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INFLUENCE OF GENOTYPE ON EGGSHELL STRENGTH AND THE HATCHABILITY OF LAYING PARENT STOCK FLOCK

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Abstract: This research was conducted with aim to establish genotype influence on eggshell strength of fertilized eggs and its hatchability at parents stock flock of laying type. Eggs from parent's flock of lines ISA Brown and DeKalb White at age of 36-60 weeks were examined. Experiment lasted 6 months, and once a month were examined samples of 30 fertilized eggs. Results have shown significant differences ($P \leq 0.05$) in eggshell strength related to genotype influence. Eggs with brown eggshell from line ISA Brown ($P \leq 0.05$) had significantly more strength eggshell compared to eggs with white eggshells from line DeKalb White. Results from the analyses of breeding eggs hatchability, examined in the mentioned period have shown that this variable was mainly influenced by age, then by genotype. Eggs of older birds were lower hatchability compared to fertilized eggs produced of younger parent stock flock during the examination period.

Key words: genotype, eggshell strength, hatchability, parent stock flock.

Introduction

The aim of each breeder of parent stock flock is to produce more fertilized eggs with good quality, which shall grow in healthy chicks. The egg is biological system that should provide comfort surrounding to embryo while it grows into the chicks *(Narushin and Romanov, 2002)*. Each breeder is trying to provide favorable conditions and system of breeding where parents' reproductive characteristics shall enable production of standardized chicken with less costs, but with good base for their successful breeding and favorable production performances. In order to achieve this, eggshell quality has an important role, which means that it should be firm and compact, to protect the embryo from mechanical injuries and regulate gas exchange between embryo and outer environment, to protect it from bacteria and

other pathogenically organisms, to be a good source of calcium for embryo development *(Hunton, 2005)*. Eggs with thinner eggshell had 3-9 % lower hatchability than the eggs with thicker eggshell *(Bennet, 1992)*. There are many factors that have an impact on eggshell strength and its hatchability especially genotype, parents' health condition and age, season, nutrition, egg size and manipulation with it, way of breeding and conditions in incubators *(Wilson, 1997; Bucher and Miles, 2003; Coutts et al., 2006)*. Main differences in eggshell's quality depend of genotype (parents' line) and way of their breeding *(Buss and Guyer 1982).* Eggshell colour is related to eggshell quality *(Ingram et al., 2008)*. Main differences in eggshell quality are related to white and coloured hens. Brown eggs have thicker eggshell compared to white eggs *(Ledvinka et al. 2000).* It was determined that age and season as important factors, have negative influence at older birds in summer period by decrease strength of eggshell *(Nikolova and Kocevski, 2004, 2006; Nikolova et al., 2008)*. Poor eggshell quality will cause poor hatchability of fertilized eggs.

In this paper are presented the results from examination of genotype influence on eggshell strength of breeding eggs and its hatchability collected from two different parents' laying lines.

Materials and Methods

The research was in a farm for parents flock in Republic of Macedonia, country where half of the year the temperatures are very high, in specific areas permanently above 30°C degrees. Two types of parent's flocks were examined: ISA Brown and DeKalb White at age of 36-60 weeks reared and fed according to estimated breeding technology. Experiment lasted for six months and during this period of time 30 breeding eggs from each parent line were analyzed once a month in order to determine eggshell strength. The analyses were done in Laboratory for testing egg quality by gadgets Egg Multi Tester EMT 5200 and Eggshell Gauge (Robotmation Co. Ltd., Tokyo, Japan) which have computerized equipment to examine quality and physical characteristics of eggshell, yolk and egg white. In the same period, the hatchability of incubated eggs was monitored, taken from both examined parents lines.

At the end of experiment statistic analyses on found results was done by computer programmed Statistic 6 and sub-programme ANOVA to examine variable analyses and Fisher LSD test to determine the level of statistical significant difference between examined factors.

Results and Discussion

Results of eggshell strength measures which originate from two genotypes of parents lines (ISA Brown и DeKalb White) by months are presented in Table 1.

It can be seen that eggshell strength of ISA Brown eggs was thinner in I^{th}

month (3609,07), and thicker in Vth month (4105,73), while strength of DeKalb White eggshells was with lowest value for examined parameter in VIth month (3164,87), and with highest parameter value in IVth month of experiment (3753,80). Average values for eggshell strength of parent ISA Brown (3893,50) were higher than the average values for parameters of parent DeKalb White (3467,13).

Table 1. Egg shell strength of two parent stock genotypes

Egg shell strength (g/cm^2)			
Months of experiment	Age in weeks	ISA Brown	DeKalb White
I	36-40	3609.07	3419.80
II	40-44	3823.47	3309.93
III	44-48	3995.40	3708.50
IV	48-52	3870.21	3753.80
V	52-56	4105.73	3445.87
VI	56-60	3957.13	3164.87
	Average	3893.50	3467.13

The results are presented also in Graph 1 where differences in values for eggshell strength of breeding eggs from two genotypes by months can easily be seen.

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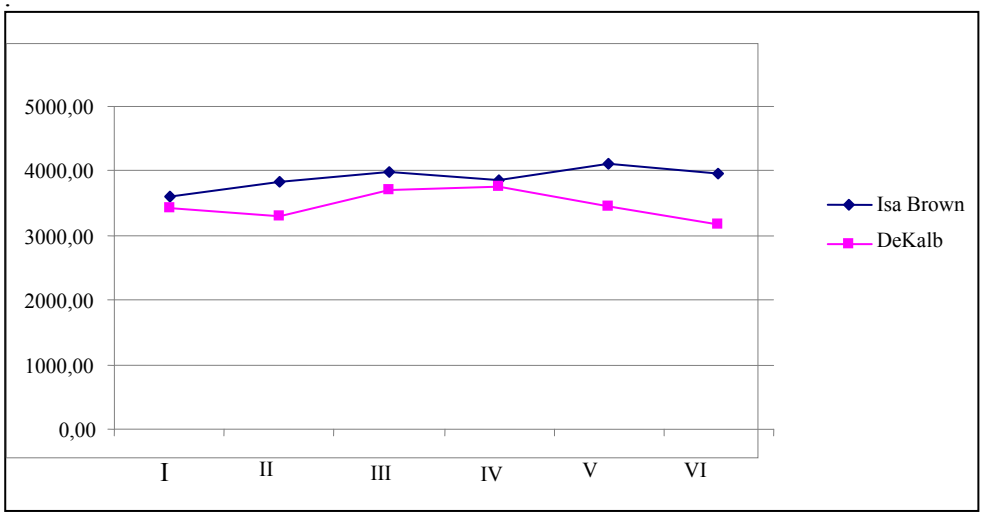


Graph 1. Egg shell strength of parent stock genotypes ISA Brown and DeKalb White in g/cm^2

The results show a condition in which the age had not significantly influence by the expected decline in the strength of the shell. Parent flock stock of

genotype ISA Brown had shown better results of eggshell strength then genotype DeKalb White in average values. Analysis of variance of the impact of the factors genotype on the variable strength of egg shell is given in Table 2.

Table 2. Influence of genotype on egg shell strength

	SS	Degr. of	MS	F	p
Intercept	2.284360E+09	1	2.284360E+09	4827.641	0.000000*
Age	3.149930E+06	5	6.299860E+05	1.331	0.253558
Genotype	7.686305E+06	1	7.686305E+06	16.244	0.000086*
Age*Genotype	2.485632E+06	5	4.971264E+05	1.051	0.390004
Error	7.570937E+07	160	4.731836E+05		

Level of signification: * $P \leq 0.05$

Generally it can be seen that genotype has statistically significant influence ($P \leq 0.05$) on eggshell strength, while age did not show any significant impact. Our results are in accordance with the certain that main differences in eggshell quality (colour, weight, strength and thickness) depend on hybrid or pure lines *(Buss and Guyer 1982).* Interaction examination between age and genotype did not give significant statistically results.

Differences between these two genotypes lead to discussions on subject how eggshell colour influences on its strength because these two are different lines, one for white eggs (DeKalb White) and the other for coloured eggs (ISA Brown). The eggs of line Isa Brown showed greater eggshell strength and it can be concluded that maybe coloured eggs have higher strength than white eggs. There are many evidences for this in literature like results of *Ledvinka et al. (2000)* according to which brown coloured eggs have thicker eggshell than white eggs, while on contrary to them *Halaj and Grofík (1994)* find out that coloured eggs have thinner eggshell. *Rayan et al. (2010)* determined the fact that eggshell strength of brown coloured eggs was higher than white coloured eggs strength, but with not statistically significant differences. On the other hand, eggshell strength depended of parents' flock age, which means that strength declines as hens grow older. In our experiment also eggshell strength declined as parents' flock was older which can be seen in the chart, especially for DeKalb White parents flock which was taken earlier to slaughtery for this reason.

For determining the existence and level of statistically significant differences between examined factors Fisher LSD-test was used and test results are presented in Table 3. There it can be seen in which combinations of months and genotypes there are some statistic differences on level $P \leq 0.05$ in eggshell strength.

Table 3. Influence of genotype and age on egg shell strength by months (LSD-test)

	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}	{9}	{10}	{11}	{12}
I month Isa Brown {1}		0.45	0.39	0.24	0.13	0.70	0.31	0.57	0.05*	0.52	0.23	0.08
I month DeKalb W {2}			0.11	0.66	0.02*	0.26	0.08	0.19	0.01*	0.92	0.06	0.31
II month Isa Brown {3}				0.04*	0.49	0.65	0.86	0.78	0.26	0.13	0.64	0.01*
II month DeKalb W {4}					0.01*	0.12	0.03*	0.08	0.00*	0.59	0.03*	0.56
III month Isa Brown {5}						0.26	0.63	0.34	0.66	0.03*	0.91	0.00*
III month DeKalb W {6}							0.53	0.86	0.12	0.31	0.39	0.03*
IV month Isa Brown {7}								0.65	0.36	0.10	0.76	0.01*
IV month DeKalb W {8}									0.16	0.22	0.48	0.02*
V month Isa Brown {9}										0.01*	0.62	0.00*
V month DeKalb W {10}											0.08	0.26
VI month Isa Brown {11}												0.01*
VI month DeKalb W {12}												

Level of signification: ***** $P \leq 0.05$

The hatchability of incubated eggs from the two genotypes in period since I to VI month is shown in Table 4. Total number of enumerated incubated eggs and total number of one-day chicken are presented, also are given monthly and general hatchability presented in percentages for both lines of parents' flocks of laying type.

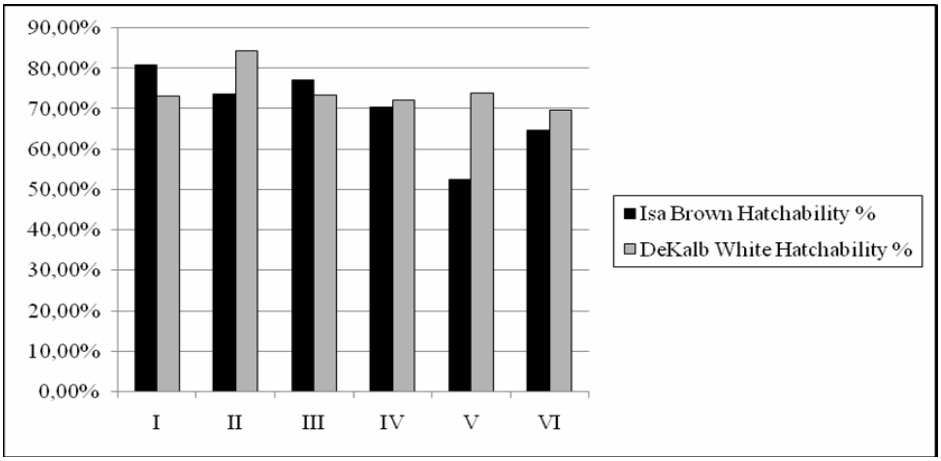
Table 4. Hatchability of fertile eggs of two parent stock genotypes by months

Months	Isa Brown			DeKalb White		
	Incubated eggs No.	Chicks hatched	Hatchability %	Incubated eggs No.	Chicks hatched	Hatchability %
I	291.690	117.878	80.82%	47.628	17.376	72.97%
II	215.964	79.499	73.62%	38.808	16.372	84.37%
III	13.608	5.250	77.16%	82.908	30.432	73.41%
IV	237.258	83.588	70.46%	81.018	29.160	71.98%
V	166.572	43.757	52.54%	107.604	39.685	73.76%
VI	130.032	41.975	64.56%	60.480	21.045	69.59%
Total	1.055.124	371.947	70.50%	418.446	154.070	73.64%

The table shows that lowest hatchability of eggshell for ISA Brown parents flock was in V^{th} (52,54%), and the highest in I^{th} (80,82%) month with average values of 70,50%. For DeKalb White line the lowest hatchability of eggshell was in VI^{h} (69,59%), and the highest in II^{th} (84,37%) month with average hatchability value of 73,64%. It can be concluded generally that the lower hatchability of chickens was in older age, while the higher was at younger birds. According to genotypes, eggs of DeKalb White line were easier for hatchability, 3,14% more in

absolute value. In this case the shell strength of incubated eggs was not in correlation with their hatchability, which needs further investigation.

In the Graph 2 are presented chart values for eggshell hatchability in relation to their genotype and months, and it are obvious the age influence and the differences between lines.



Graph 2. Hatchability of eggs from different parent stock genotypes by different age

Egg characteristics affect a lot on process of incubation and are main factor for its successfulness *(Narushin and Romanov, 2002).* Eggshell plays big part in embryo development, because it isolates the embryo from outer influences and at the same time allows gas exchange through eggshell. *Barnett et al. (2004*) found out that eggs with damaged eggshell are more exposed to bacteria and the chickens have lower weight and higher mortality, which results in lower egg hatchability (56.4% vs. 80.9%) compared to undamaged eggshell. *Bennet (1992)* compared to breeding eggs with thin and thick eggshells and came to conclusion decline of hatchability of 3 to 9% for eggs with damaged eggshell, eggs with lower humidity and contaminated with bacteria. These authors proved that eggs with thicker eggshell can be better hatchability.

Conclusion

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

- Statistically significant ($P \leq 0.05$) was genotype influence on eggshell strength, more precisely, parents from line ISA Brown produced eggs with more strength eggshell compared to parents from line DeKalb White

- Above mentioned evidence leads to conclusion that eggs with coloured eggshell (ISA Brown) had significantly ($P \leq 0.05$) more strength eggshell than the white eggs (DeKalb White).
- Age, presented by months starting from I^{th} (36-40 weeks) did not show significant influence on breeding eggshell strength although can be noticed eggshell lower quality in IV^{th} (48-52), V^{th} (52-56) and VI^{th} (56-60) months.
- Eggs hatchability was the highest in younger and the lowest in older birds. According to genotypes, eggs of DeKalb White line were easier for hatchability, 3,14% more in absolute value compared to line ISA Brown. In this case the shell strength of incubated eggs was not in correlation with their hatchability, which needs further investigation.

Uticaj genotipa na čvrstinu ljuske i lupljivosti jaja roditeljskog jata lakog tipa

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Rezime

Ovo istraživanje sprovedeno je sa ciljem utvrđivanja uticaja genotipa na čvrstinu ljuske priplodnih jaja i njihovu lupljivost kod roditeljskih parova lakog tipa. Bila su ispitivana jaja roditeljskih jata linije ISA Brown i DeKalb White na uzrastu od 36 sve do 60 nedelje. Opit je trajao šest meseci, a jedanput mesečno za ispitivanje uzimani su uzorci od po 30 oplođenih jaja.

Rezultati su pokazali značajne razlike ($P \leq 0.05$) u čvrstini ljuske u odnosu na uticaj genotipa. Jaja braon boje ljuske linije ISA Brown imali su značajno ($P \leq 0.05$) čvršću ljusku u odnosu jaja sa belom bojom ljuske linije DeKalb White. Rezultati analize lupljivosti priplodnih jaja dobijeni u ispitivanom periodu pokazali su da je ova varijabla više pod uticajem uzrasta nego genotipa. Jaja dobijena od starijih ptica imala su slabiju ljusku u odnosu na priplodna jaja proizvedena od mlađeg roditeljskog jata u toku testiranog perioda.

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