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# THE INFLUENCE OF STRAIN AND AGE ON SOME EGG QUALITY PARAMETERS OF COMMERCIAL LAYING HENS

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**Abstract**: The experiment was conducted to evaluate the influence of strain and age on some egg quality parameters (egg weight and egg shell strength) of commercial laying hens. Layers of lines ISA Brown and DeKalb White were examined in period of nine months. Both lines were at same age (28 weeks) and were confined in common facility in battery cages. Laying hens were reared and fed according to standard breeding technology. Once a month 25 eggs of each line were taken to be examined for eggshell strength and egg weight, or in other words, total 450 table eggs were tested. Analises were done in Laboratory for testing egg quality by gaudges Egg Multi Tester EMT 5200 and Egg shell Gauge (Robotmation Co. Ltd., Tokyo, Japan) which have computerised equipment to examine quality and physical characteristics of eggs. Statistic analyses on results were done by computer sub-programme ANOVA and Fisher's LSD test to determine the level of statistical significant difference between examined factors. Egg weight was under significant impact of age ($P \leq 0,05$), but not under the influence of strain, although eggs of ISA Brown line were insignificantly heavier than eggs of DeKalb White line. Eggs were heaviest at layers with older age, while they were lightest at younger birds. The results have shown significant differences ($P \leq 0,05$) in eggshell strength compared to line influence (genotype) and months of age. Eggs from ISA Brown laying hens had much better and eggshell strength than those eggs from DeKalb White. Correlations between eggshell strength and egg weight were with significant ($P < 0,05$) negative value, which indicating that with increasing egg weight decreases of eggshell strength.

**Key words**: strain, age, egg weight, eggshell strength, layers.

# Introduction

Egg quality is factor which contributes for better economy price of fertile and table eggs. Egg quality was defined by *Stadelman (1977)* as characteristics important for consumers. Economic success for a production flock is measured with total number of qualitative produced eggs *(Monira et al., 2003)*. Egg quality is presented by its weight, percentage of eggshell, thickness and strength of eggshell. Mainly, differences in eggshell quality depend of strain or line of hen *(Buss and Guyer 1982)*. Egg weight is very different between various lines of hens, and eggshell thickness is under great influence of line *(Pandey et al., 1985)*. Many researchers have raported significant genotype differences related to egg weight *(Monira et al., 2003; Anderson et al., 2004)*. Egg weight per unit area *(Arad and Mader, 1982; Izat et al., 1985)* declined with increasing age of hens, but at the same time egg size increased *(Sauter et al., 1981)*.

Genotype has direct influence on egg weight and eggshell characteristics. Many studies showed that hens with coloured feathers lay bigger eggs than hens with white feathers *(Halaj and Grofik 1994; Arent et al., 1997; Ledvinka et al., 2000; Vits et al., 2005)*. *Baumgartner et al. (2007)* determined the age impact on egg weight for hens of Leghorn strain. Eggs weight influences on weight of egg parts or components. Correlation between egg weight and weight of albumen, yolk and eggshell are high are ranged from 0.67 to 0.97 *(Zhang et al. 2005)*. *Harms et al. (1990)* established correlation ranging between egg size and eggshell in diapazon from 0.92-0.97. It is concluded that season and age, especially high summer temperatures and hens' older age have valuable influence on egg lower weight and quality (strength) of eggshell *(Nikolova and Kocevski, 2006; Nikolova et al., 2008)*.

In this study are shown the results from researches of strain and age influence on egg weight and eggshell strength at table eggs of commercial laying hens.

# Materials and Methods

The research was in a farm for breeding commercial laying hens, housed in conventional battery cages, located in R.Macedonia, a country with over 300 sunny days a year and with high temperatures during summer (up to 40°C). Two lines of commercial laying hens, ISA Brown and DeKalb White were examined, both at age of 28 weeks, reared and fed according to standard breeding technology. The experiment lasted for nine months and during that period once a month 25 table eggs of each line were analysed, or total 450 eggs in order to determine egg weight and eggshell strength. The collection of eggs for analysis went on to have no major differences in weight between them in order to obtain more accurate results. Analises were done in Laboratory for testing egg quality by gaudges Egg Multi

Tester EMT 5200 and Egg shell Gauge (Robotmation Co. Ltd., Tokyo, Japan) which have computerised equipment to examine quality and physical characteristics of eggs. At the end of experiment statistic analyses on found results were done by computer program Statistica 6 and sub-programme ANOVA to determine analyses variables and Fisher's LSD test to determine existence and level of statistical significant differences between examined factors. Also, correlation between examined factors was done.

# Results and Discussion

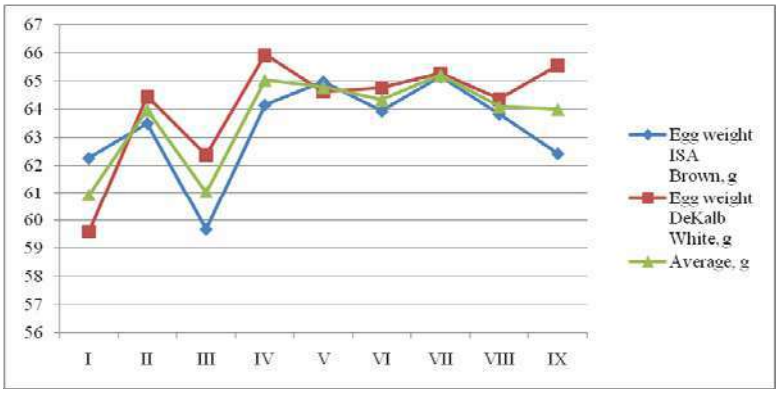
Results from egg weight measurment and eggshell strength received from two lines of commercial laying hens (ISA Brown и DeKalb White) by months are presented in Table 1. There it can be seen that weight of eggs from ISA Brown line was lowest in III$^{th}$ (59.68), and highest in VII$^{th}$ (65.16) month of experiment, while for eggs of DeKalb White line had lowest value of examined parameter in I$^{th}$ (59.61), and highest value in IX$^{th}$ (65.57) month. The average values of egg weight for laying hens from ISA Brown line were slightly bigger (64.11) compared to average values from DeKalb White line (63.72). Eggshell strength for ISA Brown line was lowest in VI$^{th}$ (3663.12) and highest in IX$^{th}$ (4050.08) compared to eggshell strength for eggs of DeKalb White line with lowest values in IV$^{th}$ (3227.28) and highest values in II$^{th}$ (3844.96) month of investigation. From the conducted analyses of the two parameters it can be concluded that ISA Brown line gave better results.

**Table 1. Egg weight (g) and egg shell strength (g/cm$^2$) of two different strains**

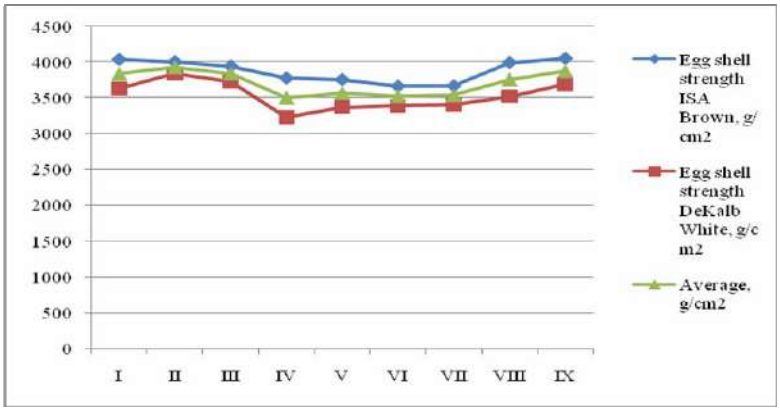
| Month (age in weeks) | Egg weight ISA Brown | Egg weight DeKalb White | Average egg weight for both genotypes | Egg shell strength ISA Brown | Egg shell strength DeKalb White | Average egg shell strength for both genotypes |
|---|---|---|---|---|---|---|
| I (28-32) | 62,26 | 59,61 | 60,93 | 4034,40 | 3627,72 | 3831,06 |
| II (32-36) | 63,50 | 64,45 | 63,98 | 4002,68 | 3844,96 | 3923,82 |
| III (36-40) | 59,68 | 62,38 | 61,03 | 3942,16 | 3728,68 | 3835,42 |
| IV (40-44) | 64,16 | 65,95 | 65,05 | 3776,16 | 3227,28 | 3501,72 |
| V (44-48) | 64,99 | 64,62 | 64,80 | 3755,20 | 3372,04 | 3563,62 |
| VI (48-52) | 63,94 | 64,77 | 64,35 | 3663,12 | 3385,52 | 3524,32 |
| VII (52-56) | 65,16 | 65,28 | 65,22 | 3668,92 | 3403,68 | 3536,30 |
| VIII (56-60) | 63,83 | 64,37 | 64,10 | 3990,52 | 3521,64 | 3756,08 |
| IX (60-64) | 62,42 | 65,57 | 64,00 | 4050,08 | 3692,00 | 3871,04 |
| **Average** | **64,11** | **63,72** | | **3875,92** | **3533,72** | |

Results from Table 1 are presented in Charts (Chart 1 and 2) where differences in egg weight and eggshell quality between two commercial lines for egg production for consumation are so obvious.

In the first chart (chart1) it can be noticed that there is continually increase of egg weight with increase of poultry age for both strain during the investigation period, although for the analyses were chosen eggs with similar size.




**Graph 1. Egg weight of commercial laying hens Isa Brown and DeKalb White in g**




**Graph 2. Egg shell strength of commercial laying hens Isa Brown and DeKalb White in g/cm$^2$**

At the following chart (chart 2) is presented eggshell strength for both lines and their average values, where it is obvious that strength declines in older birds, something that counts for the two lines.

Analyses of variables from genotype and age influence on egg weight and eggshell strength are given in Table 2.

**Table 2. Influence of strain and season on egg weight and egg shell strength**

| | Degr. of | Egg weight | Egg shell strength |
|---|---|---|---|
| Intercept | **1** | **0,000000*** | **0,000000*** |
| Genotype | 1 | 0,063970 | **0,000000*** |
| Age | 8 | **0,000180*** | **0,000210*** |
| Month*Gen.*Age | 8 | 0,395275 | 0,842386 |

Level of signification: * $P \leq 0.05$

The impact of age on egg weight ( $P \leq 0.05$) was significant, but not for genotype (Table 2). These results are in accord with results of *Silversides and Scott (2001), Oloyo (2003), Johnston and Gous (2007), Zita et al. (2008)*, which showed that egg weight, increases with hens' age. In this research interaction among the two varibles was not significant for any of the factors, although there were differences in egg size in favour of ISA Brown strain. In previously mentioned literature more interactions between hens' genotype and age can be found. Hisex Brown and ISA Brown had a significantly ($P \leq 0.001$) higher egg weight (55.0 vs. 54.0 g) than the Moravia BSL (51.1 g) at the beginning of the experiment, but at the end of the experiment Moravia BSL produced the heaviest eggs (65.3 g).

**Table 3. Inflence of genotype and age on egg weight by months (LSD-test)**

| | Month | Genotype | {1} | {2} | {3} | {4} | {5} | {6} | {7} | {8} | {9} | {10} | {11} | {12} | {13} | {14} | {15} | {16} | {17} | {18} |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | I | Isa Brown | | | | | | | | | | | | | | | | | | |
| **2** | I | DeKalb | 0,11 | | | | | | | | | | | | | | | | | |
| **3** | II | Isa Brown | 0,45 | **0,02** | | | | | | | | | | | | | | | | |
| **4** | II | DeKalb | 0,19 | **0,00** | 0,57 | | | | | | | | | | | | | | | |
| **5** | III | Isa Brown | 0,12 | 0,97 | **0,02** | **0,00** | | | | | | | | | | | | | | |
| **6** | III | DeKalb | 0,94 | 0,09 | 0,50 | 0,21 | 0,10 | | | | | | | | | | | | | |
| **7** | IV | Isa Brown | 0,25 | **0,01** | 0,69 | 0,86 | **0,01** | 0,29 | | | | | | | | | | | | |
| **8** | IV | DeKalb | **0,03** | **0,00** | 0,14 | 0,37 | **0,00** | **0,03** | 0,28 | | | | | | | | | | | |
| **9** | V | Isa Brown | 0,25 | **0,01** | 0,69 | 0,86 | **0,01** | 0,29 | 1,00 | 0,28 | | | | | | | | | | |
| **10** | V | DeKalb | **0,03** | **0,00** | 0,14 | 0,37 | **0,00** | **0,03** | 0,28 | 1,00 | 0,28 | | | | | | | | | |
| **11** | VI | Isa Brown | 0,31 | **0,01** | 0,79 | 0,76 | **0,01** | 0,35 | 0,89 | 0,22 | 0,89 | 0,22 | | | | | | | | |
| **12** | VI | DeKalb | 0,13 | **0,00** | 0,45 | 0,85 | **0,00** | 0,15 | 0,71 | 0,48 | 0,71 | 0,48 | 0,62 | | | | | | | |
| **13** | VII | Isa Brown | 0,08 | **0,00** | 0,32 | 0,67 | **0,00** | 0,10 | 0,55 | 0,63 | 0,55 | 0,63 | 0,46 | 0,82 | | | | | | |
| **14** | VII | DeKalb | 0,07 | **0,00** | 0,28 | 0,62 | **0,00** | 0,08 | 0,50 | 0,69 | 0,50 | 0,69 | 0,42 | 0,76 | 0,94 | | | | | |
| **15** | VIII | Isa Brown | 0,34 | **0,01** | 0,84 | 0,71 | **0,01** | 0,38 | 0,85 | 0,20 | 0,85 | 0,20 | 0,95 | 0,57 | 0,42 | 0,38 | | | | |
| **16** | VIII | DeKalb | 0,20 | **0,00** | 0,60 | 0,96 | **0,00** | 0,23 | 0,90 | 0,34 | 0,90 | 0,34 | 0,79 | 0,81 | 0,63 | 0,58 | 0,75 | | | |
| **17** | IX | Isa Brown | 0,92 | 0,09 | 0,51 | 0,22 | 0,10 | 0,98 | 0,30 | **0,03** | 0,30 | **0,03** | 0,36 | 0,16 | 0,10 | 0,09 | 0,40 | 0,24 | | |
| **18** | IX | DeKalb | **0,05** | **0,00** | 0,21 | 0,50 | **0,00** | 0,06 | 0,39 | 0,82 | 0,39 | 0,82 | 0,32 | 0,63 | 0,80 | 0,86 | 0,29 | 0,47 | 0,06 | |

LSD test; variable Egg weight (Spreadsheet1 in Workbook1)
Probabilities for Post Hoc Tests
Error: Between MS = 34,342, df = 432,00
($P \leq 0.05$ is **bold**)

There were important differences ($P \leq 0.05$) in eggshell strength examined under genotype and age influence and the values of the same declined for both lines of hens, though less for ISA Brown. These results are in compliance with results from *Zita et al. (2008)* where ($P \leq 0.001$) eggshell of ISA Brown eggs had greater quality during all periods of research. We came to conclusion that genotype has significant impact on eggshell quality which is not in accordance with *Basmacioglu and Ergul (2005)* results which did not confirm the same conclusion. *Yannakopoulos et al. (1994)* found no significant effect of hen age on eggshell characteristics and on eggshell thickness *(Van den Brand et al., 2004),* which is not in compliance with results from this study.

To determine the existence and level of statistically significant differences between examined factors Fisher LSD-test was used, and the results from it are presented in Tables 3 and 4. There can be noticed the combinations by age and genotypes where these significantly differences on level $P \leq 0.05$ occur.

**Table 4. Inflence of genotype and age on egg shell strength by months (LSD-test)**

| | Month | Genotype | {1} | {2} | {3} | {4} | {5} | {6} | {7} | {8} | {9} | {10} | {11} | {12} | {13} | {14} | {15} | {16} | {17} | {18} |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | I | Isa Brown | | | | | | | | | | | | | | | | | | |
| **2** | I | DeKalb | **0,02** | | | | | | | | | | | | | | | | | |
| **3** | II | Isa Brown | 0,86 | **0,03** | | | | | | | | | | | | | | | | |
| **4** | II | DeKalb | 0,28 | 0,21 | 0,36 | | | | | | | | | | | | | | | |
| **5** | III | Isa Brown | 0,60 | 0,07 | 0,73 | 0,58 | | | | | | | | | | | | | | |
| **6** | III | DeKalb | 0,08 | 0,56 | 0,12 | 0,50 | 0,22 | | | | | | | | | | | | | |
| **7** | IV | Isa Brown | 0,14 | 0,39 | 0,19 | 0,69 | 0,34 | 0,78 | | | | | | | | | | | | |
| **8** | IV | DeKalb | **0,00** | **0,02** | **0,00** | **0,00** | **0,00** | **0,00** | **0,00** | | | | | | | | | | | |
| **9** | V | Isa Brown | 0,11 | 0,46 | 0,16 | 0,61 | 0,28 | 0,88 | 0,90 | **0,00** | | | | | | | | | | |
| **10** | V | DeKalb | **0,00** | 0,14 | **0,00** | **0,01** | **0,00** | **0,04** | **0,02** | 0,41 | **0,03** | | | | | | | | | |
| **11** | VI | Isa Brown | **0,03** | 0,84 | **0,05** | 0,30 | 0,11 | 0,71 | 0,52 | **0,01** | 0,60 | 0,09 | | | | | | | | |
| **12** | VI | DeKalb | **0,00** | 0,16 | **0,00** | **0,01** | **0,00** | **0,05** | **0,03** | 0,36 | **0,03** | 0,94 | 0,11 | | | | | | | |
| **13** | VII | Isa Brown | **0,04** | 0,81 | 0,06 | 0,31 | 0,12 | 0,73 | 0,54 | 0,01 | 0,62 | 0,09 | 0,97 | 0,10 | | | | | | |
| **14** | VII | DeKalb | **0,00** | 0,20 | **0,00** | **0,01** | **0,00** | 0,06 | **0,03** | 0,31 | **0,04** | 0,86 | 0,14 | 0,92 | 0,13 | | | | | |
| **15** | VIII | Isa Brown | 0,80 | **0,04** | 0,94 | 0,40 | 0,78 | 0,13 | 0,22 | **0,00** | 0,18 | **0,00** | 0,06 | **0,00** | 0,07 | **0,00** | | | | |
| **16** | VIII | DeKalb | **0,00** | 0,54 | **0,01** | 0,06 | **0,02** | 0,23 | 0,14 | 0,09 | 0,18 | 0,39 | 0,42 | 0,43 | 0,40 | 0,50 | **0,01** | | | |
| **17** | IX | Isa Brown | 0,93 | **0,02** | 0,79 | 0,24 | 0,54 | 0,07 | 0,12 | **0,00** | 0,09 | **0,00** | **0,03** | **0,00** | **0,03** | **0,00** | 0,73 | **0,00** | | |
| **18** | IX | DeKalb | **0,05** | 0,71 | 0,07 | 0,38 | 0,15 | 0,83 | 0,63 | **0,01** | 0,72 | 0,07 | 0,87 | 0,08 | 0,89 | 0,10 | 0,09 | 0,33 | 0,04 | |

LSD test; variable Egg shell strength (Spreadsheet1 in Workbook1)
Probabilities for Post Hoc Tests
Error: Between MS = 3780E2, df = 432,00
($P \leq 0.05$ is **bold**)

The correlations among age, genotype, eggshell strength and egg weight are presented in Table 4.

**Table 4 Correlation between months, genotypes, eggshell strength and egg weight**

| | Age | Genotype | Egg shell strength | Egg weight |
|---|---|---|---|---|
| **Age** | 1,000 | -0,000 | -0,061 | 0,145 |
| **Genotype** | -0,000 | 1,000 | -0,264 | 0,085 |
| **Egg shell strength** | -0,061 | -0,264 | 1,000 | **-0,175*** |
| **Egg weight** | 0,145 | 0,085 | **-0,175*** | 1,000 |

Correlations (Spreadsheet1 in Workbook1)
Marked correlations are significant at p < 0,05

Significant ($P < 0,05$) negative correlation was found between eggshell strength and egg weight (-0,175), which indicating that with increasing egg weight decreases of eggshell strength. In the table it can be noticed that correlation coefficient of eggshell strength was insignificantly negative (-0,061, -0,264, *NS*) for influence of age and genotype (-0,061, -0,264, *NS*), while correlation coefficient of egg weight with same variables was insignificantly positive (0,145, 0,085, *NS*). Discovered results are in accordance with results received from *Zita et al. (2009)* research which state high significant negative correlation between egg weight and eggshell strength (-0.100).

# Conclusion

According to previously mentioned data, more important conclusions can be brought:

- Average values for egg weight and eggshell strength for the eggs of ISA Brown line were better than values for eggs of DeKalb White line.
- The influence of age on egg weight was significant ( $P \leq 0,05$) but not for genotype.
- Differences in eggshell strength under genotype and age influence were significant ( $P \leq 0.05$) and the same declined for both lines, though lighter for ISA Brown line
- There was significant ($P < 0,05$) negative correlation between eggshell strength and egg weight (-0,175).

# Uticaj linije i uzrasti na neke parametre kvaliteta jaja komercijalnih koka nosilja

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## Rezime

Ogled je izveden radi procenjivanja uticaja faktora linije i uzrasta na neke parametre kvaliteta jaja (težina jaja i tvrdoća ljuske jaja) kod komercijalnih nosilja. Bile su istestirane nosilje linije ISA Brown i DeKalb White u periodu od devet meseci. Obe linije su bile istog uzrasta (28 nedelja), smeštene u zajednički objekat u konvencionalnim baterijskim kavezima. Nosilje su odgajane i hranjene po standardnim tehnološkim normativima. Jednom mesečno skupljana su 25 jaja po liniji radi ispitivanja težine jaja i snage jajčane ljuske ili ukupno testirana su 450 jaja za konzum. Analize su izvršene u laboratoriji za ispitivanje kvaliteta jaja, a koristili su se aparati Egg Multi Tester EMT 5200 i Egg shell Gauge (Robotmation Co. Ltd., Tokyo, Japan) sa kompjuterskim računarom za ocenu kvalitativnih fizičkih osobina jaja. Statistička obrada podataka vršila se pomoću kompjuterskog podprograma ANOVA, dok je testiranje signifikantnosti rezultata izvedeno Fisherovim LSD testom. Osim toga, utvrđene su i korelacije između ispitivanih faktora.

Masa jaja je bila pod značajnim uticajem ($P \leq 0,05$) uzrasta, ali ne i pod uticajem linije (genotipa), iako su jaja linije ISA Brown bila nešto teža od onih linije DeKalb White. Jaja su imala najveću masu kod starije živine, dok su najmanju imala kod mlađih nosilja.

Rezultati su pokazali značajne razlike ($P \leq 0,05$) u snazi ljuske, u odnosu na uticaj linije i meseca (uzrasta) testiranja. Jaja nosilja ISA Brown bila su značajno tvrđa u odnosu na jaja DeKalb White nosilja. Što se tiče uzrasta, on je uticao statistički značajno kod obe linije, s tim što je jačina ljuske bila vidljivo smanjena kod starijih ptica u odnosu na ostale. Korelacije između mase jaja i jačine ljuske jaja imale su značajno negativnu vrednost ($P < 0,05$), što je potvrdilo tezu da se sa povećanjem mase jaja smanjuje jačina ljuske.

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