

INFLUENCE OF FLOOR EGG SHELL CLEANLINESS AND CLEANING TREATMENT ON HATCHABILITY AND CHICK QUALITY

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Abstract: A total of 3,600 floor eggs from a 59-week-old Cobb 500 parent flock were collected to examine the effects of shell cleanliness and cleaning treatment on incubation results. The eggs were divided into two equal groups according to the cleanliness of the shell: eggs with a visually clean shell (clean eggs) and eggs with a dirty shell (dirty eggs). Depending on the cleaning treatment, clean and dirty eggs were divided into three equal groups: eggs that were not cleaned at all (intact), eggs that were cleaned with metal wire (scraped eggs) and eggs that were washed (washed eggs). Cleaning treatment significantly affected egg weight loss ($p = 0.057$). The hatchability of set eggs was under significant influence of egg cleanliness ($p = 0.018$), while the hatchability of fertile eggs was under significant influence of egg cleanliness ($p = 0.003$) and cleaning treatment ($p = 0.029$). Significant influence of shell cleanliness ($p = 0.000$) and cleaning treatment ($p = 0.000$) on egg contamination was also observed. Early, middle and total embryonic mortality were not significantly influenced by shell cleanliness and cleaning treatment, in contrast to late mortality which was under significant influence of egg cleanliness ($p = 0.028$). The number of first grade chicks per incubator tray was significantly influenced by egg cleanliness ($p = 0.018$). Chick weight and length were not significantly affected by shell cleanliness and cleaning treatment. The study showed that washed eggs had a higher weight loss compared to intact and scraped eggs. Dirty eggs had a lower hatchability, a higher percentage of contamination and late mortality as well as a lower number of first grade chicks per incubation tray, compared to clean eggs. Cleaning treatments did not have a significantly positive effect on the incubation results of either clean or dirty eggs. Washing treatment had a particularly negative effect on dirty eggs as they had reduced hatchability and increased contamination. The absence of a positive effect of scraping and washing treatment on the incubation results makes justification of these cleaning treatments for floor eggs doubtful.

Key words: hatching eggs, floor eggs, egg cleaning, hatchability, chick quality

Introduction

A broiler hatching egg should not only meet certain criteria in terms of weight, shape, shell quality, cleanliness and freshness, but should also be laid in a nest (King'ori, 2011). However, it is known that a certain number of eggs are laid outside the nest, most often on the part of the floor covered with bedding or on grid, which is why they are known as floor eggs. According to field data, the percentage of floor eggs on broiler parents' farms varies from 0.1 to almost 18%, which can be related to a number of factors such as genotype, bird health, flock management, facility design, ambient conditions, and the number of nests, their location, type and attractiveness (Hulzebosch, 2006). In addition to requiring additional collection work, the percentage of contamination is higher in floor eggs than nest eggs from the same flock, which results in lower hatchability and making them a source of contamination for other eggs (Van den Brand et al., 2016; Ahamed et al., 2019). Namely, during the cooling of the eggs after oviposition, the contents of the egg are shrinking, so the resulting negative pressure creates the suction effect that promotes the entry of microorganisms through the shell pores (Berrang et al., 1999). Floor eggs are cooled in an environment rich in microorganisms, which is why they have higher level of initial contamination than nest eggs (Deeming et al., 2002). Also, floor eggs have a higher percentage of cracked shell, which is known from the production of table eggs (De Reu et al., 2009), which can facilitate bacterial penetration (Berrang et al., 1999) and adversely affect the hatchability and chick quality (Khabisi et al., 2012).

The use of floor eggs in incubation for higher production of chicks or due to insufficient available nest eggs is not a rare practice in commercial hatcheries (Fasenko et al., 2000; Van den Brand et al., 2016), which is why there is interest in examining the possibility of increasing of their hatchability. The possibility of cleaning dirty nest and floor eggs in order to increase the incubation results has been considered in previous studies. Buhr et al. (1994) did not improve hatchability of clean and dirty nest eggs by sanitizing them, nor did Yoho et al. (2008) who wiped dirty nest eggs with a damp cloth or scraped them. Van den Brand et al. (2016) found a higher percentage of contamination and lower hatchability in washed and unwashed floor eggs compared to clean nest eggs, in contrast to Fasenko et al. (2000) who reported that washed floor eggs were suitable for incubation, as they did not differ in hatchability from washed nest eggs.

Therefore, the aim of this study was to examine the influence of floor egg cleanliness at the time of collection (clean and dirty eggs) and egg cleaning treatment (intact, scraped and washed) on the hatchability and chick quality.

Materials and Methods

The experiment used eggs produced from a 59-week-old Cobb 500 broiler parent flock, reared in accordance with the recommendations of the producer of a given hybrid in a typical closed facility equipped with system for mechanical egg collection.

A total of 3,600 eggs were collected, of which 1,800 were floor eggs with a visually clean shell (clean eggs, without any visible dirt or materials on the shell), and 1,800 were eggs with a visually soiled shell (dirty eggs, with visible dirt or materials on the shell). The design of the experiment was set up to determine whether shell cleaning treatments had a positive effect on incubation parameters in dirty eggs. The same cleaning treatments were applied to clean eggs (as a control), to determine whether cleaning procedures as such had an impact on the incubation parameters. Clean and dirty eggs are further divided into three equal subgroups ($n = 600$ eggs) depending on the cleaning treatment: intact - eggs that are not cleaned at all, washed - eggs that are washed in water, then wiped with a damp cloth and left to dry before storage, scraped - eggs that were cleaned by scraping with a dry metal wire. All eggs in the study were stored for five days in the same ambient conditions. Each group consisted of four incubator trays of 150 eggs each, representing four replicates. Preheating and incubation of eggs was performed identically and simultaneously in all groups, following the standard procedure of the commercial hatchery where the research was conducted. Egg weight was determined before setting and when transferring eggs from the setter to the hatcher (18th day of incubation) to calculate egg weight loss during incubation (*Ahamed et al., 2019*). After removing the hatchery crates, the number of first and second grade chicks was determined, as well as the number of dead chicks. Chicks that were dry, clean, with a closed and clean navel, acceptable body size and without deformities or lesions were classified as the first grade, and all other chicks as the second grade chicks (*Reijrink et al., 2010*). All unhatched eggs were examined to determine the number of contaminated eggs, unfertile eggs, as well as the number of eggs with dead embryos, classified according to the day of death as early (0-9 days), medium (10-17 days) or late mortality (18 -21 days) (*Reijrink et al., 2010*). The length of the chick (cm) was determined using a ruler, as the distance from the tip of the middle toe to the tip of the beak, as described by *Reijrink et al. (2010)*, while a technical scale (Kern EMB 200-2) was used to measure the chick weight. The length and weight of the chicks were individually measured in a sample of ten randomly selected chicks per replicate in each group. Hatchability percentage was calculated for set and fertile eggs, and embryonic mortality parameters as a percentage of fertile eggs (*Reijrink et al., 2010*).

The statistical analysis was performed using Statistica 13 (Tibco Software Inc, 2017). The incubation tray was considered the experimental unit. The two-way ANOVA was used to determine the effects of treatments. The means were sepa-

rated using the Tukey *post hoc* test and values were considered statistically different if $p < 0.05$ i $p < 0.01$.

Results and Discussion

The results of the examination of the influence of shell cleanliness and cleaning treatment of floor eggs on the incubation results are shown in Table 1.

Egg weight loss was not significantly influenced by the shell cleanliness ($p = 0.376$), but it was significantly influenced by the cleaning treatment ($p = 0.057$). On average, higher values of weight loss were determined in the washed group compared to scraped and intact eggs. The cuticle is a surface shell layer that participates in the regulation of gas exchange through the shell (Samiullah and Roberts, 2014). Peebles *et al.* (1998) reported that eggs with the removed cuticle had a higher weight loss compared to intact eggs, which in this study may be related to a washing treatment that probably removed the cuticle to a greater extent and increased the number of open pores, ultimately causing higher weight loss.

Table 1. Effect of egg shell cleanliness and cleaning treatment on incubation results (mean $\pm$ stan. dev.)

Parameters	Clean eggs			Dirty eggs			p values for main effects		
	Int	Scr	Wash	Int	Scr	Wash	C	T	C x T
Egg weight before setting, g	72.52 ± 0.58	73.26 ± 0.77	73.32 ± 0.64	72.98 ± 0.65	72.98 ± 0.46	72.87 ± 0.46	0.719	0.382	0.279
Egg weight at transfer, g	62.73 ± 0.75	63.76 ± 0.76	63.25 ± 1.10	63.61 ± 0.75	63.50 ± 0.74	60.99 ± 3.11	0.379	0.141	0.128
Egg weight loss, %	13.51 $\pm 0.45^b$	12.96 $\pm 0.28^b$	13.74 $\pm 0.83^{ab}$	12.84 $\pm 0.28^b$	13.00 $\pm 0.52^b$	16.31 $\pm 4.11^a$	0.376	0.057	0.176
Hatchability of set eggs, %	66.8 $\pm 3.2^a$	75.2 $\pm 3.6^a$	71.8 $\pm 9.4^a$	71.8 $\pm 4.8^a$	64.3 $\pm 13.0^a$	52.3 $\pm 9.1^b$	0.018	0.127	0.021
Hatchability of fertile eggs, %	80.5 $\pm 2.7^{ab}$	86.2 $\pm 4.2^a$	81.4 $\pm 7.4^{ab}$	81.7 $\pm 6.1^{ab}$	73.9 $\pm 11.8^b$	59.7 $\pm 10.1^c$	0.003	0.029	0.030
Contaminated eggs, %	2.0 $\pm 0.5^{bc}$	1.2 $\pm 1.1^c$	2.8 $\pm 1.7^{bc}$	1.3 $\pm 1.2^{bc}$	6.3 $\pm 3.5^b$	19.0 $\pm 7.2^a$	0.000	0.000	0.000
Early mortality, %	10.5 ± 1.9	8.1 ± 3.6	11.6 ± 5.8	6.9 ± 2.3	9.1 ± 5.6	14.1 ± 4.2	0.978	0.094	0.334
Middle mortality, %	0.8 ± 0.6	0.2 ± 0.4	0.6 ± 0.7	0.4 ± 0.8	0.4 ± 0.5	1.2 ± 0.5	0.574	0.172	0.245
Late mortality, %	6.2 ± 3.4	3.7 ± 1.7	3.7 ± 2.1	7.5 ± 2.6	8.7 ± 3.9	7.8 ± 3.4	0.028	0.704	0.665
Total mortality, %	16.6 ± 2.5	11.2 ± 5.2	15.5 ± 5.9	14.1 ± 3.8	16.5 ± 9.2	21.8 ± 5.3	0.210	0.254	0.256
First grade chicks / incubator tray, n	103.0 $\pm 4.9^a$	112.8 $\pm 5.4^a$	107.8 $\pm 14.1^a$	108.0 $\pm 7.1^a$	96.5 $\pm 19.5^a$	78.5 $\pm 13.6^b$	0.018	0.124	0.021

Int – intact eggs; Scr – scraped eggs; Wash – washed eggs

C – Egg cleanliness, T – Cleaning treatment

^{abc} – Values in the same row with different letters are statistically different

The hatchability of set eggs differed statistically significantly in relation to the egg shell cleanliness ($p = 0.018$), but not in relation to the cleaning treatment ($p = 0.127$), while the hatchability of fertile eggs was influenced by both egg shell cleanliness ($p = 0.003$) and cleaning treatment ($p = 0.029$). Significantly higher hatchability of set and fertile eggs was obtained with clean eggs compared to dirty eggs. Also, intact and scraped eggs had a higher hatchability compared to washed eggs. The hatchability of intact dirty eggs was significantly higher than washed and scraped dirty eggs, while no significant differences in hatchability were found between intact, scraped and washed clean eggs. These results are consistent with the results of *Buhr et al. (1994)* who reported that sanitized and unsanitized dirty nest eggs have significantly lower hatchability compared to sanitized and unsanitized clean eggs, which indicates the absence of a positive sanitation effect in both clean and dirty eggs. Also, *Yoho et al. (2008)* did not improve the hatchability of dirty nest eggs by wiping them with a damp cloth or sanded them with an abrasive pad, as they did not differ significantly from uncleaned dirty nest eggs. On the other hand, *Fasenko et al. (2000)* found a significantly higher hatchability of fertile eggs in washed floor eggs compared to unwashed floor eggs, while washed nest eggs did not differ from these groups.

Egg contamination in this study was influenced by shell cleanliness ($p = 0.000$) as well as cleaning treatment ($p = 0.000$). Higher values were found for dirty compared to clean eggs, as well as for washed compared to intact and scraped eggs. A drastic increase in contamination was observed in washed dirty eggs compared to other groups in the study. *Fasenko et al. (2000)* determined a significantly higher percentage of contamination in washed floor eggs compared to washed nest eggs, while unwashed floor eggs did not differ from these two groups.

No significant effect of shell cleanliness and cleaning treatment was found for early, middle and total embryonic mortality. Late mortality was significantly influenced by egg shell cleanliness ($p = 0.028$), so that dirty eggs had a significantly higher value compared to clean eggs. *Deeming et al. (2002)* found that dirty floor eggs have a higher degree of contamination compared to nest eggs, which is why they also had a higher percentage of late mortality. *Buhr et al. (1994)* also reported higher late embryonic mortality after incubation of dirty nest eggs compared to clean nest eggs. *Fasenko et al. (2000)* observed significantly higher mortality between 8 and 14 days of incubation in unwashed floor eggs compared to washed floor eggs, while washed nest eggs did not differ from these groups. The cuticle is a physical barrier to the penetration of microorganisms into the egg because it closes the pore openings and contains certain antimicrobial substances (*Samiullah and Roberts, 2014*), so any damage to this layer, such as scraping or washing, can impair its defense function (*Berrang et al., 1999*).

The number of first grade chicks per incubator tray was significantly influenced only by egg shell cleanliness ($p = 0.018$), but not by cleaning treatment ($p = 0.254$). A higher number of first grade chicks were obtained from clean

compared to dirty eggs. The value of this parameter was particularly low in dirty scraped and washed eggs compared to other eggs in the study. The absence of a significant difference in the percentage of first grade chicks between washed and unwashed floor and clean nest eggs was reported by *Van den Brand et al. (2016)*, as well as *Fasenko et al. (2000)* in a comparison of washed nest, washed and unwashed floor eggs.

The average weight and length of chicks obtained in this study are shown in Table 2.

Table 2. Effect of egg shell cleanliness and cleaning treatment on chick quality (mean $\pm$ stan. dev.)

Parameters	Clean eggs			Dirty eggs			p values for main effects		
	Int	Scr	Wash	Int	Scr	Wash	C	T	C x T
Chick weight, g	48.42 $\pm$ 0.78	48.54 $\pm$ 1.97	47.88 $\pm$ 0.85	49.42 $\pm$ 1.67	48.40 $\pm$ 2.70	48.91 $\pm$ 1.19	0.369	0.792	0.729
Chick length, cm	19.91 $\pm$ 0.22	19.77 $\pm$ 0.25	19.57 $\pm$ 0.04	19.71 $\pm$ 0.10	19.52 $\pm$ 0.24	19.84 $\pm$ 0.50	0.579	0.473	0.133

Int – Intact eggs; Scr – scraped eggs; Wash – washed eggs

C – Egg cleanliness, T – Cleaning treatment

Chick weight did not differ significantly depending on egg shell cleanliness ($p = 0.369$) and egg cleaning treatment ($p = 0.792$). Similarly, the absence of a significant influence of shell cleanliness ($p = 0.579$) and cleaning treatment ($p = 0.473$) was determined for chick length. *Buhr et al. (1994)* also found no significant difference in chick weight between sanitized and unsanitized clean and dirty nest eggs. *Van den Brand et al. (2016)* found a higher chick weight in the group of clean nest eggs and mixed groups (floor and clean nest eggs) compared to the groups of washed and unwashed floor eggs.

Conclusion

Based on the obtained results, it can be concluded that clean eggs had significantly higher hatchability and the number of first grade chicks per incubator tray compared to dirty eggs. Scraping and washing as cleaning treatments did not have a positive effect on incubation results in both clean and dirty eggs. Also, washing of dirty eggs significantly reduced the hatchability and number of first grade chicks and increased the percentage of egg contamination. Chick weight and length were not influenced by the cleanliness of the shell and the cleaning treatment.

Efekat čistoće ljuske i tretmana čišćenja na inkubacione rezultate podnih jaja

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Rezime

U cilju ispitivanja uticaja čistoće ljuske i tretmana čišćenja na rezultate inkubacije sakupljeno je ukupno 3.600 podnih jaja od 59-nedelja starog roditeljskog jata Cobb 500. Jaja su bila podijeljena u dvije jednake grupe po čistoći ljuske: jaja sa vizuelno čistom ljuskom (čista jaja) i jaja sa prljavom ljuskom (prljava jaja). Čista i prljava jaja su zavisno od tretmana čišćenja bila podijeljena u tri jednake grupe: jaja koja uopšte nisu čišćena (intaktna), jaja koja su očišćena pomoću metalne žice (ostrugana jaja) i jaja koja su oprana (oprana jaja). Tretman čišćenja je značajno uticao na gubitak mase jaja ($p = 0.057$). Leženost uložениh jaja značajno je bila uslovljena čistoćom jaja ($p = 0.018$), dok je leženost oplođenih jaja bila značajno uslovljena čistoćom jaja ($p = 0.003$) i tretmanom čišćenja ($p = 0.029$). Zapažen je značajan uticaj čistoće ljuske ($p = 0.000$) i tretmana čišćenja ($p = 0.000$) na kontaminaciju jaja. Rani, srednji i ukupan embrionalni mortalitet nisu bili značajno uslovljeni čistoćom ljuske i tretmanom čišćenja, za razliku od kasnog mortaliteta koji je bio značajno uslovljen čistoćom jaja ($p = 0.028$). Broj pilića prve klase po ljesi bio je značajno uslovljen čistoćom jaja ($p = 0.018$). Masa i dužina pileta nisu bili pod značajnim uticajem čistoće ljuske i tretmana čišćenja. Istraživanje je pokazalo da su oprana jaja imala veći gubitak mase u odnosu na intaktna i ostrugana jaja. Prljava jaja su imala nižu leženost, veći procenat kontaminacije i kasnog mortaliteta kao i manji broj pilića prve klase po ljesi u odnosu na čista jaja. Tretmani čišćenja nisu imali značajno pozitivan uticaj na inkubacione rezultate ni čistih ni prljavih jaja. Pranje je imalo posebno negativan uticaj na prljava jaja zbog snižene leženosti i povišene kontaminacije. Izostanak pozitivnog efekta struganja i pranja na inkubacione rezultate dovodi u pitanje opravdanost ovih tretmana čišćenja kod podnih jaja.

Ključne reči: jaja za nasad, podna jaja, čišćenje jaja, leženost, kvalitet pilića

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