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EGG QUALITY OF COMMERCIAL LAYER HYBRID KEPT IN DIFFERENT HOUSING SYSTEMS

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Abstract: Egg quality parameters of hybrid layers were analyzed by comparative testing of conventional cage and alternative housing systems: floor pen and mobile cages on the pasture. The analysis of the quality of eggs from the conventional cage and floor pen housing system was carried out at the age of 42 to 44 weeks, and from the conventional cage and the mobile cage on pasture, in the period from 51 to 53 weeks of age. Each trial was organized in 3 repetitions in the 3 seven-day periods and 30 eggs per repetition, i.e. 90 per housing system were analyzed. The quality of 360 eggs in total was analyzed. The initial egg quality was studied based on the properties of the external and internal quality of eggs and eggshell quality. In the conditions of the same genetic of laying hens, the parameters of the egg quality that were significantly affected by the housing system are the egg weight, certain properties of eggshell quality (cleanliness, colour and weight), the ratio of the albumen and yolk, and the yolk colour. Significantly higher egg weight and a lower albumen to egg yolk ratio were recorded in eggs from alternative housing systems compared to the conventional cage system. Eggs from the floor system had a darker and dirtier egg shell compared to the conventional cage system. The eggshell weight and the yolk colour were significantly higher in eggs from mobile cages.

Key words: layers, egg quality, housing systems

Introduction

Changes in the housing system for laying hens is implied by the necessity for improvement of the conditions for the welfare of layers, and the expected

legislation on permitted housing systems in order to harmonize with the adopted principles contained in the EU Regulation *(Council Directive 1999/74/EC).* There is a great deal of consumer pressure imposing more natural production conditions as an imperative for a better product. Therefore, the topic of the effect of the housing system for layers is inspirational for researchers, not only from the aspect of hens welfare, but also from the aspect of the quality of eggs, productivity, and economy.

The effect of the housing system is based on the differences in the available space for the hens' movement and level of equipment of that space, related to the manifestation of common patterns of behaviour and welfare of hens, ambient conditions, nutrition, exposure to stress factors.

Previous studies of the effects of the housing system on the egg quality are without a clear answer to the question of the superiority of a particular system in terms of the egg quality. The reason is the inability to fully reconcile the factors important for the quality of eggs (genetic of laying hens, hen age, oviposition time, nutrition), as well as certain specificities of the investigated housing systems. The observed differences in the egg quality under the influence of the housing system relate to the egg weight, the eggshell cleanliness, the yolk colour, Haugh units *(Pavlovski et al., 2004; Pištekova et al., 2006; Rossi, 2007; Sekeroglu et al., 2008; Đukić-Stojčić et al., 2009; Yilmaz Dikmen et al., 2016*). The advantage of the cage in relation to alternative housing systems in terms of the egg weight is stated by *Minelli et al. (2007),* in terms of the albumen quality and eggshell quality, *Englmaier et al. (2014). Svobodova et al. (2014)* indicate significantly higher egg weight and better albumen quality in floor compared to the cage system. By contrast, *Rizzi et al. (2006)* have not determined the differences in the individual properties of egg quality from different housing systems. Similarly, *Sekeroglu et al. (2010)* report that there are no major differences in egg quality between the floor, free range and cage systems.

Based on the above mentioned, the aim of the present study was to provide a contribution to the results of the research in this field by comparative testing of the conventional cage system and floor pens, i.e. conventional cage system and mobile cages on the pasture, from the aspect of the egg quality.

Material and Methods

The quality of the eggs from the conventional cage system was compared with the quality of the eggs from the floor pen, i.e. mobile cages on the pasture. In all three systems Tetra SL layers were used. The quality of eggs from the conventional cage and floor system of housing was tested at the age of layers of 42

to 44 weeks, and the effect of the housing in mobile cages, due to the vegetation and the adjustment of the length of the light day, was examined later, at the age of the layers of 51 to 53 weeks. Each trial was organized in 3 repetitions (3 seven-day periods) and 30 eggs per repetition were analyzed, respectively 90 per housing system. The quality of total of 360 eggs has been analyzed. The cage system of housing was in three-tier conventional cages with 4 layers per cage. The floor system was on a deep litter, in a pen area of $8m^2$ and a stocking density of 4 layers/m^2. The facilities in both systems were without windows and with artificial lighting of 15 hours a day. The housing in mobile cages was on a natural pasture. The surface of the cage was 4.5 m^2 and the stocking density 3 layers/m^2. Layers were exposed to natural light for 15 hours. Nutrition of layers was consistent with their requirements at the given stage of the production cycle (*Management Guide Babolna Tetra Hybrids*) and identical for all studied housing systems. In addition, the availability of pasture for layers in mobile cages was constant. Food and water were available ad libitum. The eggs were sampled in the morning and the initial quality of the eggs was examined based on the exterior and interior egg quality properties *(Pavlovski et al., 1997)* as well as the eggshell quality *(Pavlovski and Vitorović, 1996).*

Statistical data processing was done by the One-way ANOVA variance using the statistical software package STATISTICA, version 8, StatSoft, Inc. (www.statsoft.com).

Results and Discussion

The egg quality from the conventional cage and floor pen systems was statistically significantly different in terms of the egg weight, the eggshell colour, the eggshell cleanness, and the albumen yolk ratio (Table 1).

Eggs from the floor pen housing system in relation to the conventional cage system had significantly higher weight. The higher egg weight in the floor system compared to the cage system was determined by *Svobodova et al. (2014), Pištekova et al. (2006).* Contrary to these results is study by *Đukić-Stojčić et al. (2009)* in which they conclude that the eggs from the cage system have the greatest weight in relation to the floor system with the range and the free range system. It is difficult to discuss which factors in the housing system have caused the differences in the egg weight. In conditions of the same genetic basis and age of hens layers, and nutrition, the differences between the cage and the floor system of housing are in the environment and technological processes, and consequently, physiological stress *(Holt et al., 2011).* The lower albumen/yolk ratio in the floor pen compared to the cage system indicates a higher proportion of egg albumen in the structure of

eggs in the floor system. Reduction of the proportion of yolk, generally in the last decades, *Flock (2019)* attributes to the selection in order to effectively convert food into egg weight. Expectedly, the eggs from the floor pen system have a dirtier shell, although there are also contrary findings *(Ahammed et al., 2014).* The eggshell colour is a genetically conditioned trait, but it differed in the examined systems of housing. However, it should be noted that the established values for the eggshell colour in both examined systems were within the standard for given layer hybrid. The differences in the eggshell colour under the influence of the housing system were determined by *Pavlovski et al. (2004)* and *Sekeroglu et al. (2010).* Contrary to our results, *Sekeroglu et al. (2010)* have found that the eggs from the floor system have the brightest shell, while *Pavlovski et al. (2004)* have found that eggs from the cage system have a darker shell compared to eggs from the free range system.

Table 1. Quality of eggs from conventional cage and floor pen systems at the age of layers of 42-44 weeks

Parameter	Conventional cages		Floor pen		p
	Mean	SD	Mean	SD	
Egg weight, g	61.99	5.94	64.82	4.44	0.0082
Egg shape index	77.88	2.27	78.00	1.95	0.777
Shell colour, points	3.46	0.58	3.82	0.48	0.0010
Shell cleanness, points	4.64	0.78	3.94	1.20	0.0008
Shell deformation, mm	0.215	0.057	0.201	0.023	0.361
Shell weight, g	8.51	0.96	8.66	0.98	0.452
Shell thickness, mm	0.355	0.032	0.351	0.023	0.546
Shell breaking force, kg	2.74	0.66	2.76	0.35	0.886
Albumen height, mm	8.126	1.09	8.35	1.49	0.393
Albumen/Yolk ratio	2.21	0.2	2.03	0.16	<0.0001
Yolk colour, Roche	12.64	1.06	12.56	1.55	0.764
Haugh Units	88.98	6.49	90.10	5.28	0.346

The average values of egg quality parameters from the conventional cage and the system in mobile cages on the pasture are shown in Table 2.

Significant differences in egg quality parameters are determined for the egg weight, the eggshell weight, the albumen/yolk ratio and the yolk colour. Layers housed in mobile cages on the pasture laid eggs of an average weight of 66.97 g, or 5.6% heavier than eggs from conventional cages (63.22 g). The shell weight of eggs from mobile cages was significantly higher (9.45 vs 8.73 g), which contributed to an increase in the share of egg shell in the structure of these eggs by 0.3% compared to conventional cage eggs. The ratio of albumen/yolk in eggs from mobile cages was lower compared to conventional cages, similar to the previous

comparison of floor and cage systems. The yolk colour was more intense with the access to pasture in mobile cages.

Table 2. Quality of eggs from conventional cage system and mobile cages on the range system at the age of layers of 51-53 weeks

Parameter	Conventional cages		Mobile cages on the pasture		p
	Mean	SD	Mean	SD	
Egg weight, g	63.22	4.38	66.97	5.31	0.0194
Egg shape index	76.20	2.02	77.35	2.58	0.125
Shell colour, points	3.65	0.59	3.70	0.57	0.786
Shell cleanness, points	4.90	0.31	4.70	0.73	0.267
Shell deformation, mm	0.209	0.032	0.221	0.041	0.333
Shell weight, g	8.73	0.76	9.45	0.77	0.0053
Shell thickness, mm	0.352	0.022	0.337	0.034	0.105
Shell breaking force, kg	2.37	0.53	2.40	0.41	0.843
Albumen height, mm	7.455	1.234	8.205	1.504	0.0929
Albumen/Yolk ratio	2.11	0.23	2.02	0.22	<0.0001
Yolk colour, Roche	11.77	0.63	13.25	0.64	<0.0001
Haugh Units	84.60	7.02	87.20	9.66	0.336

In agreement with the obtained results suggesting that free range housing leads to an increase in the weight of eggs, are results presented by *Rossi et al. (2007). Holt et al. (2011)* present similar results and bring them in conjunction with different ambient conditions in the conventional cage and free range system, primarily temperature. *Minelli et al. (2007)* emphasize the importance of nutrition and conclude that the housing system itself has no decisive importance on the weight of the eggs. In this regard, the results of our research can be discussed, as the layers in mobile cages had available pasture area within the cages, as an additional source of nutrition and more favourable environmental conditions compared to the conventional cage system. The lower average weight of eggs in the free range system *Krawczyk (2009)* explains the result of the conditions of nutrition, when the protein requirements of layers on the range are not met. A significantly higher share of egg shell in the structure of eggs from the free range system, stated by *Lewko and Gornowicz (2011),* is confirmed by our results. One of the parameters of the quality of eggs from free range that meets consumer expectations is the yolk colour *(Svobodova et al., 2014; Sokolowicz et al., 2018).* Stronger pigmentation of egg yolk from the mobile cages is the result of additional intake of natural pigments from pasture, in addition to the equal content of synthetic pigments in the feed mixture of both groups of layers.

Conclusion

In conditions of the same genetic basis and age of the layers, the parameters of the eggs quality that are significantly affected by the housing system are the egg weight, certain properties of eggshell quality (cleanliness, colour and weight), the albumen/yolk ratio and the yolk colour. The housing system in the mobile cages on the pasture, as well as the floor pen system, showed an advantage over conventional cages for most of the mentioned parameters except for the cleanliness of the shell. From the aspect of creating the conditions for more intensive development of alternative table egg production systems, the presented results indicate the possibility of improving certain quality properties, important for producers, but also those that satisfy consumer preferences.

Kvalitet jaja komercijalnih hibridnih nosilja u različitim sistemima gajenja

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Rezime

Parametri kvaliteta jaja hibridnih nosilja su analizirani uporednim ispitivanjem konvencionalnog kaveznog i alternativnih sistema gajenja: podnog (u boksevima) i u mobilnim kavezima na pašnjaku. Analiza kvaliteta jaja iz konvencionalnog kaveznog i podnog sistema gajenja obavljena je u uzrastu nosilja 42 do 44 nedelje a iz konvencionalnog kaveznog i mobilnih kaveza na pašnjaku, u periodu 51 do 53 nedelje starosti nosilja. Svaki ogled je organizovan u 3 ponavljanja u 3 sedmodnevna perioda i analizirano je 30 jaja po ponavljanju, odnosno 90 po sistemu gajenja. Ukupno je analiziran kvalitet 360 jaja. Ispitivan je inicijalni kvalitet jaja baziran na osobinama spoljašnjeg i unutrašnjeg kvaliteta jaja i kvaliteta ljuske. U uslovima iste genetske osnove i uzrasta nosilja, parametri kvaliteta jaja koji su bili pod značajnim uticajem sistema gajenja su težina jajeta, pojedine osobine kvaliteta ljuske (čistoća, boja i težina), odnos belanca i žumanca, kao i boja žumanca. Signifikantno veću težinu jaja i manji odnos belanca i žumanca su imala jaja iz alternativnih sistema gajenja u odnosu na kavezni sistem. Jaja iz podnog sistema su imala tamniju i prljaviju ljusku u odnosu na

konvencionalni kavezni sistem. Težina ljuske i boja žumanca su bili signifikantno veći kod jaja iz mobilnih kaveza na pašnjaku.

Ključne reči: nosilje, kvalitet jaja, sistem gajenja

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