Brazilian Journal of Poultry Science
Revista Brasileira de Ciência Avícola

ISSN 1516-635X 2023 / v.25 / n.1 / 001-004

http://dx.doi.org/10.1590/1806-9061-2022-1639

Original Article

Effect of the Line and Age of Female Broiler Breeder on Hatchability Performance of Eggs

Author(s)

Rebolledo OFP[I] https://orcid.org/0000-0001-8802-0177
López MFA[II] https://orcid.org/0000-0003-0836-8988
Rivera JAH[I] https://orcid.org/0000-0003-1805-5264
Canul AC[III] https://orcid.org/0000-0003-4412-4972
Isaias GT[IV] https://orcid.org/0000-0002-2416-2747
Casillas ACG[I] https://orcid.org/0000-0002-7716-210X

[I] Faculty of Veterinary Medicine and Zootechnics, University of Colima.
[II] Student. Faculty of Veterinary Medicine and Zootechnics, University of Colima.
[III] Academic Division of Agricultural Science, Juárez Autonomous University of Tabasco.
[IV] Poultry Science Department, University of Arkansas.

Mail Address

Corresponding author e-mail address
Arturo César García Casillas
Doctor of Philosophy (PhD) in Agricultural Sciences - Universidad de Colima Ringgold standard institution - Faculty of Veterinary Medicine and Zootechnics, Tecomán, Avenida Universidad 333, Las Víboras, Colima, Colima, 28040, Mexico.
Phone: 313 3229407
Email: cesargarciacasillas@hotmail.com

Keywords

Broiler breeder line, Broiler breeder age, Hatchability, Embryonic mortality.

CC BY

Submitted: 20/February/2022
Approved: 07/December/2022

ABSTRACT

An experiment was conducted to assess how hatchability performance of eggs is affected by line and age of female broiler breeders. Response variables analyzed were hatchability, infertility, pipping (i.e., pipped shell but not emerged), embryonic mortality (1st, 2nd, and 3rd wk), and embryonic malposition. The trials involved a total of 2,880 fertile eggs from two broiler breeder lines (Ross 308 and Cobb 500) at two different ages (30 and 50 wk). A 2 x 2 factorial design was used, where the broiler breeder line and broiler breeder age were the main effects. The hatchability in the Ross 308 line was higher than the Cobb 500 line, but its infertility was higher than the Ross 308 line. Hatchability in interaction (50 wk age of the hen in the Cobb 500 line) was less, and their infertility was higher. Embryonic mortality, pipping, and embryonic malposition did not present differences for the interaction between factors. The results suggest that hatchability performance of eggs can be improved, if egg management and incubation procedures are adjusted to account for the interaction between broiler breeder line and broiler breeder age.

INTRODUCTION

The poultry industry wants fast-growing and uniform broilers (Bryant *et al.*, 2021). However, the chick quality and hatchability are affected by some factors, such as broiler breeder age (Damaziak *et al.*, 2021b), egg size (Luquetti *et al.*, 2004), length of time eggs are stored (Tesarova *et al.*, 2021), temperature (El-Shater *et al.*, 2021), humidity (Abioja *et al.*, 2021), controlled atmosphere (Damaziak *et al.*, 2021a), and the orientation and position of the eggs (Ozlu *et al.*, 2021b). There is a complex relationship between these factors. In the case of the reproductive female, her age is associated with a decrease in albumen height and viscosity, hatching time, and subsequent embryogenesis (Tona *et al.*, 2002; Bouba *et al.*, 2021; Ozlu *et al.*, 2021b). The most obvious characteristic of eggs from young breeder females is low egg weight (Ozlu *et al.*, 2021a). Because chick body weight is proportional to egg weight, small chicks are to be expected (Tesarova *et al.*, 2021). Young breeder flocks are often reported to produce eggs with low hatching potential, extended incubation periods, and chicks of low quality (Tesarova *et al.*, 2021), as judged by subsequent mortality and growth (Nangsuay *et al.*, 2013). In addition, broiler breeder age affects internal egg and eggshell quality characteristics (Nasri *et al.*, 2020). Young breeders lay eggs with thicker eggshells than those of older breeders; therefore, less oxygen is supplied to the embryos (Okur *et al.*, 2022), which may explain their slower development, and the lack of hatching of the eggs (Damaziak *et al.*, 2021b). Failure of eggs to hatch is determined by two factors: infertility and embryonic mortality prior to, and during, incubation (Grochowska *et al.*, 2019). Failure of an egg to hatch reduces reproductive efficiency and, therefore, is of economic interest to the poultry industry (Bryant *et al.*, 2021). Thus, the objective of this study was to examine the effect of the line and age of female broiler breeders on hatchability, infertility, pipping (i.e., pipped shell but not emerged), embryonic mortality (1st, 2nd, and 3rd wk), and embryonic malposition.

MATERIALS AND METHODS

Ethics Statement

All handling was performed in compliance with standard veterinary practice, and in accordance with Bioethics and Animal Welfare Commission of the Faculty of Veterinary Medicine and Zootechnics of the University of Colima. Evaluation act: No. 2, October 10, 2021.

Eggs And Incubation Conditions

An experiment was carried out over a period of 21d, using 2,880 fertile eggs from two commercial broiler breeder lines (Ross 308 and Cobb 500) in the tropical zone of two age groups (30 and 50 wks of age). As the two broiler breeder lines were obtained from different broiler breeder flocks, the effects of age that were analyzed reflect the joint effect of flock age and housing conditions. Nevertheless, the temperature (14ºC to 18ºC for the younger and older lines) and feeding (2,850 kcal ME/kg, 16.60% CP, 3.12% calcium ion, and 0.37% phosphorus ion) were identical in the two poultry farms.

The incubation was performed in a commercial hatchery. The eggs were pre-warmed in the incubator for 10h at around 30ºC and 65% relative humidity, just before the incubation period, which took place in one electronically controlled, single-stage incubator (HatchTech; Gildetrom 25.3905 TB., Veenendaal, Netherlands), with a capacity of 4,800 eggs in trays holding 150 eggs. All eggs were fumigated in the incubator on the day of setting. Incubation conditions were 37.7ºC dry bulb temperature and 29.3ºC wet bulb temperature, until eggs were turned at an angle of 45º at a frequency of 24 times/d. The incubator has temperature sensors (±0.1ºF), humidity sensors [±0.1% relative humidity (RH)], and CO_2 sensors (±100ppm). The air circulation was horizontal and laminar, through perforated radiators, to provide pressure differences, better air distribution, and a uniform flow through each egg, from top to bottom and from front to back.

Before hatching, the eggs were individually marked with indelible ink and weighed to the nearest 0.1g. The eggs with apparently living embryos (18d of incubation) were transferred to hatching baskets. All chicks were removed at 514h post incubation, individually weighed to the nearest 0.1g, and humidity losses were quantified. The eggs that failed to hatch were broken out and examined macroscopically to determine the infertile eggs and dead embryos. From the data, hatchability, infertility, pipping, embryonic mortality, and embryonic malposition were calculated.

Statistical Analyses

We processed the data using software SPSS (IBM SPSS Statistics, v. 22.O, Armonk, NY. IBM Corp). The experimental design was completely randomized. Broiler breeder line and broiler breeder age were the main effects in the 2 x 2 factorial design with four replicates (n = 1,440 egg/factor). The comparison between groups (broiler breeder line and broiler breeder age) was assessed by Analysis of Variance. A multiple comparison test of Tukey was performed when the effect of group was found to be significant ($p<0.05$). Angular transformations (arc sine of the square root of the proportion affected) were performed on all percentage data prior to the analysis.

RESULTS

The effect of the line and age of female broiler breeder on hatchability performance of eggs are shown in Table 1. The hatchability in the Ross 308 line was higher than the Cobb 500 line, but its infertility was higher than the Ross 308 line. Hatchability in interaction (50 wk age of the hen in the Cobb 500 line) was less, and its infertility was higher. Embryonic mortality, pipping, and embryonic malposition did not present differences in the interaction between factors.

DISCUSSION

Eggs from youngest hens have been shown to have low hatchability and tend to be more susceptible to dehydration than eggs from older breeders (Bruzual *et al.*, 2000; Archer *et al.*, 2009; Damaziak *et al.*, 2021b). It is not clear to what extent the changes in the hatchability of fertile eggs in relation to flock age are caused by associated changes in egg weight or breeder line (Vieira *et al.*, 2005). Therefore, it is important to know the extent to which changes in hatchability are due to age of the hen (Bouba *et al.*, 2021), the breeder line (Ozlu *et al.*, 2021a), or a combination of the two factors (Table 1).

Table 1 – Effects of the line and age of breeder on hatchability performance of eggs, n = 1440 egg/factor

Factor	Hatchability	Embryonic mortality			Infertility	Pipping[3]	Embryonic malposition
		1st wk	2nd wk	3rd wk			
Breeder age							
30 wk	85.34± 3.05^{a}	5.24 ± 2.51^{a}	1.36 ± 1.21^{a}	1.80 ± 1.43^{a}	4.74 ± 2.24^{a}	0.90 ± 0.51^{a}	0.53 ± 0.71^{a}
50 wk	82.19 ± 4.40^{a}	4.93 ± 1.33^{a}	1.60 ± 1.14^{a}	1.61 ± 0.82^{a}	6.39 ± 3.33^{a}	1.25 ± 0.75^{a}	0.36 ± 0.65^{a}
p[1]	0.05	0.75	0.67	0.72	0.07	0.23	0.60
EEM[2]	0.75	0.59	0.03	0.30	0.58	0.20	0.08
Breeder line							
Ross 308	85.93± 2.26^{a}	5.37± 1.79^{a}	1.16 ± 0.64^{a}	1.82 ± 0.62^{a}	3.75 ± 1.74^{b}	1.24 ± 0.62^{a}	0.23 ± 0.25^{a}
Cobb 500	81.59 ± 4.28^{b}	4.80± 2.20^{a}	1.81 ± 1.43^{a}	1.59 ± 1.47^{a}	7.39 ± 2.66^{a}	0.91± 0.67^{a}	0.65 ± 0.86^{a}
p[1]	0.01	0.56	0.25	0.64	0.01	0.27	0.20
EEM[2]	1.35	0.20	0.39	0.42	0.84	0.21	0.27
Interaction							
30 wk * Ross 308	87.16±2.14^{a}	4.93 ± 1.05^{a}	0.97 ± 0.75^{a}	1.47 ± 0.46^{a}	3.99 ± 1.78^{b}	0.85 ± 0.51^{a}	0.29 ± 0.20^{a}
50 wk * Ross 308	84.69±0.83^{a,b}	5.80 ± 2.27^{a}	1.35 ± 0.579^{a}	2.18 ± 0.57^{a}	3.50 ± 1.88^{b}	1.63 ± 0.49^{a}	0.76 ± 0.29^{a}
30 wk * Cobb 500	83.51±2.78^{a,b}	4.93 ± 1.65^{a}	1.76 ± 1.47^{a}	2.13 ± 1.93^{a}	5.49 ± 2.54^{b}	0.95 ± 0.57^{a}	0.18 ± 0.91^{a}
50 wk * Cobb 500	79.68 ± 4.93^{b}	4.67 ± 2.85^{a}	1.86 ± 1.56^{a}	1.05 ± 0.63^{a}	9.28 ± 0.72^{a}	0.88 ± 0.83^{a}	0.54 ± 0.88^{a}
p[1]	0.65	0.57	0.79	0.10	0.02	0.16	0.87
EEM[2]	0.42	0.45	0.26	0.25	0.66	0.15	0.15

[1]Significance; [2]standard error of measurements; [3]pipped shell but not emerged; data expressed as mean ± standard deviation; significant differences were obtained between groups indicated with different letters.

The eggshell provides the incubation environment that causes the embryo to develop and perform gas exchange (Shafey, 2002). Its quality is an important factor to the poultry industry, due to reproductive and economic implications (Luquetti *et al.*, 2004). The youngest hens lay eggs with thicker eggshells than those of older breeders, and, therefore, less oxygen is supplied to the embryos (Okur *et al.*, 2022). The eggshell thickness decreases with advancing breeder age, because the egg size increases more quickly than the shell weight (Shafey, 2002), and because there is an increase in egg size, rather than calcium deposition in the eggshell (Kismiati *et al.*, 2018). Hen age also affects the proportion of yolk and albumen (Grochowska *et al.*, 2019). However, in the study, although the weight of the egg varied with the age of female breeder, no significant differences were observed in embryonic mortality, pipping, and embryonic malposition. These results can be partly attributed to the different breeder lines, which is also related to shell quality. The interaction between the age of the hen and the breeder line did not show significance in pipping and embryonic malposition. In addition, their values are within the values reported in the literature (Grochowska *et al.*, 2019; Damaziak *et al.*, 2021b). The embryonic mortality observed during the 1st wk suggests adjustments in the handling and storage time of the egg prior to incubation (Table 1); the breeder line is what makes the difference in the main incubation variable. In this work, it was shown that the interaction of the two main factors (the age and the line) are the ones that influence hatchability, so those in charge of hatcheries must emphasize these factors to improve hatchability and chicken quality.

CONCLUSION

The findings of this study revealed that embryonic mortality, infertility, pipping, and embryonic malposition are not dependent on breeder age. The results suggest that the hatchability performance of eggs can be improved, if egg management and incubation procedures are adjusted to account for the interaction between broiler breeder line and broiler breeder age.

ACKNOWLEDGMENTS

This project was supported by the National Council of Science and Technology-México (CONACyT-México) and the Network Advances in Agricultural Research in Mexico.

REFERENCES

Abioja MO, Abiona JA, Akinjute OF, Ojoawo HT. Effect of storage duration on egg quality, embryo mortality and hatchability in FUNAAB-a chickens. Journal of Animal Physiology and Animal Nutrition 2021;105:715-24.

Archer GS, Shivaprasad HL, Mench JA. Effect of providing light during incubation on the health, productivity, and behavior of broiler chickens. Poultry Science 2009;88:29-37.

Bouba I, Visser B, Kemp B, Rodenburg TB, Brand H van den . Predicting hatchability of layer breeders and identifying effects of animal related and environmental factors. Poultry Science 2021;100:101-14.

Bruzual JJ, Peak SD, Brake J, Peebles ED. Effects of relative humidity during the last five days of incubation and brooding temperature on performance of broiler chicks from young broiler breeders. Poultry Science 2000;79:1385-91.

Bryant RB, Endale DM, Spiegal SA, Flynn KC, Meinen RJ, Cavigelli MA, *et al.* Poultry manureshed management: opportunities and challenges for a vertically integrated industry. Journal of Environmental Quality 2021;1:1-12.

Damaziak K, Musielak M, Musielak C, Riedel J, Gozdowski D, Grzybek W. Effect of different rearing system on eggs production, hatchability, and offspring quality in layer breeders. Poultry Science 2021a;100:101-10.

Damaziak K, Koznaka LM, Gozdowski D, Golebiowska A, Kedziorek E. Effects of broiler breeder strain, age, and eggs preheating profile in single-stage systems on the hatchability of eggs and quality of chicks. Animal 2021b;15:100-17.

El-Shater SN, Rizk H, Abdelrahman HA, Awad MA, Khalifa EF, Khalil KM. Embryonic thermal manipulation of Japanese quail: effects on embryonic development, hatchability, and post-hatch performance. Tropical Animal Health and Production 2021;53:263-9.

Grochowska E, Kinal A, Sobek Z, Siatkowski I, Bednarczyk M. Field study on the factors affecting egg weight loss, early embryonic mortality, hatchability, and chick mortality with the use of classification tree technique. Poultry Science 2019;98:3626-36.

Kismiati S, Yuwanta T, Zuprizal, Supadmo, Atmomarsono U. Calcium deposition in egg due to substitution of limestone by eggshell flour in feed of laying hens. Journal of the Indonesian Tropical Animal Agriculture 2018;43:257-64.

Luquetti BC, Gonzales E, Bruno LDG, Furlan RL, Macari M. Egg traits and physiological neonatal chick parameters from broiler breeder at different ages. Brazilian Journal of Poultry Science 2004;6:13-17.

Nangsuay A, Meijerhof R, Ruangpanit Y, Kemp B, Brand H van den. Energy utilization and heat production of embryos from eggs originating from young and old broiler breeder flocks. Poultry Science 2013;92:474-82.

Nasri H, Brand H van den, Najjar T, Bouzouaia M. Interactions between egg storage duration and broiler breeder age on egg fat content, chicken organ weights, and growth performance. Poultry Science 2020;99:4607-15.

Okur N, Eratalar SA, Yigit AA, Kutlu T, Kabakci R, Ozsoy SY. Effects of incubator oxygen and carbon dioxide concentrations on hatchability of fertile eggs, some blood parameters, and histopathological changes of broilers with different parental stock ages in high altitude. Poultry Science 2022;101:116-20.

Ozlu S, Ucar A, Erkus T, Yasun S, Nicholson AD, Elibol O. Effects of flock age, storage temperature, and short period of incubation during egg storage, on the albumen quality, embryonic development and hatchability of long stored eggs. British Poultry Science 2021a;62:611-9.

Ozlu S, Ucar A, Erkus T, Nicholson AD, Elibol O. Research note: effects of turning and short period of incubation during long-term egg storage on embryonic development and hatchability of eggs from young and old broiler grandparent flocks. Poultry Science 2021b;100:110-26.

Shafey TM. Eggshell conductance, embryonic growth, hatchability and embryonic mortality of broiler breeder eggs dipped into ascorbic acid solution. British Poultry Science 2002;43:135-40.

SPSS. IBM SPSS statistics uuser's guide. 22.0. Armonk: IBM Corp; 2013.

Tesarova MP, Skoupa M, Foltyn M, Tvrdon Z, Lichovnikova M. Research note: effects of preincubation and higher initiating incubation temperature of long-term stored hatching eggs on hatchability and day-old chick and yolk sac weight. Poultry Science 2021;100:293-7.

Tona K, Bamelis F, De KB, Bruggeman V, Decuypere E. Effect of induced molting on albumen quality, hatchability, and chick body weight from broiler breeders. Poultry Science 2002;81:327-32.

Vieira SL, Vieira SL, Almeida JG, Lima AR, Conde ORA, Olmos AR. Hatching distribution of eggs varying in weight and breeder age. Brazilian Journal of Poultry Science 2005;7:73-8