

The effect of housing system and storage time on egg quality characteristics

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Abbreviated title: Housing system, storage and egg quality

Summary

The effect of housing system (conventional cages and litter) and storage time (0, 7, 14 and 21 days) on egg quality was investigated. The housing system and storage time significantly ($P < 0.001$) influenced egg weight. The fresh eggs from litter were heavier (64.5 g) in comparison with eggs from cages (63.3 g). The egg weight decreased about 3.3 g within 21 days of storage in both housing systems. The storage time markedly ($P < 0.001$) affected all characteristics of internal quality, whereas housing system had significant impact on eggshell quality. Higher eggshell quality was recorded in eggs from litter. Furthermore, albumen quality of fresh eggs was higher in eggs from litter: Haugh Units (87.2 versus 85.0), albumen index (10.0% versus 9.5%), albumen share (61.7% versus 60.6%) and albumen pH (8.32 versus 8.34). On the other hand, higher yolk share (27.2% versus 26.7%) and yolk index (44.2% versus 43.4%) were ascertained in eggs from cages. Greater deterioration in albumen quality characteristics was occurred in eggs from litter. Presumably, this deterioration related to higher pore count of egg shell from litter eggs.

Keywords: egg quality, pore density, housing system, time of storage

Introduction

Numerous studies indicate that housing system has considerable effect on egg quality. Egg quality characteristics are better in eggs produced in cages compared to alternative housing systems (Anderson and Adams, 1994; Moorthy *et al.*, 2000; Tůmová and Ebeid, 2003; Ledvinka *et al.*, 2004). Eggs from cage systems have thicker eggshell and achieve higher values of Haugh Units, albumen and yolk index. Moreover, eggshell strength is higher in cages than on litter (Tůmová *et al.*, 2009).

The quality of fresh eggs is subsequently changed in relation to storage conditions. In this case, important effect have temperature and humidity. Within storage period, egg and albumen weights decrease, whereas yolk weight increase slightly (Scott and Silversides, 2000; Silversides and Budgell, 2004; Samli *et al.*, 2005). Egg weight decreasing is caused especially by decline of albumen weight (Scott and Silversides, 2000) in consequence of water evaporation from egg through shell.

During storage, albumen quality decreases. It is evident from decreasing values of Haugh Units (Samli *et al.*, 2005; Keener *et al.*, 2006; Ragni *et al.*, 2007), albumen index and albumen height (Scott and Silversides, 2000; Silversides and Scott, 2001; Silversides and Budgell, 2004). Reduced albumen height has been variously attributed to proteolysis of ovomucin, cleavage of disulfide bonds, interactions with lysozyme, and changes in the interaction between α and β ovomucins with no clear favorite (Stevens, 1996).

Aim of the study was to determine the effect of housing system and storage time at room temperature on egg quality.

Materials and methods

The effect of housing system and time of storage was observed in eggs from ISA Brown hens from the 20th to 60th week of age. The laying hens were housed in conventional cages (550 cm² per hen) and on litter (7 birds per m²). Laying hens in both housing systems were fed by a commercial type food mixtures.

The experiment was focused on long-term storage of eggs at room temperature. A total of 640 eggs were analyzed (80 at each time). Part of eggs was analyzed immediately after laying (zero day), others were stored 7, 14 and 21 days and then assessment was carried out. The egg quality was found out in terms of egg quality characteristics determination. Individual eggs were weighed on laboratory scale. From eggshell quality characteristics there were evaluated shell weight after drying, shell share, shell thickness and shell surface. Shell thickness at equatorial plane was measured by the device QCT (TSS England) after inner and outer eggshell membranes removing. For determination of shell surface was used formula: $4.67 * m^{2/3}$, where m is egg weight. Albumen quality was express through the use of Haugh Units, albumen index, albumen share and pH. Albumen pH measurement was carried out by the pH meter (device pH 330i from firm WTW, Germany). Yolk was evaluated on the basis yolk index and yolk share.

For pore density determination, shells were boiled in a 5% NaOH solution for 15 min to remove shell membranes and then rinsed three times in distilled water. Rinsed eggshells were dried in oven heated up to 50 °C. Inside surface of shells were dyed by methylene blue. The dye solution was made by dissolving 0.5 g of 89% methylene blue crystals in one liter of 70% ethanol. The pores appeared as a blue dot on the outside surface due to capillary action. A total of 40 eggs from each system were analyzed.

Resultant values were statistically analyzed by SAS program and an analysis of variance (ANOVA) was used for resultant values evaluation. There was studying the combining effect of housing system and different time of storage.

Results and discussion

As shown in Table 1, the housing system and storage time had significant ($P < 0.001$) influence on egg weight. The fresh eggs from litter were heavier (64.5 g) in contrast with eggs from cages (63.3 g). These results are in accordance with the findings of many other authors (Ledvinka *et al.*, 2004; Tůmová and Ebeid, 2005) who stated that heavier eggs are produced by hens from litter. On the contrary, Anderson and Adams (1994) and Moorthy *et al.* (2000) observed higher weight in eggs laid in cages. The egg weight decreased about 3.3 g within 21 days of storage at room temperature in both housing systems. In addition, albumen share significantly ($P < 0.001$) decreased while yolk and shell share increased with time of storage. The similar findings stated Scott and Silversides (2000), Silversides and Budgell (2004) and Samli *et al.* (2005).

A number of authors showed that better egg quality characteristics had eggs from cages in comparison with alternative housing systems (Anderson and Adams, 1994; Moorthy *et al.*, 2000; Tůmová and Ebeid, 2003; Ledvinka *et al.*, 2004). In our case, there was not found any significant effect of housing system on egg content quality characteristics whereas storage time highly significantly ($P < 0.001$) influenced all characteristics of egg content quality. During storage, Haugh Units, albumen index and yolk index declined and albumen pH increased. Higher decline of Haugh Units (from 87.2 to 44.1 *versus* from 85.0 to 44.2) and albumen index (from 10.0 to 2.9 *versus* from 9.5 to 2.8) were recorded in eggs from litter in comparison with cages. On the other hand, yolk index declined faster in eggs from cages.

Housing system had mainly significant influence on eggshell quality which is characterized by shell weight ($P < 0.001$), shell thickness ($P < 0.003$) and shell surface ($P < 0.001$). Higher eggshell quality was recorded in eggs from alternative housing system, from litter.

Table 1 Egg quality characteristics

Characteristic	Housing system	Time of storage (days)				Significance		
		0	7	14	21	Housing	Storage	Housing* storage
Egg weight (g)	Cage	63.3	61.6	61.1	60.0	0.001	0.001	NS
	Litter	64.5	63.5	63.6	61.2			
Haugh Units	Cage	85.0	59.6	46.5	44.2	NS	0.001	NS
	Litter	87.2	59.8	48.0	44.1			
Albumen pH	Cage	8.34	9.22	9.30	9.29	NS	0.001	NS
	Litter	8.32	9.20	9.29	9.27			
Albumen index (%)	Cage	9.5	4.4	3.1	2.8	NS	0.001	NS
	Litter	10.0	4.4	3.3	2.9			
Albumen share (%)	Cage	60.6	59.6	58.9	58.0	NS	0.001	NS
	Litter	61.7	59.1	59.3	58.3			
Yolk index (%)	Cage	44.2	38.0	31.0	25.6	NS	0.001	NS
	Litter	43.4	38.9	31.1	26.4			
Yolk share (%)	Cage	27.2	28.9	29.6	30.2	NS	0.001	NS
	Litter	26.7	29.3	29.1	30.0			
Shell share (%)	Cage	12.2	11.5	11.5	11.8	NS	0.001	0.015
	Litter	11.7	11.6	11.5	11.7			
Shell weight (g)	Cage	6.4	6.2	6.2	6.2	0.001	NS	NS
	Litter	6.4	6.4	6.4	6.3			
Shell thickness (mm)	Cage	0.365	0.364	0.360	0.357	0.003	NS	NS
	Litter	0.370	0.370	0.372	0.366			
Shell surface (cm ²)	Cage	74.1	72.8	72.4	71.6	0.001	0.001	NS
	Litter	75.1	74.3	74.4	72.5			

NS Not significant

However, there was occurred greater deterioration in albumen quality characteristics of eggs from litter than from cages during storage. This fact is probably related to number of pores and subsequently albumen share decreases. The eggs of hens from litter had namely greater density of pores in the blunt region (Table 2) and higher decrease of albumen share (about 3.4%) compared to cages (about 2.6%).

Table 2 Pore density (number of pores/cm²) in eggshells

Region	Housing system	
	Cage	Litter
Sharp end	65.9	50.2
Blunt end	158.5	165.6
Equator	116.7	119.2

Conclusion

The egg weight was significantly ($P < 0.001$) influenced by both, housing system and storage time. The heavier eggs were observed in laying hens from litter. The egg weight decreased about 3.3 g within 21 days of storage at room temperature. The housing system had significant effect on shell quality characteristics while quality of albumen and yolk was influenced only by storage time. The eggs with higher shell quality characteristics were laid by hens from litter. During storage, Haugh Units, albumen index, albumen share and yolk index significantly ($P < 0.001$) declined whereas albumen pH, yolk share and shell share increased. Greater deterioration in albumen quality characteristics was occurred in eggs from litter. Presumably, this deterioration related to higher pore density in shells from litter eggs.

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