APPLYING THERMAL TREATMENTS TO CHICKEN HATCHING EGGS DURING STORAGE AND THE EFFECTS ON HATCHABILITY

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Abstract

Eggs incubation delay leads to lower hatching performance and weaker chick. The study was performed on ROSS 308 breeder eggs and followed the fertility and the impact of storage time on hatchability (A series), with decrease of hatchability with increase of storage time, from 80.77% (7 days) to 62.96% (21 days). The research in series A was based on results obtained from 936 eggs, spread over storage times (7, 14, 21 days) at 16°C, RH% 75%. Series B, followed the impact of thermal treatments applied to eggs during storage (7, 14, 21 days), on hatchability. Thermal treatment required egg exposure to 37.5°C for 120, 180 and 240 min. Three types of thermal treatments were applied, once for 7 days egg storage, 3 times for 14 days, 5 times for 21 days. Each thermal period x treatment combination was performed on 234 eggs, resulting a total of 6,318 eggs. Combinations for 7 days storage did not bring statistically significant improvements, combination of 2 x 180 min. is recommended for 14 days storage and for 21 days storage the combinations of 4 x 180 min. and 4 x 120 min.

Key words*:* storage, eggs, thermal, treatment, hatchability

INTRODUCTION

The effects of long storage times on eggs has been studied in depth, and it is well known that the hatchability decreases, extends the incubation time, and the quality of the chickens can be affected [15].

The cause of the negative effects is not fully known. Embryo viability decreases, most likely due to cellular mortality [3]. In addition, egg quality decreases due to water and CO_2 loss. Also, the pH of the white increases from 7.6 to about 9.0 during the first 4 days of storage [11], the pH of the yolk increases from 6.0 to 6.5, the viscosity of the white drops [17] and the resistance of the yolk membrane decreases [9]. Also, during storage, the egg loses weight due to water loss, about 0.5% per week [1]. Storage between 5 and 10 days, reduces hatchability between 0.8% and 2.8%, respectively. On average, increasing one-day storage time can reduce hatchability by 1% and may add 1 h incubation time [6].

At the time of egg lay, the embryo is in the EGK-X development stage [8], consisting of about 54,000 cells [14], arranged in a white and transparent area inside it (germinative disc or blastoderm). The storage of eggs for a long time can induce embryonic stress manifested by large cell death by apoptosis or necrosis, impaired embryonic metabolism and delay in development, generating possible irreparable destruction of the embryo. These facts can lead to embryo death or low chick performance in farms [10].

MATERIALS AND METHODS

The experiment was structured in 2 experimental series (A, B). The research material is represented by individuals belonging to the commercial broiler breeder hybrid ROSS 308. This is a performing hybrid, chicks as hatched can achieve 2.8 kg average body weights at 42 days with a feed conversion ratio of 1.687 [2].

For the A series of experiments, the research was carried out on based on results obtained from 936 incubated eggs, distributed for each storage period and referred to as control groups: 234 eggs - 7 days, 351 eggs -

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14 days, 351 eggs - 21 days. During the incubation, a candling was performed to identify viable eggs. In the A series, the studied parameters were: number of viable chicks, total loss, total infertile eggs, total deaths, % total death, % total malformations, % embryonic loss at candling, % early death at 24 hours, % early 48 hours, % blood ring at 3 days, % eye black at 5-12 days. These characters are important in determining the two parameters related to the efficiency of the incubation: fertility % and hatchability %.

For the B series of experiments, the study was performed based on the results obtained from 6,318 incubated eggs, distributed in combinations. For each storage period, three types of thermal treatments were performed by exposing the eggs at 37.5 °C for 120 minutes, 180 minutes and 240 minutes, respectively. Within the 7-day storage time, a single series of thermal treatments was carried out, covering the three types previously mentioned, for the 14-day storage period, the series was repeated 3 times, and for the storage period of 21 days, the series was repeated 5 times.

Each thermal treatment (27 combinations) was performed on 234 eggs, resulting in the total of 6,318 eggs shown above. In series B, the studied parameters were fertility % and hatchability %.

The followed parameters (fertility % and hatchability %) in the experimental series A and B were determined by specific methods, respectively, counting and observation during candling.

For the phenotypic characterization of the batches the classical statistical methods were used [16]: mean, variation, standard deviation, average error, coefficient of variability.

The used tests, in order to study the variation of the parameters with a normal distribution were: the χ^2 test used to check the consistency of an empirical distribution (observed frequencies O_j) with a theoretical distribution (T_j frequencies), the Student test for comparing the homogeneity of the means of two samples [16, 7] and the Fisher test was applied to the case of several samples, preceded by a variance analysis. The calculated F value was obtained by plotting the mean squares between the samples at the mean of the intraprobe squares.

In order to study the binomial variation of fertility and hatchability, frequency comparison by means of the normal approximation, the Fisher comparison of binomial proportions, also known as the "exact probability test" and the "square chi" test with correction of continuity of Yates applied to binary contingency tables [7] were used.

Individual variations on the characters considered to have a binomial distribution, can be noted with terms such as yes / no, 0/1, success / failure.

RESULTS AND DISCUSSIONS

Series A determined fertility rates and hatching percentages (fig. 1). Eggs from this series were not thermal treated during storage (7, 14 and 21 days). The tests showed that there are insignificant differences between the fertility and storage time of eggs (table 1), respectively that this attribute is controlled by much more complex mechanisms. Even if it is physiologically normal, a variation in fertility % based on the environment or individuality, under the conditions of total artificial and controled microclimate, can be largely canceled regardless of the season.

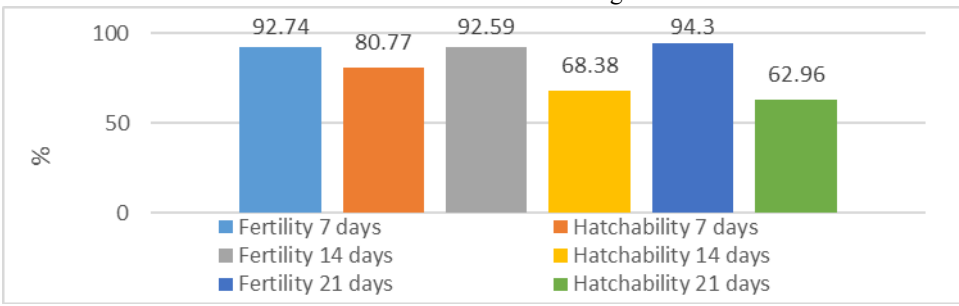

Fig. 1 Values of fertility and hatch percentages in the control groups, related to each storage impairment

Table 1 Comparison of fertility with the normal approximation between the three storage periods

Specification	Storage 7 days	Storage 14 days	Storage 21 days
Storage 7 days	-	0.0358^{NS}	0.7941^{NS}
Storage 14 days		-	0.0474^{NS}

The analysis of the obtained results indicates the significant differences between the hatchability values associated with the different storage periods, except for the couple storage 14 day – storage 21 days, which makes it possible to state that at least under the experimental conditions of this paper a storage time of more than 7 days, without the application of any thermal treatment, has negative repercussions on the hatching percentage.

Table 2 Comparison of hatchability with the normal approximation between the three storage periods

Specification	Storage 7 days	Storage 14 days	Storage 21 days
Storage 7 days	-	3.3008^{**}	4.5904^{***}
Storage 14 days		-	1.5122^{NS}

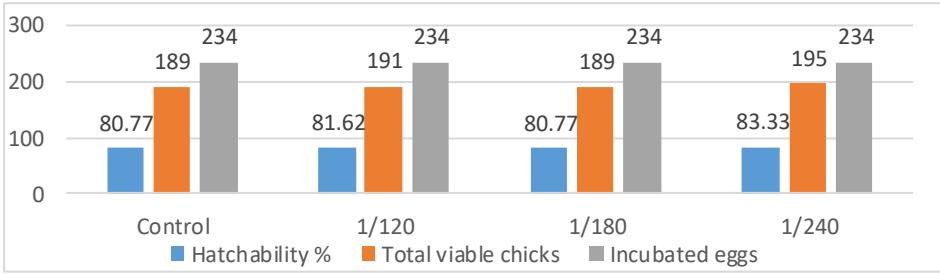

Fig. 2 Comparison of hatchabilities between thermal treatments in the 7 days storage

The results reported in a series of papers suggest that eggs hatchability begins to decrease 2-3 days after laying [4, 5, 18], but it is often indicated that the percentage of hatchability begins to decline only after the seventh storage day [12, 13]. In the experimental series B, the results obtained with the storage of the eggs for 7 days (fig. 2) confirm the idea that it does not affect the hatchability, indifferently of the thermal treatment applied.

Table 3 Comparison of hatchabilities with a normal approximation of thermal treatments in case of 7 days storage

Specification	Control	1/120	1/180	1/240
Control	-	0.2366^{NS}	0^{NS}	0.7227^{NS}
1/120		-	0.2366^{NS}	0.4864^{NS}
1/180			-	0.7227^{NS}

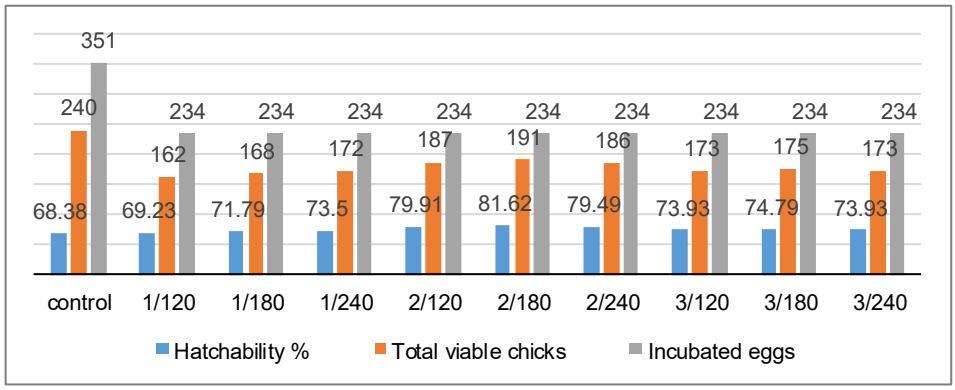

Fig. 3 Comparison of hatchability between thermal treatments in case of 14 days storage

In the case of the results obtained with the 14 day storage (fig. 3), the calculated values of the normal approximation test are those which make the difference and allow to state the recommendations (table 4). Thus, 2 thermal treatments of 180 minutes, are recommended. Differences are most likely determined by sampling errors which, under industrial conditions, are greatly minimized due to the size of the samples.

Concluding on the results obtained in experimental variants associated with egg storage for 21 days, as in the case of other storage variants, the calculated approximate values are base on which the recommendations will be made (table 5). In the case of egg storage for 21 days, the variant with 4 thermal treatments was noticed for 180 and 120 minutes, respectively.

Table 4 Comparison of hatchability with the normal approximation of thermal treatments in case of 14 days storage

Specif.	Control	1/120	1/180	1/240	2/120	2/180	2/240	3/120	3/180	3/240
Control	-	0.2002 NS	0.8635 NS	1.3130 NS	3.0602 **	3.5452 ***	2.9404 **	1.4263 NS	1.6543 NS	1.4263 NS
1/120		-	0.6082 NS	1.0226 NS	2.6539 **	3.1138 **	2.5407 **	1.1274 NS	1.3385 NS	1.1274 NS
1/180			-	0.4148 NS	2.0522 *	2.5153 *	1.9385 NS	0.5158 NS	0.7313 NS	0.5198 NS
1/240				-	1.6404 NS	2.1054 *	1.5262 NS	0.1050 NS	0.3167 NS	0.1050 NS
2/120					-	0.4692 NS	0.1149 NS	1.5360 NS	1.3252 NS	1.5360 NS
2/180						-	0.5840 NS	2.0014 *	1.7914 NS	2.0014 *
2/240							-	1.4217 NS	1.2108 NS	1.4217 NS
3/120								-	0.2117 NS	0 NS
3/180									-	0.2117 NS

The calculated values of the normal approximation presented in table 5 show that there are differences with different degrees of statistical significance between the hatching percentages associated with different treatments. As shown in fig. 4, the highest hatchability value is recorded for variant 4/180, but with insignificant differences compared to other experimental variants (eg. 3/120), making the choice in practice of one or the other, eventually, on the costs associated with the production, in addition with the value of the hatching percentage of larger quantities than those presented in this paper. Under the experimental conditions of the present paper, three 120 minute thermal treatments appear to be sufficient.

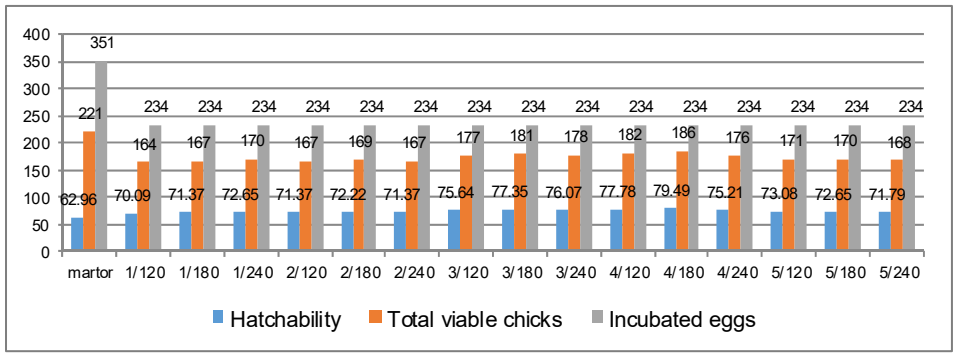

Fig. 4 Comparison of hatchability between thermal treatments in the case of 21 days storage

Table 5 Comparison of hatchability with the normal approximation between thermal treatments in the case of 21 days storage

Specif.	Ctrl	1/120	1/180	1/240	2/120	2/180	2/240	3/120	3/180	3/240	4/120	4/180	4/240	5/120	5/180	5/240
Control	-	0.76 14^{NS}	2.08 93*	2.42 00*	2.08 93*	2.30 95*	2.08 93*	3.20 32**	3.65 87***	3.31 65**	3.77 36***	4.23 72***	3.09 03**	2.53 09*	2.42 00*	2.19 92*
1/120		-	0.30 48^{NS}	0.61 35^{NS}	0.30 48^{NS}	0.51 02^{NS}	0.30 48^{NS}	1.35 14^{NS}	1.78 53^{NS}	1.45 90^{NS}	1.89 53^{NS}	2.34 19*	1.24 44^{NS}	0.71 74^{NS}	0.61 35^{NS}	0.40 72^{NS}
1/180			-	0.30 89^{NS}	0^{NS}	0.20 54^{NS}	0^{NS}	1.04 74^{NS}	1.48 21^{NS}	1.15 52^{NS}	1.59 23^{NS}	2.04 00*	0.94 03^{NS}	0.41 28^{NS}	0.30 89^{NS}	0.10 25^{NS}
1/240				-	0.30 89^{NS}	0.10 34^{NS}	0.30 89^{NS}	0.73 90^{NS}	1.17 43^{NS}	0.84 69^{NS}	1.28 47^{NS}	1.73 34^{NS}	0.63 18^{NS}	0.10 40^{NS}	0^{NS}	0.20 64^{NS}
2/120					-	0.20 54^{NS}	0^{NS}	1.04 74^{NS}	1.48 21^{NS}	1.15 52^{NS}	1.59 23^{NS}	2.04 00*	0.94 03^{NS}	0.41 28^{NS}	0.30 89^{NS}	0.10 25^{NS}
2/180						-	0.20 54^{NS}	0.84 24^{NS}	1.27 74^{NS}	0.95 02^{NS}	1.38 78^{NS}	1.83 62^{NS}	0.73 51^{NS}	0.20 74^{NS}	0.10 34^{NS}	0.10 30^{NS}
2/240							-	1.04 74^{NS}	1.48 21^{NS}	1.15 52^{NS}	1.59 23^{NS}	2.04 00*	0.94 03^{NS}	0.41 28^{NS}	0.30 89^{NS}	0.10 25^{NS}
3/120								-	0.43 61^{NS}	0.10 80^{NS}	0.54 68^{NS}	0.99 73^{NS}	0.10 74^{NS}	0.63 52^{NS}	0.73 90^{NS}	0.94 52^{NS}
3/180									-	0.32 81^{NS}	0.11 08^{NS}	0.56 18^{NS}	0.54 34^{NS}	1.07 06^{NS}	1.17 43^{NS}	1.38 00^{NS}
3/240										-	0.43 89^{NS}	0.88 95^{NS}	0.21 54^{NS}	0.74 31^{NS}	0.84 69^{NS}	1.05 29^{NS}
4/120											-	0.45 11^{NS}	0.65 41^{NS}	1.18 11^{NS}	1.28 47^{NS}	1.49 03^{NS}
4/180												-	1.10 44^{NS}	1.63 01^{NS}	1.73 34^{NS}	1.93 84^{NS}
4/240													-	0.52 79^{NS}	0.63 18^{NS}	0.83 80^{NS}
5/120														-	0.10 40^{NS}	0.31 03^{NS}
5/180															-	0.20 64^{NS}

CONCLUSIONS

Significant differences between the hatchability values associated with different storage periods allow us to state that at least under the experimental conditions of the present paper a storage time of more than 7 days without the application of any thermal treatment has negative repercussions on the hatchability %.

The results obtained with the storage of eggs for 7 days confirm the idea that it does not affect the halo, irrespective of the thermal treatment applied. The results are consistent with those reported by other authors, according to which 7 days of storage do not significantly affect incubation parameters.

After the results of the 14-day storage, two heat treatments are recommended for 180 minutes. Any other combinations, even if they offer higher hatching rates, do not statistically differ significantly from recommendations. These differences are most likely determined by sampling errors which, under industrial conditions, are greatly minimized due to the size of the samples.

According to results obtained in the case of eggs storage for 21 days, the variant with 4 thermal treatments for 180 and 120 minutes, respectively, was noted. The fact that between these recommended values and

other experimental variants there are no significant differences, at least under the experimental conditions of the present paper, the exposure of the eggs stored over 21 days to 3 thermal treatments, 120 minutes per treatment could have the same effect. The decision in practice will be based on financial considerations and on the basis of a lower associated error.

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