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Age related changes in laying pattern and egg weight of different laying hen genotypes

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ABSTRACT

The aim of the study was to evaluate changes in laying patterns depending on the age of different genotypes of laying hens. In the experiment, six genotypes were evaluated (brown-egg hens Bovans Brown, Bovans Sperwer and Isa Sussex, white-egg hens Dekalb White, and laying hens with tinted shells Moravia Barred and Moravia BSL) in three periods during the laying cycle (the onset of lay between 20 and 26 weeks of age, the middle from 36 to 42 weeks of age and the end of lay between 64 and 70 weeks of age). A significant interaction between genotype and age was apparent in mean sequence length ($P < 0.001$), length of the prime sequence ($P < 0.001$), mean number of sequences ($P < 0.001$) and mean time of oviposition ($P < 0.001$). The longest lag during the course of the experiment was with Moravia BSL, which was more than 3 h; the shortest lag was observed in Bovans Brown, which was less than 1 h. The mean time of oviposition was also affected by genotype ($P < 0.001$). Bovans Brown laid their eggs approximately 3.5 h after the lights came on, whereas Moravia BSL laid their eggs almost 6 h after the lights came on. Egg weight increased with age ($P < 0.001$), and the smallest differences in egg weight were with ISA Sussex (5 g), whereas the biggest differences were with Moravia BSL (10 g).

1. Introduction

The number of eggs laid by a hen during her reproductive life and the mean weight of the eggs produced are dependent on the age at sexual maturity, on the genetically-determined internal cycle length (ICL) and egg weight, and particularly the changes that occur over time in ICL and egg weight. Total egg production of a flock of hens at a particular age is determined by the individual patterns of sequential laying at that time (Johnston and Gous, 2003). Laying sequence or clutch is defined as the number of eggs that are laid on consecutive days and separated from another by one or more pause days (Akil and Zakaria, 2015).

The first egg in a sequence is laid early in the morning, and subsequent eggs are laid later in succeeding days, the difference in time between successive ovipositions minus 24 h, termed the lag, being longer in short sequences and shorter (sometimes negative) in long sequences. Oviposition time and the position of an egg in a sequence affects egg weight (Tumova and Ledvinka, 2009; Tumova and Gous, 2012; Samiullah et al., 2016). Patterson (1997) indicated that higher egg weight occurred in the morning and declined between 5:00 and 18:00 h by 2–9 g/egg/day.

Egg production traits are affected by the age of hens. Robinson et al. (1990) observed that after the onset of laying, hens lay short sequences of eggs until peak production is reached. Around the peak of the production, there is one long sequence called the prime

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sequence. The prime sequence length and the rate of lay decline thereafter are all under genetic control and will vary between individuals and between strains. The correlation between the length of the prime sequence and the laying rate was reported by Robinson et al. (1990) to be 0.40, when the laying rate was measured over the nineteen 14-d periods from 24 to 62 weeks of age. Additionally, the time of oviposition depends on hen age, and eggs produced by old hens tend to be laid later in the day (Zakaria et al., 2005; Tumova and Gous, 2012; Akil and Zakaria, 2015). A shorter sequence is a result of a retarded rate of follicle maturation with advancing age (Johnston and Gous, 2003; Zakaria and Omar, 2013).

Each genotype is characterized by unique performances. Johnston and Gous (2007a) observed differences in mean sequence length, mean prime sequence length and mean pause length between Hy-Line Brown and Hy-Line Silver Brown. Data regarding the laying patterns for different layer genotypes are limited. On the other hand, the effects of genotype on oviposition time has been widely described. Lewis et al. (1995) indicated that brown-egg laying hens laid eggs 1.2–1.4 h earlier than those of white-egg hens. Campo et al. (2007) observed that white and tinted eggs tended to be laid in the afternoon, whereas brown eggs were laid in the morning. The data indicate that each genotype of laying hens has a particular laying pattern, and variations in laying characteristics with advancing age are also unique. Therefore, the aim of this study was to evaluate changes in laying patterns due to hen age and the genotype of laying hens.

2. Material and methods

An experiment with six laying hen genotypes was conducted at a testing station of the Central Institute for Supervising and Testing in Agriculture in Havlíčkův Brod and was approved by the Ethics Committee of the Czech University of Life Sciences Prague and the Central Commission for Animal Welfare at the Ministry of Agriculture of the Czech Republic. In total, 90 laying hens were individually housed in cages (550 cm^2 per bird) on a medium floor of a three-floor battery system. The birds were divided into six groups according to genotype. There were brown-egg hens Bovans Brown, Bovans Sperwer and Isa Sussex, white-egg hens Dekalb White and laying hens with tinted shells Moravia Barred and Moravia BSL. Each genotype included 15 birds, and each bird was considered an experimental unit. Laying hens were placed into cages at 16 weeks of age until the end of the experiment at 70 weeks of age. Before the experiment, pullets were reared in the same conditions. During the rearing period, the lighting regime consisted of 19 h of light during the first week which was then reduced to 9 h at six weeks of age. Nine hours of light was maintained between 6 and 15 weeks of age, and then gradually increased to 16 h at 20 weeks of age.

The beginning of the experiment was at 20 weeks of age. The laying cycle was split into three experiment periods of seven weeks: the onset of lay was between 20 and 26 weeks of age, the middle was between 36 and 42 weeks of age, and the end of lay was between 64 and 70 weeks of age. During the experiment, laying hens were fed an identical commercial feed mixture, N1 (176 g crude protein, 11.0 MJ of metabolizable energy and 33.2 g Ca) for weeks 20–56 and N2 (156 g crude protein, 9.9 MJ of metabolizable energy and 36.8 g Ca) from 57 weeks until the end of the experiment. Feed and water were available *ad libitum*. The daily photoperiod consisted of 16 h light and 8 h darkness, with lights turning on at 3:00 a.m. The microclimate conditions were in accordance with laying hen needs (Skrivan et al., 2015).

Egg production and mortality for the basic genotype characteristics were recorded daily. The mean age at the first egg (AFE) was measured as the number of days until the first egg was laid. The mean rate of lay (%) was calculated as the proportion of eggs laid over the experimental period divided by a number of hen-days in the period (Tumova et al., 2016). The mean sequence length was counted as the number of days where an egg was laid before a pause day. The longest sequence in each period was considered the prime sequence. The mean number of sequences was evaluated for each period. The mean time of oviposition was estimated as the length of time from when the lights turned on until the egg was laid. The mean internal cycle length (ICL) was calculated using the equation from Ferreira et al. (2016): ICL = (DL/LP) x 100, where DL is day length, and LR is the rate of lay (%). Egg weight was evaluated for two purposes, for the basic genotype characteristics (Table 1) which was evaluated at 4-week intervals when all laid eggs in one day were weighed. Egg weight in each period (Table 3) was determined by daily weighing.

The data were analyzed using an analysis of variance with ANOVA and PROC GLM in SAS (SAS, 2013). The results of AFE, total egg production, and egg weight were calculated by one-way analyses of variance, and significance was evaluated using Duncan's test.

Table 1
Production characteristics of the evaluated genotypes.

Genotype	Mean age at first egg (days)	Mean number of eggs laid per hen to 70 weeks (n)	Mean egg weight to 70 weeks of age (g)	Mortality 20–70 weeks of age (%)
Bovans Brown	135^{b}	336^{b}	61.5^{bc}	7.69
Bovans Sperwer	133^{bc}	331^{b}	61.8^{bc}	1.82
ISA Sussex	133^{bc}	343^{a}	62.7^{b}	3.64
Moravia Barred	132^{c}	303^{d}	60.6^{c}	3.70
Dekalb White	134^{bc}	322^{c}	61.8^{bc}	9.26
Moravia BSL	143^{a}	294^{d}	64.3^{a}	1.85
RMSE[a]	4	1	3.8	
Significance	0.001	0.001	0.001	

[a,b,c,d] Statistically significant differences ($P < 0.05$) within columns are indicated by different superscripts.
[a]RMSE – Root mean square error.