IMPROVEMENT PERFORMANCE OF HATCHERY DUE TO THERMAL EGGS HANDLING

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Abstract

The objective of the experiment was to evaluate the influence of thermal manipulation on the improvement of hatching eggs of different weights of laying breeder hens in the last embryonic stage. The experiment was carried out in a commercial hatchery of laying breeder hens, located in Birigui - SP, Brazil. 1950 light-colored eggs of the Dekalb White commercial strain were used. The eggs were classified among different sizes and n in hatching trays. In the period from 19 to 21 days, two hatching machines were used, where the first machine maintained the temperature and humidity values of the hatchery's standard air (37.0 ° C and 60% RH) and in the second machine the temperature was adjusted to 37.7 ° C with 60% RH. The treatments differed according to the residence time in the second machine, and egg weight (G and M) controls T1 (0h-G) and T6(0h-M), 1 hour T2(1h-G) and T7(1h-M), 3 hours T3(3h-G) and T8(3h-M), 6 hours T4(6h-G) and T9(6h-M) 9 hours T5(9h-G) and T10 (9h-M). The design was completely randomized, in a 2X5 factorial scheme. Regarding thermal stimulation, the best results were observed in the 1h-G treatment. However, in the productive life of these birds, the thermal stimulation showed no influence. Concluded that for large eggs (G), the residence time of 1 hour (T2), obtained a better index of commercially viable females and lower rates of late-stage embryo mortality and shelter.

Keywords: epigenetics, thermal stress, animal welfare, posture.

1. INTRODUCTION

In the last decades in poultry farming, there has been a great increase in productivity, compiled to the pillars of nutrition, sanity, and genetic improvement. However, it is reported in the literature a high mortality and fall in poultry productivity due to heat stress [1];[2].Concomitant to this fact, it is noticed that the climate undergoes changes and the animals will have to undergo adaptations to global warming.

These results suggest that there is an increase in the prevalence of climatic phenomena known as heat waves ([1];[2], which relate a combination of factors such as high temperature and relative humidity and absence of ventilation, and these are related to the mortality of commercial laying hens) [1].

Facing this challenge, studies to acclimatize birds at high environmental temperatures, through embryonic thermal manipulation or also called epigenetic temperature adaptation [3];[4] are being developed. This procedure alters the points of thermoregulation of birds, and it is necessary that changes in the temperature of the prenatal body occur during the critical periods of embryonic development, making the thermoregulatory function more flexible, and improving the performance in responses to the variation of temperature of the birds [5]; [6].

Thus, the objective of the study was to evaluate the influence of thermal manipulation on the productivity of hatching eggs of different laying breeder hens weights in the last embryonic stage.

2. LITERATURE REVIEW

In order to perform embryonic thermal manipulation, three important factors must be considered: (A) the sensitive embryonic period, where this factor can vary between the beginning of the hatching until the moment of hatching; (B) Temperature intensity, which can be positive or negative in relation to the standard temperature; and (C) Embryo exposure time to temperature change [3];[7].

To evaluate the effects of the different treatments on the embryo development stage, several protocols have been studied [8];[9];[10];[11];[12];[13];[14];[15];[16]. In these studies, the sensitive period was maintained in the intermediate phase of embryonic development, however, with changes in temperature intensity and time of exposure.

Following a different protocol, [5] reported that the period of exposure during the late embryonic stage developed greater resistance to heat stress during adult life.

Reported in a thermal manipulation study that in the commercial poultry industry [17], the hatching process of fertile eggs is performed and commercially distributed, where the optimization of chick production does not only imply in the hatching of fertile eggs but in high productivity in a sustainable manner, including the hatching yield of healthy chicks with high survival rates and maximum expression of their genetic potential under any conditions.

In this line of research, [18] evaluated the embryonic development of the Ross lineage, thermally manipulating the embryonic development in a period of 14 to 18 days, verifying that the thermal manipulation did not increase the embryonic mortality and observed improvements in chick quality.

With thermal manipulation protocol during the last phase in the incubator and in the hatchery [5], reported effects on hatching productivity as improvements of 1.5% hatch rate. Thus, forms of changes in the hatching process must be researched to develop improvements and make the process more efficient in

the embryonic development as in the productive life of the bird [19]; [18]; [20].

3. MATERIAL AND METHODS

The study was conducted in a commercial hatchery, certified by the Committee of Ethics in the Use of Animals (CEUA), of the Animal Science Course, São Paulo State University (UNESP), Faculty of Agricultural and Technological Sciences, Dracena/SP under the No. 11/2016 in accordance with the ethical principle of animal experimentation.

The study was carried out in a commercial hatchery of laying breeder hens, located in Birigui-SP, in the "latitude of 21º16'53" south and longitude 50º19'35"west, an altitude of 406 meters, with climatic classification according to Koppen Wa.

For the experiment, 1950 light-colored eggs of the commercial Dekalb White® lineage were used at 39 weeks of age, produced on the same day, and incubated after 3 days of storage. These eggs were classified in the Yamasa® CHS 54 machine with egg weight ranging from 53g to 58g (M), and 59g and 64g (G), totaling 975 eggs of each weight, automatically allocated in hatching trays acclimated for 2 hours before the standard hatching process of the hatchery until the 18th day of embryonic development.

The eggs were incubated in the CASP CM® machine, with multiple hatching phase, where the thermostat was set to keep the temperature constant at 36.5 °C and 60% relative humidity. The temperature control was regulated through sensors built to operate in the range of 21.1 °C to 43.3 °C (70 to 100 °F), calibrated by the system through a high precision thermostat.

In the period from 18 to 21 days, two CASP® machines were used, positioned frontally to the central corridor. In the first machine, standard temperature and relative humidity of the hatchery were maintained (37.0 °C with 60%) and in the second machine, the temperature was adjusted to 37.7 °C with 60% RH. Adapting this to the protocol used by [5] for the thermal manipulation of the embryos in the last phase of embryonic development.

For the experiment, a completely and randomized design with 2x5 factorial design (2 egg weights and 5 exposure periods) was used (Table1).

Table 1 - Exposure Period at 37,7°C

Treatment	Thermal maintenance hours/37,7C°	Standard temp. hours/37,0C°
T1/G	0	24
T2/G	1	23
T3/G	3	21
T4/G	6	18
T5/G	9	15
T6/M	0	24
T7/M	1	23
T8/M	3	21
T9/M	6	18
T10/M	9	15

Source: Elaborated by the authors.

In the first selected machine the temperature and relative humidity of the hatchery were maintained (37.0 °C with 60%) and in the second selected machine, the temperature was adjusted to 37.7 °C with 60% RH. The treatments were differentiated according to the length of stay in the second machine and egg weight (G and M), for the control groups T1 (G) and T6 (M) 0 hours, T2 (G) and T7 (M) 1 hour, T3 (G) and T8 (M) 3 hours, T4 (G) and T9 (M) 6 hours and T5 (G) and T10 (M) 9 hours. The formation of the design occurred on the 18th day of hatching, where the eggs were transferred from the incubators to the delivery room and were distributed in 130 trays of births, with 15 eggs each, identified according to the treatment, thus making each tray an Experimental Unit.

The removal of the chicks from the hatchery machines occurred at 504 hours (21 days of hatching), following the standard hatchery process, starting with the transfer of the trays to the chick's room, where the number of live chicks and unhatched eggs from each tray were counted (experimental unit). The live chicks were referred to as the process of quality selection, sexing and vaccination. The quality selection process was carried out through a careful analysis of the birds, in which chicks with poor formation, low vitality, dehydration, leg problems, open navels, omphalitis, and neurological problems were discarded.

The sexing of the chicks was performed by a trained collaborator of the hatchery, using the primary feather method on the wings, chickens out of the hatchery quality standard and the male chicks were numbed by the CO^2 method, sacrificed according to the humanitarian method.

Vaccination of the chicks was performed by pneumatic machines, by subcutaneous administration to the posterior neck, where all the females that underwent the selection process were vaccinated against Marek's Disease and Gumboru's Disease and then sent to the transport sector for individual weighing of each chick.

For the weighing process, a digital scale of the brand Tanita® model 1475, with a scale of 1g, was used, where all the birds had their weight checked individually and recorded according to their treatment and replication.

The unhatched eggs were identified and sent to the embryo diagnostic room, where they were opened to diagnose the embryonic mortality stage and calculate the fertility rate.

For the differential diagnosis of the mortality phase, the methodology was used to establish the moment when the incubation process was interrupted or if it was an infertile egg and these data were recorded in a specific worksheet.

The following phases were considered hatching failures in the embryo diagnosis: fertility rate (%), embryo mortality rate (TME) in the early and intermediate stages (0 to 18 days), late-stage mortality (18 to 21 days).

The fertility rate was calculated to determine the exact number of fertile eggs incubated, differing from the influence of variables of the egg production sector, with the hatching process. In this way, the fertility rate was used to determine the number of fertile eggs submitted to thermal stimulation (Equation 1).

Fertility rate (TF).

$$TF=(NOTI-NOI)/NOTI*100\ (\%) \qquad \text{Eq.1}$$

Where: TF = Fertility rate, NOTI = number of total incubated eggs, NOI = number of infertile eggs.

To determine possible problems in the incubators or in the hatching process, the embryonic mortality rate was calculated for the period of 0-17 days of hatching (Equation 2).

Embryonic mortality rate (TME).

TME= NEM /NOTI*100 (%) Eq.2

Where: TME = Embryo mortality rate, NOTI = number of total incubated eggs, NEM = number of dead embryos

The fertility rate and mortality rate from 0-17 days of hatching were used to determine the exact number of fertile and viable eggs that underwent thermal stimulation from the 18th day of hatching.

In addition to these variables, hatching rate, number of viable eggs for treatment (NOVT) in (%), productivity of commercially viable females on total incubated eggs (PFCT) in (%), commercially viable females on viable eggs (PFCV) in (%), rejected chicks plus embryonic mortality in hatching of 18 to 21 days (PRME) in (%) for total eggs and for viable eggs, were also evaluated.

The hatching rate determines the number of birds of both sexes, which hatched in relation to the number of incubated eggs, (Equation 3).

Hatch Rate (TE).

TE=NOE/NOTI*100 (%) Eq.3

Where: TE = Hatching rate, NOE = number of hatching eggs, NOTI = number of total incubated eggs

The form of calculation of the number of viable eggs for the treatment (NOVT) is shown in Equation 4.

The number of viable eggs for treatment (NOVT).

NOVT=NOTI-(NOI+NEM from 0 to 17 days) Eq.4

Where: NOVT = Number of viable eggs for treatment, NOTI = Total number of incubated eggs, NOI = number of infertile eggs, NEM = number of dead embryos

The number of viable eggs submitted to treatment (NOVT) was used to avoid that variables such as; fertility rate and embryonic mortality from 0-17 days of hatching, influenced the production results of commercially viable females.

The rate of productivity of commercially viable females (PFCT), considered a variable of great importance for hatchery incubators, was also calculated in Equation 5.

Production of commercially viable females on total incubated eggs (PFCVT).

PFCVT=(NFCV)/NOTI*100 (%) Eq.5

Where: PFCT = Production of commercially viable females on eggs, NFCV = number of commercially viable females, NOTI = number of total incubated eggs

To determine the influence of the treatments on the productivity of commercially viable females

without the influence of egg fertility and embryonic mortality of 0-17 days, the percentage of the productivity of commercially viable females was calculated on the number of viable eggs with 18 days of hatching (PFCV), (Equation 6).

Productions of commercially viable females on the number of viable eggs with 18 days of hatching (PFCV).

PFCV=(NFCV)/NOVT*100 (%) Eq.6

Where: PFCVV = Production of commercially viable females on the number of viable eggs, NFCV = number of commercially viable females, NOVT = number of viable eggs.

Equations 7 and 8 show the calculation of the rate of rejected chicks and late mortality in the hatching of 18 to 21 days (TPRMT) for total eggs and for viable eggs (TPRMV) respectively.

Rates of the number of rejected chicks and embryo mortality from 18 to 21 days, on the number of eggs incubated (TPRMT).

TPRMT=(NPR+NEM from 18 to 21 days)/NOTI*100 (%) Eq.7

Where: TPRMT = Rate of sum of rejected chicks and number of dead embryos from 18 to 21 days over total number of incubated eggs.

NPR + NEM = number of rejected chickens + number of dead embryos from 18 to 21 days, NOTI = number of incubated eggs.

Rate of the rejected chicks sum and embryo mortality from 18 to 21 days, on the number of viable eggs (TPRMV).

TPRMV=(NPR+ NEM de 18 a 21 dias)/NOVT*100 (%) Eq.8

Where: TPRMT = 'Rejected chicks' sum and embryo mortality rate from 18-21 days on the number of viable eggs, NPR + NEM = number of chicks rejected + number of dead embryos from 18 to 21 days, NOVT = number of viable eggs.

Data analysis

For the variables studied, comparisons were made between the control treatment and the treatments with better results, through an accurate Binomial test (95%), totalizing 13 replicates per treatment, 130 trays. Comparisons were made respecting the sizes of the eggs (MinitabStatistical Software – version 18).

4. RESULTS AND DISCUSSION

It was not identified, from 0-17 days of hatching, the influence of treatments for infertile eggs, fertilityrate, embryonic mortality rate, the sum of infertile eggs + embryonic mortality. The same behavior was observed for the numberofviable eggs with 18 days of hatching (Table 2).

Table 2 - Variables not influenced by the treatments: infertile eggs, fertility rate, embryonic mortality 0-17 days hatching, Embryonic mortality rate 0-17 days, the sum of infertile eggs + embryo mortality 0-17 days and number

of viable eggs with 18 days.

	0h-G	*0h-M*	*1h-G*	*1h-M*	*3h-G*	*3h-M*	*6h-G*	*6h-M*	*9h-G*	*9h-M*
NOI (eggs)	12	7	11	10	11	7	7	10	9	12
TF(%)	93,85	96,41	94,36	94,87	94,36	96,41	96,41	94,87	95,38	93,85
NEM 0-17 days (Eggs)	7	10	6	9	10	18	10	8	9	9
TME 0-17 (%)	3,59	5,13	3,08	4,62	5,13	9,23	5,13	4,10	4,62	4,62
NOI+NEM 0-17days (Eggs)	19	17	17	19	21	25	17	18	18	21
NOV – 18 days (Eggs)	176	178	178	176	174	170	178	177	177	174

M= eggs (53g to 58g) G= eggs (59g to 64g). h: hours, NOI= Number of infertile eggs.

TF= Fertility Rate (%). NEM = Number of dead embryosTME= Embryonic mortality rate (%).

NOV= Number of viable eggs.

Source: Elaborated by the authors

These results corroborate with studies [24] who evaluated the effect of three sizes of small, medium and large (60g, 65g, and 70g) broiler breeders eggs on hatching and reported maximum fertility on small eggs (96.67%), followed by medium eggs (93.33%) and large (90.33%) eggs.

Reported [5] that in 6 hatching trials, with a total of 9,88 eggs of heavy matrices found mean fertility of these protocols of 94.7%.

In viable eggs submitted to thermal manipulation, (Table 3) It is perceived that smaller eggs (M) thermally manipulated for 6 hours, were the only ones who obtained favorable results in relation to the control group. However, recent studies have identified that pre-or post-hatching thermal manipulation may improve the thermotolerance of broiler chickens in the long term [3].

This fact demonstrates the importance of adapting the suggested protocols and the various physical characteristics of the eggs.

Table 3 - Embryo hatch rate

	0h G	*0h M*	*1h G*	*1h M*	*3h G*	*3h M*	*6h G*	*6h M*	*9h G*	*9h M*
NOE (Eggs)	173	175	172	169	168	169	170	178	170	171
NOTI (Eggs)	195	195	195	195	195	195	195	195	195	195
TE(%)	88,72	89,74	88,21	86,67	86,15	86,67	87,18	91,28	87,18	87,69
P-value			**SEF**	**SEF**	**SEF**	**SEF**	**SEF**	**0,2846**	**SEF**	**SEF**

The P-values are the result of the exact test based on Binomial Distribution, comparing the respective treatment against

the control, for eggs of the same size.

P-value ≤0.05 shows the effect on treatment. The values should be read in the column.

M=eggs (53g to 58g) G= eggs (59g to 64g), NOE= Number of hatched eggs, NOTI= total number of incubated eggs

TE(%)= Hatch Rate (%). SEF= no favorable effects, h: hours

Source: Elaborated by the authors

However, they did not present P value ⩽0.05, therefore without statistical evidence. In this variable, no relation was observed between thermal manipulation, egg size, and control group.

Close results were found by [21] who evaluated the influence of egg classification in the hatchery of heavy matrices with 25 to 60 weeks of age. They observed a hatching rate of 89.6% for eggs weighing 58g to 65g, but for eggs weighing between 52g and 57g the hatching rate was 87.1%, and this small difference may be related to the lineage of the matrices (laying and broiler breeder hens), age of matrices and differences in the hatching process.

In contrast, [5] found a high hatching rate in the embryos of the Ross 308 embryo. The authors thermally handled 30 to 50-week broiler breeder hens eggs in the final hatching phase (18 to 21 days of hatching) with two thermal manipulation protocols that obtained hatch rates above 94%.

The eggs of size (M), except for eggs stimulated for 1 hour, had lower embryonic mortality of 18 to 21 days (Table 4), indicating a favorable effect of the stimulated eggs with 3 hours, however, with a P-value of 0.196. For size eggs (G), the thermal stimulation did not show favorable effects in relation to the control group.

Table 4 - Embryonic mortality 18-21 or late mortality

	0h G	***0h M***	***1h G***	***1h M***	***3h G***	***3h M***	***6h G***	***6h M***	***9h G***	***9h M***
NEM 18-21days (Eggs)	3	3	4	7	6	1	8	3	7	2
NOTI (Eggs)	195	195	195	195	195	195	195	195	195	195
ME 18-21 days (%)	1,54	1,54	2,05	3,59	3,08	0,51	4,10	1,54	3,59	1,03
P-value			**SEF**	**SEF**	**SEF**	**0,1968**	**SEF**	**0,6472**	**SEF**	**0,4215**

The P-values are the result of the exact test based on Binomial Distribution, comparing the respective treatment against the control, for eggs of the same size. P-value ≤0.05 shows the effect on treatment. The values should be read in the column.

M=eggs (53g to 58g) G= eggs (59g to 64g), NEM= Number of dead embryos,

NOTI= total number of incubated eggs,ME (18-21) % = Embryonic mortality 18-21 or late mortality (%),

SEF= no favorable effects, h: hours

Source: Elaborated by the authors

As one of the biggest challenges currently in poultry production is the thermal stress and its

consequences for the main zootechnical indexes, including mortality. There is indicative that the size of the eggs may have an influence on the protocol adopted. Verified by [22] that the thermal manipulations, with temperatures below the recommended for quails, delayed hatching and reduced birth weight.

Subtle changes (< 1.0 oC) in the hatching environment lead to important physiological changes in the physical fitness of the chick. Suggests by [23] that pre-hatch thermal manipulation has a greater influence on thermotolerance than post-hatch.

Thus, these changes found in thermotolerance due to the hatching environment, bring limitations in the performance and economic return of the whole system [16].

By [24] when evaluating eggs from three different sizes of heavy matrices, observed maximum embryonic mortality in the last phase ($P \leqslant 0.05$) during hatching in the group of large eggs (70g) followed by the group of eggs of medium (65g) and small (60g) size.

Thermally manipulating eggs of heavy matrices [12], during the period from 7 to 16 days of hatching, with a temperature of 39.5 ° C (+ 2 ° C) and duration of 12 and 24 hours of elevation of temperature, reported that in the 60% of the embryos failed to perform complete hatching, compared to 33% and 23% in the 12-hour and control treatments respectively, reporting a negative effect on embryo development, due to the factors; temperature and time of exposure.

The treatment, referring to 1 hour of thermal stimulation in G eggs (Table 5), was more effective (P-value 0.033) in relation to the quality of hatched chicks. It was observed (Table 5) that the thermal stimulation of 1 hour in eggs (G), showed P-value 0.033, evidencing its favorable effect of the thermal stimulation, in relation to the quality of hatchlings. These results agree with [5], who evaluated the effects in 6 trials of thermal manipulation of 2 hours in the last 4 days of hatching in broilers, reporting clear signs of improvement in chick quality in relation to the control group.

Table 5 - Rate of the number of chicks slaughtered and the number of dead embryos in 18-21 days of hatching, in relation to the number of eggs incubated and viable with 18 days.

	0h G	***0h M***	***1h G***	***1h M***	***3h G***	***3h M***	***6h G***	***6h M***	***9h G***	***9h M***
NPR+ NEM 18 to 21days (Chicks)	16	16	9	31	22	12	42	11	43	30
NOTI (Eggs)	195	195	195	195	195	195	195	195	195	195
TPRMET (%)	8,21%	8,21%	4,62%	15,90%	11,28%	6,15%	21,54%	5,64%	22,05%	15,38%
P-value			**0,0372**	**SEF**	**SEF**	**0,1819**	**SEF**	**0,1166**	**SEF**	**SEF**
NPR+ NEM 18 to 21 days	16	16	9	31	22	12	42	11	43	30

(Chicks)										
NOVT (eggs)	176	178	178	176	174	170	178	177	177	174
TPRMV (%)	9,09	8,99	5,06	17,61	12,64	7,06	23,60	6,21	24,29	17,24
P-value			**0,0332**	**SEF**	**SEF**	**0,2329**	**SEF**	**0,1199**	**SEF**	**SEF**

The P-values are the result of the exact test based on Binomial Distribution, comparing the respective treatment against the control, for eggs of the same size. P-value ≤0.05 shows the effect on treatment. The values should be read in the column.

M=eggs (53g to 58g) G= eggs (59g to 64g), NPR+NEM 18 to 21days = Number of rejected chicks and embryonic mortality from 18 to 21 days hatching, NOTI = total number of incubated eggs, NOVT = number of viable eggs, TPRMET (%) = Rate of rejected chicks sum and embryo mortality from 18 to 21 days of hatching, on the total number of incubated eggs, TPRMV (%) = Rate of rejected chick sum and embryo mortality from 18 to 21 days of hatching on the number of viable eggs, SEF= no favorable effects, h: hours

Source: Elaborated by the author

Studied the thermal manipulation [18] for hot and cold, in eggs of heavy matrices and also reported the increase in hatching and quality of the chicks, however, the negative results of the present study also corroborate with other authors, such as [25] who also manipulating thermally for hot and cold but with temperature intensity of 40.6ºC, reports an increase in mortality of chicks after hatching.

Thermally manipulating eggs of heavy matrices [12]; [13], during the period from 7 to 16 days of hatching, with temperature variables and duration of 12 and 24 hours of temperature rise, reported that the percentage of hatched chicks, with presence of the external yolk sac of the abdominal cavity, and chicks with open navels, reached 34% for embryos exposed to 24 hours, 14% and 5% for 12 hours and control treatment respectively, demonstrating negative effects on mortality and quality of chicks when embryonated eggs are exposed to long-term thermal manipulation.

The best results regarding productivity (Table 6) were found by thermal stimulation of 1h-G, (P-value 0.021), showing its favorable effect. However, this increase in the productivity of commercially viable females was not related to a higher number of hatched eggs (Table 2), but to a reduction in the variable chicks and mortality from 18 to 21 days of hatching (Table 4). However, large (G) eggs handled with exposure time over 6 hours (6h-G and 9h-G) presented the worst results, dramatically decreasing the quality of hatched chicks, and increased embryo mortality (18-21 days).

Table 6 - Production of commercially viable females in relation to the total number of incubated eggs and viable eggs with 18 days.

	0h G	***0h M***	***1h G***	***1h M***	***3h G***	***3h M***	***6h G***	***6h M***	***9h G***	***9h M***
NFCV (Chicks)	84	86	99	74	82	90	63	92	61	71
NOTI (eggs)	195	195	195	195	195	195	195	195	195	195
PFCVT (%)	43,08%	44,10%	50,77%	37,95%	42,05%	46,15%	32,31%	47,18%	31,28%	36,41%
P-value			**0,0184**	**SEF**	**SEF**	**0,3062**	**SEF**	**0,2135**	**SEF**	**SEF**
NFCV (Chicks)	84	86	99	74	82	90	63	92	61	71
NOVT (eggs)	176	178	178	176	174	170	178	177	177	174
PFCVV (%)	47,73	48,31	55,62	42,05	47,13	52,94	35,39	51,98	34,46	40,80
P-value			**0,0211**	**SEF**	**SEF**	**0,1292**	**SEF**	**0,1841**	**SEF**	**SEF**

The P-values are the result of the exact test based on Binomial Distribution, comparing the respective treatment against the control, for eggs of the same size. P-value ≤0.05 shows the effect on treatment. The values should be read in the column.

M=eggs (53g to 58g) G= eggs (59g to 64g), NFCV= Number of commercially viable females, NOTI = number of incubated eggs, NOVT = number of viable eggs (18 days), PFCVT= Productivity of commercially viable females on the total number of incubated eggs (%), PFCVV= Productivity of commercially viable females on the number of viable eggs (%)

SEF= no favorable effects, h: hours

Source: Elaborated by the authors

The negative results for production of heat-engineered chicks with a 9-hour exposure period in this study corroborate the results of [13], who thermally manipulated eggs from heavy matrices during the period of 7 to 16 days of hatching, with a temperature of 39.5 ° C (+ 2 ° C) and a duration of 12 and 24 hours of exposure to high temperature, and found a reduction in chick productivity due to lower quality of the hatched chicks manipulated thermally in relation to the control group.

Evaluated the hatchability of eggs from thermally manipulated [25]heavy matrices during the hatching period until the 18th day, with a controlled temperature of 37.6 °C, high (40.6 °C) and low temperature (34.6 °C), with a 24-hour exposure period. Significant negative differences were observed in chick productivity of the group exposed to high temperature in relation to the control treatment, demonstrating that the time of exposure to high temperatures may lead to a decrease in chick production in the hatchery. The same authors also present positive results that agree with the evaluation of [5], thermally manipulating

eggs of heavy matrices, noted that the short-term thermal manipulation, in the final 4 days, with intensity + 1 °C for 2 hours per day, improved hatching results by 1.5%.

In the results observed in Table 6, the group of large eggs submitted to the exposure time of 1 hour (1h-G), achieved positive results, with differences of 7.8% in relation to the control treatment. Although the results of the findings are consistent with [5]; [11], thermally manipulating eggs from heavy matrices, in the period from 16 to 18 days of hatching, with 4 exposure time of 3, 6, 12 and 24 hours, reported increase in chick productivity in eggs with exposure time of 12 and 24 hours, in contrast to the results found in Table 5, which showed a drastic drop in chick production as the egg exposure time increased.

When it comes to hatching performance, it is important to highlight welfare indicators in the productive life of these animals. These indicators can be leg and walking problems.

Found that thermal manipulations [22], with temperatures below the recommended for quails, affected the frequency of falls during bird walking. In a study of broiler chickens, it was found that increased embryonic activity provides a mechanism that explains increased leg and bone muscle growth in embryos incubated for 3 days at higher temperatures.

5. CONCLUSION

In conclusion, it is noticed that there is an interaction between the size of hatched eggs and the time of thermal manipulation, and with 1 hour of stimulation had better results.

It is expected that, with the next analyzes carried out, the influence of thermal handling and its interactions with thermal stressand productivity.

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