Original scientific paper
Оригиналан научни рад
UDC 636.5.084.52:637.412.053
DOI 10.7251/AGREN2103077V

University of Banjaluka, Faculty of Agriculture
Agro-knowledge Journal

Effect of nest and floor eggs with visually clean shells on hatchability and chick quality in broiler breeders

Marinko Vekić[1], Boban Bijelonić[1], Lidija Perić[2], Đorđe Savić[1], Stoja Jotanović[1], Mirjana Mitraković[3]

[1] *University of Banja Luka, Faculty of Agriculture, 78000 Banja Luka, Bosnia and Herzegovina*
[2] *University of Novi Sad, Faculty of Agriculture, 21000 Novi Sad, Republic of Serbia*
[3] *Avis DM, 78420 Srbac, Bosnia and Herzegovina*

Abstract

The aim of this study is to determine whether the site of oviposition has an impact on the results of incubation of broiler hatching eggs. In order to determine this, eggs laid in the nest, eggs laid in the nest and then placed on the floor to cool and eggs laid on the floor were compared. All eggs had a visually clean shell, including eggs laid on the floor. A total of 1,800 eggs from a 59-week-old Cobb 500 parent flock were examined, divided into three groups (n = 600) with 4 replicates (150 eggs per replicate). Compared to nest eggs, floor eggs had significantly higher weight loss ($p<0.05$), lower hatchability of set eggs and total embryonic mortality ($p<0.01$), as well as a lower number of first grade chicks per incubator tray ($p<0.05$). The percentage of contamination differed significantly between groups and it was the highest in floor eggs and the lowest in nest eggs ($p<0.01$). Nest eggs placed on the floor did not differ statistically significantly from nest and floor eggs in hatchability, total mortality and number of first grade chicks per incubator tray, although these eggs achieved more favourable results compared to floor eggs ($p>0.05$). The applied treatments did not affect the weight and length of the chicks ($p>0.05$). This research confirmed that floor eggs, despite their clean shell, have lower hatchability and a higher percentage of contamination than nest eggs, which emphasizes the importance of maintaining hygiene in nests and preventing the appearance of floor eggs in order to ensure the maximum number of eggs suitable for incubation.

Key words: hatching eggs, eggshell cleanliness, floor eggs, hatchability, chick quality

Introduction

The production of day-old broiler chicks is inseparable from the production of hatching eggs. This means that only good quality eggs, laid in nests, adequately kept and incubated, can be expected to produce good quality chicks (Meijerhof, 2006). Farms for parent flocks are designed, constructed, and equipped to provide the necessary conditions in which hens will lay eggs in nests, as the only environment in which eggs can be protected from a number of adverse influences (Hulzebosch, 2006). However, in the production of hatching eggs, the appearance of eggs laid outside the nest, which are known as floor eggs, is evident. Genetic factors, rearing and housing conditions, as well as the number, location, and characteristics of nests may be the causes of this problem (Appleby, 1984). Hulzebosch (2006) claimed that it is possible to achieve less than 1% floor eggs with good flock management. Eggs laid outside the nest are exposed to great microbiological risk, because the bedding on floor or raised slats is an environment rich in microorganisms that can penetrate the shell and its membranes after oviposition, especially during the period of egg cooling (Berrang et al., 1999). The number of bacteria on the surface of the floor egg shell is higher compared to clean eggs from the nest at the time of collection and storage (Hamidu et al., 2018), but also inside the eggs during incubation (Deeming et al., 2002). Therefore, lower incubation results of floor eggs are a consequence of increased percent of contamination, so they are a source of contamination for other eggs (van der Brand et al., 2016; Jabbar & Ditta, 2017; Ahamed et al., 2019). An additional negative factor in incubation may be that floor eggs more often have a cracked shell. Despite the above, floor eggs are used in commercial incubation, especially in the case of insufficient quantities of nest eggs (van der Brand et al., 2016).

The aim of this study was to compare broiler hatching eggs with visually clean shell laid in the nest, laid on the floor, as well as eggs laid in the nest which were placed in the floor bedding and collected again after three hours in order to determine whether the place of oviposition regardless of the fact that it is visually clean has an effect on hatchability and chick quality.

Material and Methods

A total of 1,800 eggs from the Cobb 500 parent flock, aged 59 weeks, reared on a commercial farm according to the recommendations of the producer of a given hybrid in a floor system within a closed facility with mechanical egg collection, were used in the experiment. Three groups with equal number of eggs (n = 600) were formed: visually clean eggs laid in the nest, visually clean eggs laid on the floor and visually clean eggs laid in the nest which were placed on the floor after collection, where they spent three hours for soiling of shell, after which they were collected. Storage of all groups in cardboard boxes lasted for five days at temperature of 19ºC and a relative humidity of 56.0%. Eggs were placed in incubator trays with a capacity of 150 eggs, so that each group consisted of a total of four incubator trays (repetitions). Also, all groups were incubated under identical conditions following the standard procedure of the commercial hatchery where research was performed. In order to determine the egg weight loss during incubation, the weight of empty incubator trays and trays filled with eggs was measured immediately before setting and during egg transfer (18th day of incubation). On the day of hatching, the number of first and second grade chicks was determined, as well as the number of dead chicks. Then, the unhatched eggs were examined in order to determine the number of unfertilized eggs, contaminated eggs and the number of eggs with dead embryos, classified into early (0-9 days), medium (10-17 days) and late (18-21 days) mortality. Individual assessment of chick quality was performed by observing qualitative indicators: chicks with dry and clean down, closed and clean navel and without deformations or lesions were classified as the first grade, and all other chicks as the second grade (van der Brand et al., 2016). Hatchability was calculated for set and fertile eggs, and mortality parameters as a percentage of fertile eggs. The length of the chick was determined individually using a ruler as the distance between the tip of the middle finger and the tip of the beak according to the instructions of Mukhtar et al. (2013). The weight of the chick was determined individually by measuring with a Kern EMB 200-2 technical balance (±0.01 g). The length and weight were determined in a sample of 10 randomly selected first grade chicks for each repetition in group.

The statistical analysis was performed using the statistical package STATISTICA 13 (TIBCO Software Inc., 2017). The hatcher tray was considered the experimental unit. A one-way ANOVA was used to determine the effects of treatment. The means were separated using the Tukey *post hoc* test and values were considered statistically different if $p<0.05$.

Results and Discussion

Table 1 shows the egg weight determined before setting and at the transfer, as well as the egg weight loss that occurred during the first 18 days of incubation.

Tab. 1. Egg weight and egg weight loss (mean ± standard deviation)

Treatments	Egg weight before setting, g	Egg weight at transfer, g	Egg weight loss, %
Nest eggs	72.81 ± 0.31	63.49 [b] ± 0.25	12.80 [b] ± 0.08
Nest eggs placed on the floor	73.48 ± 0.51	63.95 [b] ± 0.54	12.98 [b] ± 0.19
Floor eggs	72.52 ± 0.58	62.73 [a] ± 0.75	13.51 [a] ± 0.45
P values	0.866	0.035	0.016

[ab] – Mean values in the same column with a different letter differ significantly ($p<0.05$)

The egg weight before setting did not differ significantly between groups ($p>0.05$), but at the time of transfer, significantly lower egg weight was found in floor eggs compared to other groups ($p<0.05$). Also, the egg weight loss was significantly higher in floor eggs compared to other groups ($p<0.05$). These results are in contrast to the results of Jabbar and Ditta (2017) who reported lower weight loss in floor eggs compared to nest eggs, or Ahamed et al. (2019), who did not find a statistically significant difference between these two groups of eggs. Egg weight loss depends on both egg weight and shell quality, as well as incubation conditions, especially relative humidity (Molenaar et al., 2010), and greater weight loss may be due to shell cracks, that are more common in floor eggs (Khabisi et al., 2012).

The parameters of hatchability and embryonic mortality are shown in Table 2. A significant difference in the hatchability of set and fertile eggs was found between nest and floor eggs ($p<0.01$). Nest eggs placed on the floor did not differ significantly from nest and floor eggs ($p>0.05$), but hatchability values were nominally higher compared to floor eggs.

Tab. 2. Parameters of hatchability and embryonic mortality (mean ± standard deviation)

Treatments	Hatchability, %		Conta-minated eggs, %	Embryonic mortality, %			
	set eggs	fertile eggs		Early	Middle	Late	Total
Nest eggs	75.3 [a] ± 3.1	85.8 [a] ± 3.2	0.3 [c] ± 0.4	8.4 ± 1.9	0.6 ± 0.7	3.8 ± 0.1	11.8 [b] ± 1.6
Nest eggs placed on the floor	72.2 [ab] ± 5.1	84.2 [ab] ± 2.7	1.8 [b] ± 0.3	10.5 ± 2.4	0.4 ± 0.8	3.6 ± 0.5	14.0 [ab] ± 2.5
Floor eggs	66.8 [b] ± 3.2	80.5 [b] ± 2.7	2.0 [a] ± 0.5	10.5 ± 1.9	0.8 ± 0.6	6.2 ± 3.4	16.6 [a] ± 2.5
P value	0.000	0.075	0.001	0.305	0.732	0.219	0.04

[ab] – Mean values in the same column with a different letter differ significantly ($p<0.05$)

A significant difference in favour of hatchability of nest in relation to floor eggs was also confirmed by van den Brand et al. (2016), with the difference being more pronounced in eggs from the older than from the younger parent flock. Similarly, Ahamed et al. (2019) found that nest eggs have significantly higher hatchability of set eggs compared to floor eggs, but not hatchability of fertile eggs, and the numerical differences in hatchability parameters were relatively comparable to the differences in this study. Incubation results of seven egg groups, originated from different age and genotype parent flocks showed significantly higher hatchability in the group of clean eggs compared to the group of floor eggs, regardless of the age and genotype of the parent flock (Jabbar & Ditta, 2017).

The percentage of contamination differed statistically significantly among all groups included in the study ($p<0.001$), so the lowest value was found in nest eggs and the highest value in floor eggs. This is similar to the results of Ahamed et al. (2019), van den Brand et al. (2016) and Fasenko et al. (2000). Regarding embryonic mortality parameters, a statistically significant difference was absent in the comparison of early, medium and late mortality between groups ($p>0.05$), although nominally the highest values were found in floor eggs. However, a significant difference was found for total embryonic mortality ($p<0.05$), which was significantly higher in floor eggs compared to nest eggs, and nominally higher compared to nest eggs placed on the floor. Nominally, higher values of middle and late mortality in floor eggs compared to nest eggs were also obtained by Ahamed et al. (2019), while significantly higher mortality only in the first three days of incubation of floor and washed floor eggs compared to nest eggs was reported by van den Brand et al. (2016). Total embryonic mortality, according to data from Jabbar and Ditta (2017), was significantly higher in incubation of floor eggs compared to clean eggs. Floor eggs are more contaminated with bacteria compared to clean nest eggs before and during incubation (Deeming et al., 2002; Hamidu et al., 2018), probably due to the process of cooling eggs after oviposition to the ambient temperature during which negative pressure can facilitate penetration of abundantly present bacteria in the floor bedding (Berrang et al., 1999). High embryonic mortality in floor eggs is probably related to the equally high percentage of initial contamination (Deeming et al., 2002; Hamidu et al., 2018), but also to the more frequent occurrence of eggs with cracked shells which therefore have weaker defence against bacteria (Khabisi et al., 2012). The increased percentage of contamination in nest eggs placed on the floor may be related to an incomplete cooling process before placing in the floor bedding, which continued in an environment characterized by different hygienic conditions relative to the nests. In this regard, the lower hatchability of these eggs compared to nest eggs is probably caused by contamination caused during the eggs’ stay in the bedding.

In addition to the temperature differential between the egg and its environment, the transfer of bacteria through the shell is affected by other factors such as the presence of liquid or gaseous water, poor cuticle quality, high shell porosity, large open pores and the presence of certain types of bacteria particularly harmful to the embryo (Bruce & Drysdale, 1994).

The number of first grade chicks per incubation tray and chick quality parameters are shown in Table 3. A significant difference was found between the groups ($p<0.05$), but the number of chicks was significantly lower only in floor eggs compared to nest eggs. Nest eggs placed on the floor were not significantly different from other groups ($p>0.05$), but the number of first grade chicks was nominally higher than in floor eggs.

Tab. 3. Chick quality parameters (mean ± standard deviation)

Treatments	First grade chicks / tray*, n	Chick weight, g	Chick length, cm
Nest eggs	113.9 ^{b} ± 0.9	48.03 ± 0.36	20.20 ± 0.42
Nest eggs put on the floor	108.3 ^{ab} ± 7.6	48.12 ± 1.90	19.86 ± 0.14
Floor eggs	100.3 ^{a} ± 4.9	48.42 ± 0.78	19.91 ± 0.22
P value	0.038	0.889	0.237

^{ab} – Mean values in the same column with a different letter differ significantly ($p<0.05$)

* – Number of the first grade chicks per incubator tray

Fasenko et al. (2000) found no significant difference in the percentage of first grade chicks among washed nest eggs and washed and unwashed floor eggs, which is similar with a report by van den Brand et al. (2016) for difference between clean nest eggs and washed and unwashed floor eggs. In contrast, a higher percentage of first grade chicks from the group of clean eggs compared to a group of floor eggs was reported by Jabbar and Ditta (2017).

The weight of the chick in this study did not differ statistically significantly between the groups ($p>0.05$), and the same lack of significance was found for the length of the chick. Similarly, Ahamed et al. (2019) did not find a significant difference in these quantitative parameters of chicken quality between nest and floor eggs. Significantly higher weight of chicks hatched from clean eggs compared to floor eggs was reported by Jabbar and Ditta (2017), and by van den Brand et al. (2016) in the group of clean nest eggs and the group of mixed clean nest and floor eggs in relation to the groups of washed and unwashed floor eggs.

Conclusions

Based on the results of the study, it can be concluded that nest eggs had significantly higher hatchability of set and fertile eggs and a higher number of first grade chicks per incubator tray compared to floor eggs, which had significantly higher weight loss, contamination rate and total embryonic mortality. A visually clean shell cannot be considered a characteristic that will equalize the suitability of nest and floor eggs for incubation, i.e., that it will annul an inferior predisposition for incubation of floor eggs compared to nest eggs. Clean nest eggs placed on a floor bedding to cool achieved intermediate values of incubation parameters, so that they did not differ significantly from clean nest and floor eggs, but all parameters were nominally more favourable than for clean floor eggs. The difference between clean nest eggs and clean nest eggs placed on the floor bedding can be related to the egg cooling process that probably took place mostly in the floor bedding, thus causing a higher percentage of contamination. Maintaining nest hygiene, adequate dynamics of egg collection and prevention of the occurrence of floor eggs are key factors in providing clean nest eggs as a prerequisite for satisfactory incubation results.

References

Ahamed, Y.I., Adikari, A.M.J.B., Gamlath, G.A.S.N., & Somarathna, W.A.A.S.K. (2019). Effects of floor and nest eggs on hatchability and chick quality parameters in broiler breeders. *Wayamba Journal of Animal Science, 11,* 1793-1798.

Appleby, M.C. (1984). Factors affecting floor laying by domestic hens: A review. *Worlds Poultry Science Journal*, *40*(3), 241-249. doi: 10.1079/WPS19840019

Berrang, M.E., Cox, N.A., Frank, J.F., & Buhr, R.J. (1999). Bacterial penetration of the eggshell and shell membranes of the chicken hatching egg: a review. *Journal of Applied Poultry Research*, *8*(4), 499-504. doi:10.1093/japr/8.4.499

Bruce, J., & Drysdale, E.M. (1994). Trans-shell transmission. In: Board, R.G. & Fuller, R. (Eds.), *Microbiology of the Avian Egg* (pp. 63-91). Dordrecht: Springer Science+Business Media.

Deeming, D.C., Clyburn, V., Williams, K., & Dixon, R. (2002). In ovo microbial contamination of the yolk sac of unhatched broiler and pheasant embryos. *Avian and Poultry Biology Reviews, 13*(4), 240-241.

Fasenko, G.M., Robinson, F.E., Hittinger, M.G., MacLean, M.A., & White, B.A. (2000). Evaluating the hatchability of broiler chicks from washed and unwashed nest and floor eggs. In: *Abstracts 2000 Poultry Science Association Annual Meeting* (p. 4). Auburn University, Alabama.

Hamidu, J.A., Ndzibah, F.A., Allotey, W.M., Eghan, E., Kpemlie, C., Vasco, B., & Darko, J.O. (2018). Microbial load on hatching eggs from farmhouse to cold room. *International Journal of Research Studies in Agricultural Sciences*, *4*(6), 30-36.

Hulzebosch, J. (2006). How to reduce the number of floor eggs. *World Poultry*, *22*(1), 26-28.

Jabbar, A., & Ditta, Y.A. (2017). Effect of floor eggs on hatchability, candling, water loss, chick yield, chick weight and dead in shell. *Journal of World's Poultry Research*, *7*(4), 154-158.

Khabisi, M.M., Salahi, A., & Mousavi, S.N. (2012). The influence of egg shell crack types on hatchability and chick quality. *Turkish Journal of Veterinary and Animal Science*, *36*(3), 289-295. doi:10.3906/vet-1103-20

Meijerhof, R. (2006). Chick size matters. *World Poultry, 22*(5), 30-31.

Molenaar, R., Reijrink, I.A.M., Meijerhof, R., & van den Brand, H. (2010). Meeting embryonic requirements of broilers throughout incubation: A review. *Brazilian Journal of Poultry Science*, 12(3), 137-148. doi:10.1590/s1516-635x2010000300001

Mukhtar, N., Khan, S.H., & Anjum, M.S. (2013). Hatchling length is a potential chick quality parameter in meat type chickens. *World's Poultry Science Journal*, 69(4), 889-896. doi:10.1017/S0043933913000883

van den Brand, H., Sosef, M.P., Lourens, A., & van Harn, J. (2016). Effects of floor eggs on hatchability and later life performance in broiler Chickens. *Poultry Science*, *95*(5), 1025-1032. doi:10.3382/ps/pew008

Утицај јаја снесених у гнијезду и на поду са визуелно чистом љуском на валивост и квалитет пилића тешког линијског хибрида

Маринко Векић[1], Бобан Бијелонић[1], Лидија Перић[2], Ђорђе Савић[1], Стоја Јотановић[1], Мирјана Митраковић[3]

[1] Пољопривредни факултет, Универзитет у Бањој Луци, 78.000 Бања Лука, Босна и Херцеговина
[2] Пољопривредни факултет, Универзитет у Новом Саду, 21.000 Нови Сад, Република Србија
[3] Avis DM, 78.420 Србац, Босна и Херцеговина

Сажетак

Циљ овог рада био је да се утврди утицај мјеста овипозиције на резултате инкубације. У складу с тим, поређена су јаја снесена у гнијезду, јаја снесена у гнијезду, а потом стављена на под на хлађење и јаја снесена на поду. Сва јаја су имала визуелно чисту љуску, укључујући и јаја снесена на поду. Укупно је испитано 1.800 јаја од 59 недјеља старог родитељског јата Cobb 500 подијељених у три групе (n=600) са четири понављања (150 јаја по понављању). Група јаја снесених на поду у односу на групу јаја снесених у гнијезду имала је значајно виши губитак масе ($p<0.05$), нижу валивост уложених јаја и укупан ембрионални морталитет ($p<0.01$), као и мањи број пилића прве класе по љеси ($p<0.05$). Проценат контаминације значајно се разликовао међу групама и био је највиши код подних јаја, а најнижи код јаја из гнијезда ($p<0.01$). Група јаја из гнијезда стављена на под није се статистички значајно разликовала од друге двије групе у валивости, укупном морталитету и броју пилића прве класе по љеси, иако су ова јаја постигла повољније резултате у поређењу са јајима са пода ($p>0.05$). Примијењени третмани нису имали значајан утицај на масу и дужину пилића ($p>0.05$). Истраживање је потврдило да јаја снесена на поду, упркос чистој љусци, имају лошију валивост и већи проценат контаминације у односу на јаја из гнијезда, што наглашава важност одржавања хигијене у гнијездима и превенцију појаве подних јаја у циљу обезбјеђења максималног броја јаја погодних за инкубацију.

Кључне ријечи: јаја за насад, чистоћа љуске, подна јаја, валивост, квалитет пилета

Corresponding author: Marinko Vekić
E–mail: marinko.vekic@agro.unibl.org
Received: May 14, 2021
Accepted: September 14, 2021