The Effects of Housing System and Storage Length on The Quality of Eggs Produced by Two Lines of Laying Hens

Article *in* Archiv fur Geflugelkunde · June 2008

Arch.Geflügelk., **72** (3). S. 106–109, 2008, ISSN 0003-9098. © Verlag Eugen Ulmer, Stuttgart

The effects of housing system and storage length on the quality of eggs produced by two lines of laying hens

Einfluss des Haltungssystems und der Lagerdauer auf die Qualität von Hühnereiern von zwei Legeherkünften

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Manuskript eingegangen am 30. April 2007, angenommen am 3. August 2007

Introduction

Cage systems have some advantages as more clean eggs, low risk of diseases, separation of hens from their droppings, easy control of hens and minimized risk of cannibalism. Layers kept on litter are subjected to relative humidity and ammonia concentration that may contribute to weakening the birds' respiratory systems making hens more susceptible to bacteria and viral infections (PHELPS, 1991; DUN, 1992). Free-range chickens and eggs are more likely to be infected by salmonella than caged birds and eggs (MOSTERT et al., 1995).

Eggs may lose their quality rapidly between the period of collection and consumption. Egg quality is measured in order to describe difference in fresh eggs produced by hens of different genotypes which are subjected to different environmental factors (nutrition, housing systems etc.), equipment and management treatments or to describe the deterioration in egg quality with difference in storage time and storage conditions (SILVERSIDES and VILLENEUVE, 1994; STADELMAN and COTTERILL, 1995). Also, egg production, eggshell quality and interior egg quality traits are affected by modified and conventional cages and deep litter systems (ABRAHAMSSON and TAUSON, 1995; ABRAHAMSSON et al., 1995; ABRAHAMSSON and TAUSON, 1998). Albumen quality is a standard measure of egg quality that is most often measured from height of the inner thick albumen or a function of this, such as the Haugh unit.

Albumen quality can also be measured by the albumen pH. A high pH value is a reflection of lower albumen quality (SILVERSIDES and VILLENEUVE, 1994; SILVERSIDES and SCOTT, 2001). The factors that will influence albumen height are strain and age of the laying hen, storage time, storage conditions, environmental temperature, feeding stuffs, egg size and water consumption (WILLIAMS, 1992; JACOB et al., 2000; SCOTT and SILVERSIDES, 2000; FAROOQ et al., 2001; TILKI and SAATCI, 2004). The albumen height of all eggs is at maximum when the egg is laid and decreases with storage length (SILVERSIDES and SCOTT, 2001; TILKI and INAL, 2004).

It is recommended to the egg industry to treat eggs with a cold shock of 4 h which will prolong the egg shelf life and enhance egg quality during a consequent storage at 25°C (THERON et al., 2003). In the European Community and in the United States eggs are generally stored between 8°C and 16°C (SCHOENI et al., 1995). ALTAN et al., (1997) reported that weight loss is the first change in the eggs after storage due to evaporation. Percentage of weight loss of eggs stored for six weeks under 18-20°C and 48-52% relative humidity was 4% and under 4-5°C and 58-62% relative humidity it was 1.7%.

Effects of the storage length, storage temperature and genotype of the hen on egg quality have been studied by many researches. But, very little research has been conducted on housing systems, genotype and storage length together. Therefore, this study was designed to examine the effects of housing systems (free-range and deep-litter systems), genotype (white and brown layers) and storage length on egg quality parameters.

Material and Methods

Animals and husbandry

In total, 272 Eggs were collected from brown layer strain of ATAK (G_xS_x) and white layer strain ATABEY (O_1T_x) reared in floor house systems and free range systems at about 32 weeks of age. The housing systems used included deep litter system (stocking density 3.7 birds/m^2) and free range system (1.0 bird/m^2 with outside area). Layer house and free range area were located at the college farm of Gaziosmanpasa University. Watering and feeding equipments were obtained according to bird number and water and feed was supplied *ad libitum*. Nests were placed in a relatively dark area with a covering of litter, and one nest (35x35x35 cm) was allocated for 2.5 hens. The daily photoperiod consisted of 16 h light and 8 h darkness.

Egg quality analyses

Sixty-eight eggs were collected for each strain from each husbandry systems. Egg samples were stored in a none-air flow refrigerator for the periods of 1, 5, 8, 12, 16 and 20 days at 8°C and 70-80% relative humidity. Eggs were weighed and egg specific gravities were determined by sa-

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line solution. After that, eggs were broken on a flat surface where the height of the albumen and yolk was measured (Sarica and Erensayin, 2004). The pH of the mixed albumen and yolk was measured immediately using a pH meter. Haugh units were calculated from the height of the albumen and the egg weight using the formula HU=100 Log (H-1.7 $W^{0.37}$ + 7.57, where H is the height of the inner thick albumen in millimeters and W is the weight of the egg in grams (Nesheim et al., 1979). Yolk color was measured using DSM Yolk Color Fan (DSM, 2004).

Albumen index, yolk index and shape indices were calculated as follows:

Albumen index: Albumen height (mm) / [Albumen length (mm) + Albumen width (mm)/2] x 100

Yolk index: Yolk height (mm) / Yolk diameter (mm) x 100

Shape index: maximum width (mm) / maximum length (mm) x 100.

Statistical Analysis

Data of egg quality parameters were subjected to statistical analysis by the Generalized Linear Model Procedure of SPSS 11.0 (Ozdamar, 2002). General linear models procedure was applied with a 3-factorial approach with factors housing system, breed, storage length and interactions between factors. The data distribution was tested for normality by Probit analysis and variance homogeneity by Bartlett test. The significant differences were determined among mean values by Duncan's multiple range test.

Results

The mean values of the egg quality parameters measured during the research period are presented in Table 1. Eggs produced by white layers had a higher specific gravity ($P < 0.01$), pH ($P < 0.05$), albumen width ($P < 0.01$), Haugh unit score ($P < 0.05$) and yolk width, albumen width and pH than those of brown layers.

At the end of the 20-day storage period, egg weight decreased by 2.09%, but this difference was not significant ($P > 0.05$). During the 20 days of storage length, pH, albumen length and albumen width increased by 6.42%, 29.09% and 25.69%, respectively, while albumen height and specific gravity decreased by 39.83% and 1.83% respectively ($P < 0.01$). Decrease in albumen height and increases in albumen width and length have resulted in decreased albumen index and Haugh unit by 52.00% ($P < 0.01$) and 25.21% ($P < 0.05$), respectively, and the effect of the storage length was significant on these traits ($P<0.01$). Yolk width increased by 1.07% ($P > 0.05$) causing a decrease in yolk height 4.70% ($P < 0.05$) at the end of the 20-day storage. These changes on yolk characteristics have resulted in a 5.77% decrease in yolk index ($P < 0.05$). In addition, extending storage length significantly affected yolk color ($P < 0.05$).

Extending storage length decreased egg specific gravity and albumen height ($P < 0.01$), but increased albumen length and width ($P < 0.05$). As a result of these changes, albumen index ($P < 0.01$) and Haugh unit index decreased ($P < 0.05$). During storage time egg yolk height and yolk index decreased and yolk color get darker ($P < 0.01$).

Table 1. Effects of housing systems, genotype and storage length on egg quality characteristics
Einfluss von Haltungssystem, Genotyp und Lagerdauer auf die Merkmale der Eiqualität

	Egg Quality Characteristics											
	Egg weight (g)	Specific gravity (g/cm³)	pH	Albumen length (mm)	Albumen width (mm)	Albumen height (mm)	Albumen index (%)	Haugh units	Yolk width (mm)	Yolk height (mm)	Yolk index (%)	Yolk colour (DSM)
Housing system	-	-	-	-	-	-	-	-	-	-	-	**
Deep litter	57.9	1.082	7.58	102.6	81.5	6.28	7.10	77.8	41.1	17.7	43.0	10.3
Free range	57.6	1.081	7.60	101.1	82.3	6.42	7.23	78.7	41.1	17.7	43.2	10.8
SEM	0.28	0.001	0.015	0.723	0.667	0.091	0.145	0.658	0.091	0.056	0.153	0.060
Strain	**	**	*	-	**	-	-	*	**	*	-	*
Brown	61.7	1.080	7.62	102.3	85.2	6.32	7.04	77.1	41.4	17.8	43.0	10.7
White	53.8	1.083	7.57	101.4	78.7	6.38	7.29	79.4	40.8	17.6	43.1	10.4
SEM	0.28	0.001	0.015	0.723	0.667	0.091	0.145	0.658	0.091	0.056	0.153	0.060
Storage time, d	-	**	**	**	**	**	**	*	**	**	**	**
1	58.4	1.092a	7.32a	89.1a	72.9a	8.11a	10.23a	90.0a	41.0	18.1a	44.2a	10.0a
5	58.0	1.086b	7.53b	96.3b	79.1b	7.13b	8.19b	83.1b	40.7	18.2a	44.8a	10.0a
8	57.9	1.081c	7.53b	100.0c	80.6b	6.28c	7.07c	78.3c	41.2	18.2a	44.1a	10.3ab
12	57.7	1.081c	7.60b	103.0c	82.1bc	5.96cd	6.53de	76.3cd	41.0	17.4b	42.5b	10.4b
16	57.4	1.078d	7.79c	107.8d	85.0c	5.74d	6.03e	74.5d	41.5	17.1b	41.3bc	11.4c
20	57.1	1.072e	7.79c	115.1e	91.7d	4.88e	4.91f	67.3e	41.4	17.2b	41.6c	11.2c
SEM	0.28	0.001	0.015	0.723	0.667	0.091	0.145	0.658	0.091	0.056	0.153	0.060
Source of variation						P values						
Housing x Strain	<0.05	NS	NS	NS	NS	NS	NS	NS	<0.01	NS	NS	NS
Housing x Storage	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.01
Strain x Storage	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Housing x Strain x Storage	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

a-e: Within each column, means followed by different letters are significantly different ($P<0.05$). FCF; DSM Yolk Color Fan. NS; Not signific

The interactions between housing systems and strain were significant for egg weight (P<0.05) and yolk width (P<0.01), and the interactions between housing systems and storage time were significant for yolk color (P<0.01). No significant interactions were found among others characteristic (P>0.05).

Discussion

The obtained results allowed to make a comparison between the mentioned factors and to define the influence of these factors on egg quality. Weights of white and brown eggs were not affected by housing system and storage times as previously reported by SEKEROGLU, (2002), but some of the researchers have reported a significant effect of housing systems on egg weight (MOSTERT et al., 1995; DUTTA, 1993).

Storage time had a significant effect on specific gravity in the corresponding study. It was clear that increasing storage time may cause a decrease in specific gravity as supported by THOMPSON et al. (1983). On the first sight it can be seen that white layers have significant advantages over brown layers in terms of egg specific gravity parameters (Table 1). But, it is a reality that the egg of white layers is smaller with thicker egg shells and these traits can play a very important role for specific gravity. Therefore, this determined significant difference between the strains cannot be considered seriously.

An increasing trend for pH value with storage time was observed. This finding was a reflection of the decrease in albumen quality as reported by SCOTT and SILVERSIDES, (2000). LAPAO et al., (1999) and SARICA and ERENSAYIN, (2004) stated that pH increased from 8.08 to 9.12 and albumen height decreased from 7.74 mm to 5.67 mm during storage (0-18 day) of 32 weeks old layers egg. SCOTT and SILVERSIDES, (2000) reported that egg pH increased from 7.32 to 9.37 and albumen height decreased from 9.16 mm to 4.75 mm after 10 days of storage.

Although albumen length and width showed an increase with storage time, increasing storage time caused a decrease in albumen height and albumen index. Except albumen width, all the other albumen traits have been affected by housing system and strain. As mentioned in literature, during storage time height of egg albumen showed a decreasing trend (SCOTT and SILVERSIDES, 2000; TILKI and SAATCI, 2004).

Extending storage length decreased Haugh unit index as reported by many researchers (SILVERSIDES and VILLENEUVE, 1994; BELL et al., 2001; ADAMIEC et al., 2002; TONA et al., 2004). On the other hand, SAUVEUR, (1991) had stated that Haugh unit was not affected by housing systems as observed in our study, whereas, PAVLOVSKI et al., (1994a), SUTO et al., (1997) and SEKEROGLU, (2002) reported that housing system had a significant effect on Haugh unit.

It is a well known reality that genotype has significant effect on egg quality. Similarly, brown layers laid heavier eggs than white layers in this study in agreement with some other researchers (MOSTERT et al., 1995; SUTO et al., 1997; ANDERSON et al., 2004).

Although, yolk index showed a fluctuation during the storage period, a general decrease in yolk index was observed at the end of the storage time. SOUZA et al., (2001) reported that egg yolk index decreased from 45.0 to 15.7 after 28 days storage. Effects of storage length on egg quality reported in this study are in agreement with findings of other researchers (LAPAO et al., 1999; SCOTT and SILVERSIDES, 2000; SILVERSIDES and SCOTT, 2001; SOUZA et al., 2001; ADAMIEC et al., 2002). The effect of housing systems on egg yolk index was not significant and the results are in agreement with PAVLOVSKI et al., (1994a).

Significant differences between free-range and deep-litter systems in terms of yolk color have also been stated by MOSTERT et al., (1995) and PAVLOVSKI et al., (1994b) as observed in the present study. In those entire studies higher yolk color was found in free range system then in others.

As a conclusion, there were no significant differences between housing systems in terms of egg quality characteristics examined in this study. Extending storage length affected egg albumen quality more than egg yolk. Additionally, increasing storage time decreased overall egg quality characteristics. Especially, a sharper decrease was observed after the 12th day. This determined time can be used as a threshold for both hatching and market eggs.

Summary

Effects of housing systems and storage length on the quality of eggs produced from white and brown layer hens were studied. Egg samples were randomly collected from deep litter and free-range layer systems and stored in a none-air flow refrigerator for the periods of 1, 5, 8, 12, 16 and 20 days at 8°C and 70-80% relative humidity.

Specific gravity, pH, albumen index, Haugh unit score, yolk index and yolk colors of the eggs were affected by storage length (P<0.05-0.01). Egg yolk color was only affected by housing systems (P < 0.01), however, egg weight, egg specific gravity, pH, albumen width, Haugh unit, yolk height and yolk color were affected by strains of hens (P<0.05-0.01). As a conclusion, extending storage length affects egg albumen quality more than egg yolk quality. Especially, a sharper decrease was observed after the 12th day. This determined time can be used as a threshold for both hatching and market eggs.

Key words

Layer, deep litter, free range, storage length, white eggs, brown eggs, egg quality

Zusammenfassung

Einfluss des Haltungssystems und der Lagerdauer auf die Qualität von Hühnereiern von zwei Legeherkünften

In der vorliegenden Studie wurde der Einfluss von zwei verschiedenen Haltungssystemen und der Lagerdauer auf die Qualität von weiß- und braunschaligen Eiern untersucht. Die Eierstichproben wurden zufällig aus den Boden- und Freilandhaltungssystemen gesammelt und in einem Kühlschrank ohne Luftumwälzung über 1, 5, 8, 12, 16 und 20 Tage bei 8°C und einer relativen Luftfeuchtigkeit von 70-80% gelagert.

Das spezifische Gewicht, der pH-Wert, der Eiklarindex, die Haugh-Einheit, der Dotterindex und die Dotterfarbe der Eier wurde durch die Lagerdauer beeinflusst (P<0.05-0.01). Das Haltungssystem hatte sich nur auf die Dotterfarbe ausgewirkt (P<0.01), während das Eigewicht, das spezifisches Gewicht des Eies, der pH-Wert, der Eiklardurchmesser, die Haugh-Einheit, die Dotterhöhe und die Dotterfarbe vom Genotyp der Hennen abhing (P<0.05-0.01). Es kann der Schluss gezogen werden, dass die Lagerdauer eine größere Auswirkung auf die Eiklarqualität als auf die Eidotterqualität hat. Vor allem ab dem

12. Lagertag wurde ein deutlicher Rückgang in der Qualität beobachtet. Dieser Zeitpunkt kann als Schwellenwert für die Lagerdauer sowohl von Brut- als auch von Konsumeiern verwendet werden.

Stichworte

Legehenne, Bodenhaltung, Freilandhaltung, Weißleger, Braunleger, Lagerdauer, Eiqualität

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