of the egg using the formula derived by Reddy et al. (1979). The formula used to calculate the shape index is given below:

$$Egg\ shape\ index = \frac{Mean\ width\ of\ egg}{Mean\ length\ of\ egg} \times 100.$$

RESULTS AND DISCUSSION

The Table 1 shows data of the parameters that make the quality of the eggs, the egg weight, the eggshell strenght, the eggshell thickness and the egg shape index, of the flocks housed in Farm 1 and Farm 2 with Lohman Brown hybrid layers whose eggs were collected and tested in the period from March to October. In addition to the text these parameters are given graphically for each parameter separately.

No significant differences in the average values of egg size (63.09; 63.33 g), eggshell thickness (0.38; 0.38 mm) and egg shape index (75.49; 76.56 %) were registered between F1 and F2 farms, respectively. Average eggshell strength values revealed that layers kept on F2 farm produce eggs with stronger eggshell (3,434.16 g/cm^2) compared to the farm F1 (3,344.82 g/cm^2), mainly due to the fact that the drop of the eggshell quality in the sfirst farm in the hot summer period (July) was drastic (2,914.00 g/cm^2). The average data from Table 1 indicates that the F2 flock has significantly improved the eggshell, while the remaining parameters have no major differences.

The average results of examining the quality of the eggs, together for the two flocks are shown in Table 2.

The smallest egg weight were in June (57.57 g, Figure 1), the smallest eggshell strength and thickness showed in July (3112.85 g/cm^2 and 0.37 mm, Figures 2 and 3) and the lowest values of the egg shape index in the months of July and August (74.73 and 74.26%, Figure 4), respectively. These data point to the fact that in the summer months, due to high temperatures, there is a dramatic drop in the quality of the eggshell, especially the strength of the eggshell, which is explained with reduced calcium secretion, decreased calcium transport in the eggshell glands, or a decrease in the value of bicarbonate ions under the influence of respiratory alkalosis.

The first negative effect of heat stress is reduced consumption, which further causes reduced intake of calcium in the body. The inadequate amount of calcium received is affecting the drop in egg mass, drop in shell mass, and the most significant decline in eggshell quality (Roland et al., 1996).

The research of Samara et al. (1995) showed a reduced total blood calcium value at the time of forming the shell only at hens exposed to high temperatures.

Table 1

Egg quality parameters of Lohman Brown flocks in Farm 1 and Farm 2 by months

Months	FARM 1 (F1)				FARM 2 (F2)			
	Egg weight (g)	Eggshell strength (g/cm^2)	Eggshell thickness (mm)	Egg shape index (%)	Egg weight (g)	Eggshell strength (g/cm^2)	Eggshell thickness (mm)	Egg shape index (%)
March	66.24	3171.57	0.39	74.58	74.29	3457.73	0.40	76.46
April	67.26	3550.70	0.39	76.30	73.42	3234.70	0.40	77.60
May	63.00	3330.03	0.38	75.91	54.40	3794.16	0.41	77.05
June	61.86	3403.73	0.39	76.61	53.28	3398.40	0.37	78.21
July	61.12	2914.00	0.37	73.98	64.40	3311.70	0.37	75.48
August	64.31	3456.63	0.39	74.23	66.51	3276.87	0.37	74.29
September	60.50	3427.63	0.38	75.56	60.91	3372.13	0.35	75.34
October	60.45	3504.29	0.38	76.76	59.46	3627.58	0.36	78.02
AVERAGE	63.09	3344.82	0.38	75.49	63.33	3434.16	0.38	76.56

Table 2

Average values of egg quality parameters of Lohman Brown flocks by months

Months	Egg weight (g)	Eggshell strength (g/cm^2)	Eggshell thickness (mm)	Egg shape index (%)
March	70.27	3314.65	0.39	75.52
April	70.34	3392.70	0.39	76.95
May	58.70	3562.10	0.40	76.48
June	57.57	3401.07	0.38	77.41
July	62.76	3112.85	0.37	74.73
August	65.41	3366.75	0.38	74.26
September	60.71	3399.88	0.37	75.45
October	59.96	3565.94	0.37	77.39
AVERAGE	63.21	3389.49	0.38	76.03

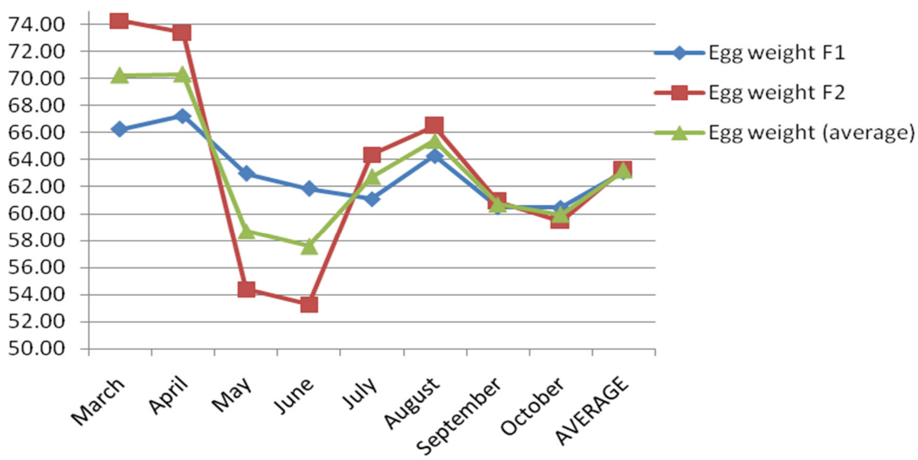

Fig. 1. Size – weight of eggs from different farms (g)

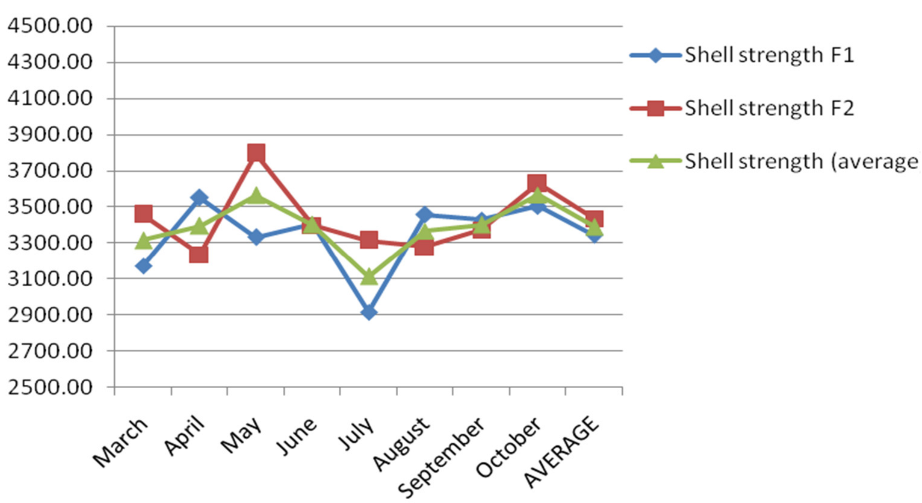

Fig. 2. Shell strength of eggs from different farms (g/cm^2)

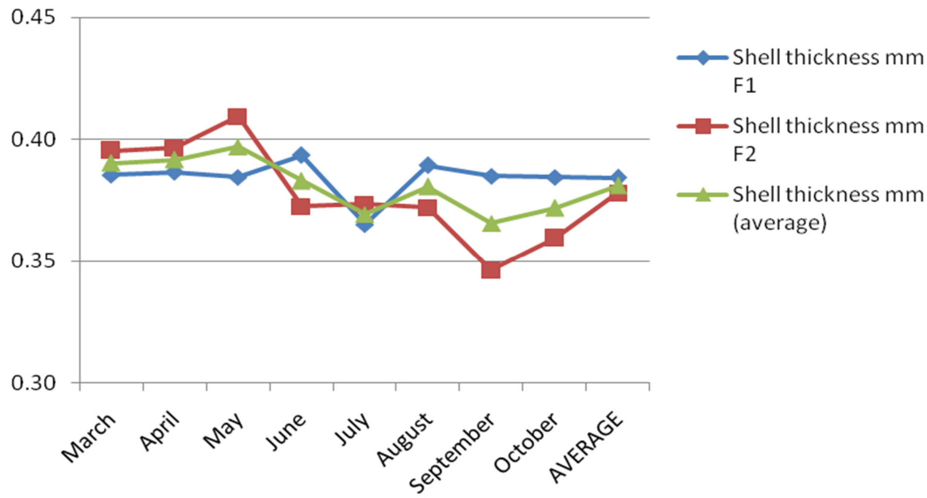

Fig. 3. Shell thickness of eggs from different terms (mm)

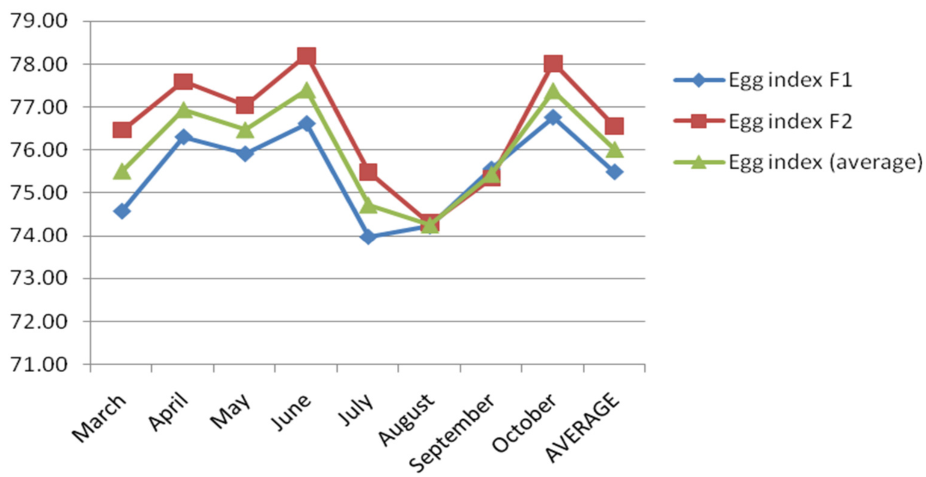

Fig. 4. Index of eggs from different farms

The results of the research by Haque et al. (2006) demonstrated that there was significant difference on egg weight under the season's regime. Warren (1939) observed decline egg weight during summer mainly due to temperature.

Season significantly ($P < 0.05$) affected egg production, feed intake, egg weight, egg crack and mortality (Yakubu et al., 2007). Egg production, egg weight and feed intake were higher in the wet season compared with the hot-dry season. Incidence of egg cracks and mortality was significantly higher in summer season. The same results had been shown in experiment by Nikolova et al. (2008). Egg laying hybrids of Dekalb White genetic provenience and the laying hens of ISA Brown genetic provenience equally react to the stress caused by high temperatures in the course of summer months (June, July, August and September) when they lay eggs with significantly decreased strength of the eggshell (Nikolova et al., 2014).

Season has no significant effect ($P > 0.05$) on eggshell thickness was concluded by Haque et al. (2006). This result is dissimilar to the findings of Izat et al. (1985) and Wilheim (1940). They reported that there is a definite seasonal trend in eggshell thickness which is correlated with temperature. Izat et al. (1985) also observed the highest eggshell thickness in summer and the lowest in spring.

According to Romanoff and Romanoff (1949), the standard eggs from hens had egg shape index of 74% with blunt and pointed ends. The percentage of egg shape index, which is ranging from 70 to 77%, can be estimated as an optimal value. Other higher and lower quantities would point out more rounded, more elliptic or more elongated eggs. The elongated eggs have lower, while the rounded eggs have higher egg shape index. In this study the eggs of the two farms had optimal value of egg shape index, only that the eggs obtained from farm F2 in some months had egg shape index values above 77% indicating eggs with a round shape.

The results by Haque et al. (2006) demonstrated that there was no significant effect of $P > 0.05$ on egg shape index, except the interaction of S × GS.

CONCLUSIONS

No significant differences in the average values of egg size (63.09; 63.33 g), eggshell thickness (0.38; 0.38 mm) and egg shape index (75.49; 76.56 %) were registered between F1 and F2 farms, respectively.

Average eggshell strength values revealed that layers kept on F2 farm produce eggs with stronger eggshell (3,434.16 g/cm^2) compared to the farm F1 (3,344.82 g/cm^2), mainly due to the fact that the drop of the eggshell quality in the second farm in the hot summer period (July) was drastic (2,914.00 g/cm^2). The other explanation of this situation could be the significant drop of egg size in the farm equipped with cooling pads at the beginning of the hot season (May–June) which most probably helps the layers in maintaining their Ca reserves that later help their metabolism maintain its shell-forming capacities.

The conclusion is that high summer temperatures influence the eggshell strength resulting in lower strength, but the cooling equipment mitigates this negative effect.

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