

The Effect of Eggshell Quality on Hatchability of Pure Chicken Breeds

Cyril Hrnčár*¹, Dominik Gič¹, Jozef Bujko²

¹Slovak University of Agriculture, Nitra, Faculty of Agrobiological and Food Resources, Department of Poultry Science and Small Animal Husbandry, Slovakia

²Slovak University of Agriculture, Nitra, Faculty of Agrobiological and Food Resources, Department of Genetics and Breeding Biology, Slovakia

Abstract

Hatchability is affected by a variety of factors. Eggshell quality plays very important role among these factors. In this work we analysed eggshell quality, hatchability and embryonic mortality of pure chicken breeds New Hampshire, Oravka, Plymouth Rock, Rhode Island Red and Sussex Light. Hatchability was significantly lower ($P>0.05$) in Sussex Light in comparison with New Hampshire. The eggshell quality for Sussex Light was significantly decreased ($P>0.05$) in eggshell thickness (398.73 vs. 356.07 μm) and eggshell percentage compared with New Hampshire (10.36 vs. 8.79 %).

Keywords: chicken breed, eggshell percentage, eggshell strength, eggshell thickness, hatchability

1. Introduction

Eggshell quality is one of the most important issues in the poultry industry, influencing the economic profitability of egg production and hatchability [1].

The eggshell is an important structure for two reasons. Firstly it forms an embryonic chamber for the developing chick, providing mechanical protection and a controlled gas exchange medium. Secondly it is a container for the marked egg, providing protection of the contents and a unique package for a valuable food [2].

The hen eggshell consists of 94% of CaCO_3 , 1% of MgCO_3 , 1% of $\text{Ca}_3(\text{PO}_4)_2$ and 4% organic substances mostly of albuminous character [3].

Egg shell quality and egg internal quality are of major importance to the egg industry worldwide. Egg shell quality may be affected by the strain and age of hen; induced moult; nutritional factors such as calcium, phosphorus, vitamins, water quality, non-starch polysaccharides, enzymes,

contamination of feed; general stress and heat stress; disease, production system, or addition of proprietary products to the diets [4].

The aim of this the work was evaluated effect eggshell quality of hatchability of pure chicken breeds New Hampshire, Oravka, Plymouth Rock, Rhode Island Red and Sussex Light.

2. Materials and methods

The observation of eggshell quality on hatchability of pure chicken breeds was realized in special poultry house for controlled breeds of poultry at University Experimental Farm in Kolíňany.

Birds were placed in breeding pen with deep litter. Feeding and watering were *ad libitum*. Feeding of poultry was providing by commercial feed mixture HYD-10. Nutritional value of diet is shown in Table 1. Fresh clean water was supplied daily. Birds were exposed to natural light as a practiced in rural areas of South-West Slovakia.

*Corresponding author: Cyril Hrnčár, Tel: + 421 37 641 4744, Email: Cyril.Hrncar@uniag.sk

Totally 500 hatching eggs (100 eggs from each breed) at the beginning, middle and end of laying period in were incubated in an incubator F500S (PL Maschine Kft, Hungary) with capacity of 500

chicken eggs with automatic regulation with temperature and relative humidity. Eggs were automatically turned in interval of two hours.

Table 1. Nutritional value of complete feed mixture

Nutrient	Unit	HYD-10
Crude protein	g/kg	158.06
ME	MJ/kg	11.32
Lysine	g/kg	8.07
Methionine and cistine	g/kg	7.02
– from that methionine	g/kg	3.87
Calcium	g/kg	35.13
Phosphorus	g/kg	5.48
Sodium	g/kg	2.17
Manganese	mg/kg	148.79
Selenium	mg/kg	0.38
Copper	mg/kg	18.74
Zinc	mg/kg	102.27
Vitamin A	i.u./kg	10000
Vitamin D ₃	i.u./kg	2500
Vitamin K	mg/kg	21.27

Hatching eggs were fumigated with formalin gas. Formalin gas was generated by mixing 40ml formaldehyde of 40 % concentration and 20g potassium permanganate on 1m³ room capacity.

We compared percentage fertility, percentage hatchability of fertile and total eggs set. Fertility was determined as 100[number of fertile eggs]/number of total eggs set; hatchability from fertile eggs was determined from the formula 100[number of chicks hatched]/number of fertile eggs and hatchability from totally eggs set calculated as the number of chicks hatched/number of total eggs set.

Hatching eggs were individually weighed to the nearest 0.01 gram on a laboratory scale Owa labor (VEB Wägetechnik Rapido, Germany). The quality of eggshell was observed strength (N/cm²), thickness (µm) and percentage of eggshell (%). Eggshell thickness was measured with a shell thickness micrometer. The eggshell strength was determined manually using an Egg Crusher device (VEIT Electronics, Czech Republic).

They were also monitored by the relative conductance by [5] and eggshell conductance was also calculated theoretically by [6] $C=0,432W^{0.780}$, where W is egg weight.

The differences among group means were verified statistically by analysis of variance using Duncan's test.

3. Results and discussion

As shown in Figure 1, fertility of eggs was no significantly affected ($P>0.05$) by breed (from 89.45 to 91.26%). The hatchability from fertile eggs was lower in Sussex Light (80.83%) and higher in New Hampshire (91.87%). In this case, we observed statistically significant difference ($P<0.05$) between New Hampshire and Sussex Light.

The parameters of eggshell quality of chicken breeds are presented Figure 2 to 6. The lowest eggshell quality parameters were found out in breed Sussex Light.

The parameters of eggshell quality of chicken breeds are presented Figure 2 to 6. The lowest eggshell quality parameters were found out in breed Sussex Light.

The eggshell quality was significantly decreased ($P<0.05$) in Sussex Light in comparison with New Hampshire (10.36 vs. 8.79 %) in eggshell percentage and eggshell thickness (398.73 vs. 356.07 µm). Also [7, 8] recorded decreased

hatchability of eggs with lower eggshell thickness than eggs with higher thickness. The eggshell conductance is suitable indicator of hatchability [9]. However, in our experiment, we recorded statistically significant differences

between pure chicken breeds either in relative (from 11.56 to 12.26 mg H₂O/day/Torr/100g) or theoretical conductance (from 10.12 to 10.65 H₂O/day/Torr). In case of Oravka, theoretical conductance was affected by lowest egg weight from observed chicken breeds.

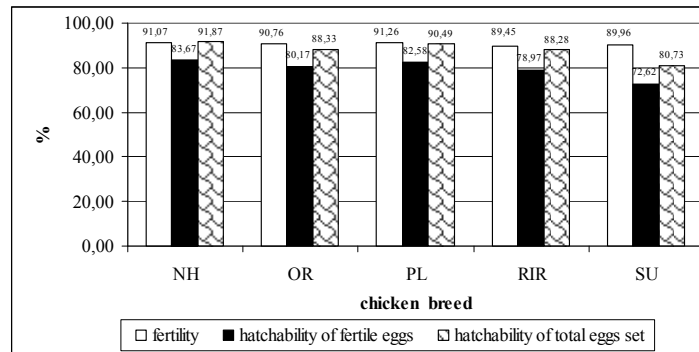


Figure 1. Comparison of hatching parameters (%) of chicken breeds NH-New Hampshire, OR-Oravka, PL-Plymouth Rock, RIR-Rhode Island Red, SU-Sussex Light

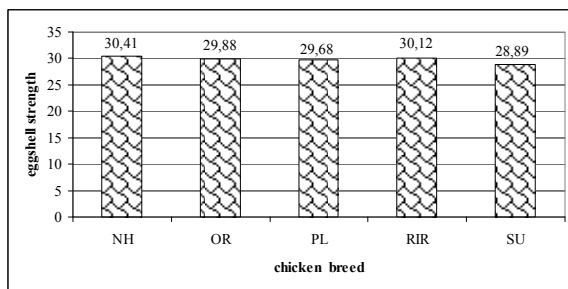


Figure 2. Comparison of egg shell strength (N/cm²) of chicken breeds NH-New Hampshire, OR-Oravka, PL-Plymouth Rock, RIR-Rhode Island Red, SU-Sussex Light

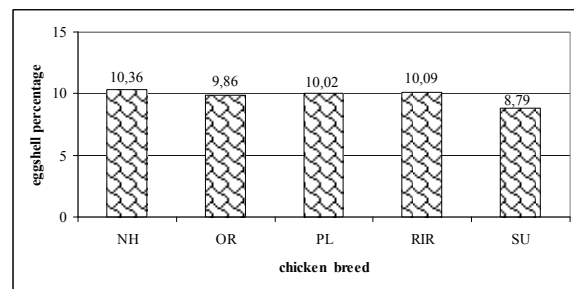


Figure 4. Comparison of percentage of eggshell (%) of chicken breeds NH-New Hampshire, OR-Oravka, PL-Plymouth Rock, RIR-Rhode Island Red, SU-Sussex Light

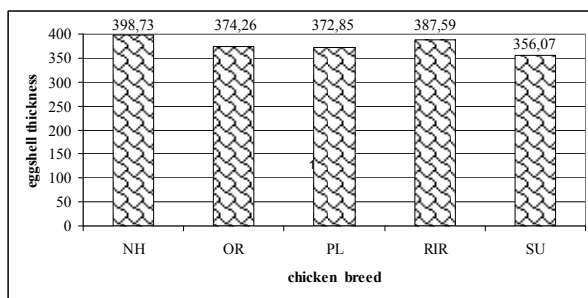


Figure 3. Comparison of eggshell thickness (µm) of chicken breeds NH-New Hampshire, OR-Oravka, PL-Plymouth Rock, RIR-Rhode Island Red, SU-Sussex Light

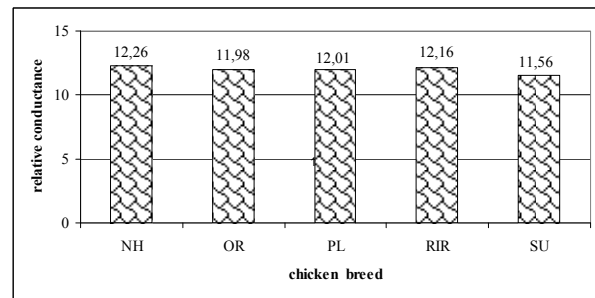


Figure 5. Comparison of relative conductance (mg H₂O/day/Torr/100g) of chicken breeds NH-New Hampshire, OR-Oravka, PL-Plymouth Rock, RIR-Rhode Island Red, SU-Sussex Light

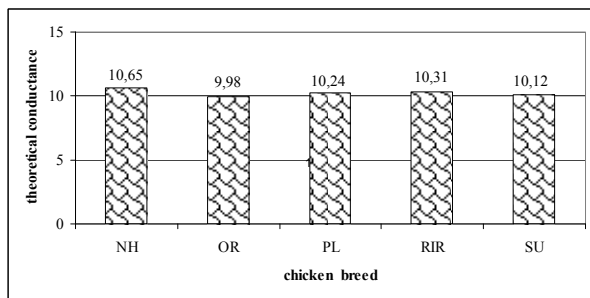


Figure 6. Comparison of theoretical conductance (mg H₂O/day/Torr)

NH-New Hampshire, OR-Oravka, PL-Plymouth Rock, RIR-Rhode Island Red, SU-Sussex Light

4. Conclusions

The results indicate that eggshell quality plays very important role among factors which affected hatchability of chickens. Lower values of eggshell thickness and eggshell percentage at Sussex Light significantly decrease the number of hatching chicks.

Acknowledgements

This work was financially supported by the Scientific Grant Agency of Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Science under the contract VEGA 1/1101/11.

References

1. Świątkiewicz, S., Koreleski, J., Arczewska, A., Laying performance and eggshell quality in laying hens fed diets supplemented with prebiotics and organic acids, *Czech Journal of Animal Science*, 2010, 55, 294-306
2. Hunton, P., Research on eggshell structure and quality: an historical overview, *Brazilian Journal of Poultry Science*, 2005, 7, 67-71
3. Nys Y., Gautron J., Structure and Formation of the Egg shell. *Bioactive Egg Compounds*. Huopalahti, R., López-Fandino, R., Rüdiger, M. A., Schade. Springer – Verlag Berlin Heidelberg, pp. 99-102
4. Ahmadi, F., Rahimi, F., Factors affecting quality and quantity of egg production in laying hens: a review, *World Applied Sciences Journal*, 2011, 12, 372-384
5. Peebles, E. D., McDaniel, G. R., A practical manual for understanding the shell structure of broiler hatching eggs and measurements of their quality, *Bulletin 1139*, Office of Agricultural Communications
6. Ar, A., Paganelli, C. V., Reeves, D. G., Greene, D. G., Rahn, H., The avian egg: water vapor conductance, shell thickness and functional pore area, *Condor*, 1974, 76, 153-158
7. Roque, L., Soares, M. C., Effect of eggshell quality and broiler breeder age on hatchability, *Poultry Science*, 1994, 73, 1838-1845
8. Zatloukal, M., Lichovnikova, M. The effect of eggshell quality on hatchability. *Proc. Poultry – TechAgro*, Brno, Mendel University, 2008, pp. 150-153
9. Peebles, E.D., Brake, J., Eggshell quality and hatchability in broiler breeder eggs, *Poultry Science*, 1987, 66, 596-604