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# Impact of Thermal Manipulation during Early Embryogenesis on Hatching Traits and Some Physiological Body Reactions in Dokii-4 and Golden Montazah Chickens Under Upper Egypt Climatic Conditions

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**Abstract**

This study was designed to evaluate the impact of strain, thermal manipulations during incubation on the hatching traits and physiological body reactions of Dokii-4 and Golden Montazah chickens. A total of 2250 fertile eggs of both Golden Montazah and Dokii-4 eggs (2 strains × 3 treatments × 3 replicates × 125 eggs). The eggs of both strains were classified into 3 equal thermal treatments. All eggs were incubated at 37.5°C and 55-60 % RH during the period from one day till hatch (control group), while those in the 2nd and 3rd groups were daily exposed to 40ºC and 35 for 3 hours during 3 successive days from 5 to 7 day of incubation. During the last three days of incubation, eggs were incurred daily to 37°C and 60-65% RH. The obtained results showed that the hatchability of Golden Montazah was significantly decreased, while CWH (g) was significantly increased compared with Dokii-4 chickens. Regarding the effect of thermal manipulations, the highest hatchability (%) was recorded at 35°C and 37.5°C groups, while the lowest one was recorded at 40°C. The chick weight at hatch in the 1st (37.5°C) and 3rd (35°C) groups significantly increased than those in the 2nd group (40°C) groups. It could be concluded that the hatchability and chick weight at hatch for Golden Montazah chickens produced from eggs exposed to normal and low incubation temperatures significantly improved compared with those under high incubation temperature group.

**Keywords**: Strain, thermal manipulation, hatching traits, Dokii-4 and Golden Montazah chicks

# INTRODUCTION

One of the significant challenges facing the poultry industry in Egypt is the elevated ambient temperature, which persists for approximately five months of the year. To address this challenge, numerous studies have concentrated on the potential of epigenetic temperature adaptation for local strains. It is widely recognized that the incubation conditions, encompassing temperature, relative humidity, gas exchange, egg turning, and light, exert a profound influence on embryonic growth and development. Among these factors, the incubation temperature is arguably the most critical, as evidenced by the findings of Yalçın et al. (2022). The optimal temperatures for incubation of chicken eggs were found to range between 37.0°C and 38.0°C (Wilson, 1991). The sources of temperature during the incubation phase include the temperature of the incubator, heat exchange between the embryo and its environment, and the metabolic heat production of the embryo (French, 1997). The EEM (%) in the 40°C group exhibited a notable increase in comparison to the control and 35°C groups. Similarly, the cloacal temperatures of chicks produced from eggs exposed to 40°C demonstrated a significant elevation in comparison to the control and low groups. With regard to the strain effect, the hatchability percentage and chick weight exhibited a notable increase in the Inshas strain in comparison to the Dokii-4 strain (Ali et al., 2012). Similarly, significant differences were observed in the weight of male chicks at hatch between different strains. The highest values were recorded for the Shaver C strain, while the lowest weight was observed in the Mandarah strain (Taha et al., 2013). The objective of this study was to investigate the impact of thermal manipulations during early embryogenesis on hatching traits and physiological body reactions in Dokii-4 and Golden Montazah chickens.

# MATERIALS AND METHODS

This study was carried out at the research Poultry Farm, Poultry Production Department, Faculty of Agriculture Sohag University during the period from April 2020 to June 2021.

**Experimental design**

A total of 2250 fertile eggs of both Golden Montazah and Dokii-4 eggs produced from hens at 42 wk old, which purchased from the Animal Production Research Institute, Agricultural Research Center, Egypt. The eggs of both strains were classified into 3 equal thermal treatments (2 strains × 3 treatments × 3 replicates × 125 eggs). All eggs were incubated at 37.5°C and 55-60 % RH during the period from one day till hatch and were considered at the control group, while those in the 2nd and 3rd groups were exposed daily to 35 and 40ºC for 3 hours (from 12PM to 3 PM) during 3 successive days (5 to 7 day) of incubation. During the end of incubation period, eggs were exposed daily to (37°C and 60-65% RH)

**Studied traits**

**Incubation traits**

**Eggshell conductance**

The egg weight loss % (EWL) = (The intimal egg weight - egg weight on day eight at incubation)/the initial egg weight*100. In accordance with the methodology proposed by Aygun and Sert (2013), the dead embryos and unfertile eggs are excluded from the percentage of egg weight loss. Embryonic mortality (early, intermittent and late %). The percentage of mortality after piping (DAP, %) was calculated using the following formula: number of piped eggs/number of total set eggs × 100. The embryonic mortality percentage was determined using the following formula:(number of dead embryos/number of total eggs) × 100. The eggs were classified according to the stage of incubation, namely early (1-7d), intermittent (8-14d), and late (15-21d).

**Hatchability (%)**

The hatchability of set eggs (HSE, %) was estimated as the number of chicks which out from the eggs divided by the number of total eggs and multiplied by 100, according to the methodology proposed by Molenaar *et al.*, (2011). The duration of incubation was determined as the number of hours elapsed from the placement of the eggs to hatching.

**Physiological body reactions**

Almost 12 hours after hatching, a total of 54 chicks (2 strains × 3 treatments × 3 replicates × 3 chicks) used to determine physiological body reaction. The cloaca temperatures (°C) of the chicks were measured to the nearest 0.1°C by inserting a digital thermometer 1 cm deep into the cloaca. The wing, head, shank, back, and cloacae temperatures of chicks measured by using an infrared thermometer and then the recorded these values. The body surface temperature (BST/°C) calculated according to the following equation: BST/°C = (0.12 × wing T) + (0.03 × head T) + (0.15 ×shank T) + (0.70 × back T), as described by Richards (1971).

**Statistical analysis**

The data were subjected to statistical analysis using the Generalized Linear Model (GLM), as implemented in the statistical analysis system (SAS, 2004). The significance of the differences between the treatment means was determined using the Duncan new multiple range test (Duncan, 1955). The following linear model was applied: Yij = μ + Si + TMj + SiTMj+ eij

Where, Yij= Observation measured, μ= Overall mean, Si= Effect of strain (i = 1, 2), TMj= Effect of thermal manipulation (j = 1, 2 and 3), SiTMj= Interaction between chicken strain and thermal manipulation, Eij= Random error component was normally distributed assumed.

# RESULTS AND DISCUSSION

**Effect of strain, thermal manipulations and their interaction on hatching traits**

**Effect of strain**

The results presented in Tables 1 & 2 showed that the IEW (g), CWH (g), RCW (%), EEM and LEM (%) of the Golden Montazah strain were significantly increased as compared with those of Dokii-4 chicken strain, and this due to strain effect. The significant increase in IEW (g), CWH (g) and RCW (%) may be due to the genetically effect of the strain, which was produced by crossing from Dokii-4 and Rhode Island Red, which was classified as the heaviest egg strain (Mahmoud *et al.*, 1974). These results is similarly with Ali et al., (2012), who found a significant increase in the body weight at hatch in Inshas as compared to Dokii-4 strain. The significant increase in EEM and LEM (%) in Golden Montazah chicken strain may be due to the lowest hatchability in this strain. These results agreed with Osman et al., (2010), who found that Fayoumi hens had lower embryonic mortality at 7 days of incubation than those of the Golden Montazah hens. The hatchability (%) in Golden Montazah chickens was lower than that of the Dokii-4 strain. This significant decrease may due to the increased embryonic mortality. These results are agreed with those of Kosba et al., (2008), who reported that the Golden Montazah chickens had significantly higher fertility and lower hatchability than Fayoumi chicken strain. Also, Osman et al., (2010), noted that the Fayoumi hens had higher hatchability percentage than those of the Golden Montazah. Also, Alsobayel et al., (2012) reported that the hatchability (%) was significantly affected by breed. The obtained results showed no significant effect due to the strain on EW at 8d (g), RWL (%), IEM (%), PE (%) and CC (%). Regarding thermal manipulations effect, the results revealed that the CWH (g) and RCWH(%) in the group (40°C) were significantly decreased as compared with those of the (control) and 3$^{rd}$ (35°C) groups. The significant decrease in CWH (g) and RCWH (%) in the 2$^{nd}$ group may be due to the increase of water evaporation from the eggshell of the eggs exposed to high incubation temperature. These results are dis agreed with Romanoff et al., (1938) reported that hatching eggs exposing to incubation temperature (40.5°C) during the first week could likewise increase embryo weight in the incubational period as compared to the control group. Also, Hulet et al., (2007) showed that the changes in the eggshell temperature during incubation period remarkably affected chick body weight, as well as Yalçin et al., (2008), recorded a transitory increase in chicks body weight of heat-treated for 6 hours/day with 38.5°C during embryogenesis period from 10$^{th}$ to 18$^{th}$ day. The results of Elsayed *et al.*, (2009) showed that the weight of hatched chicks which produced from eggs exposed to high temperatures were higher as compared to those of control group. Also, Ismail *et al.,* (2016) observed a significant increase in the weight and length of male Mamoura chick produced from eggs daily exposed to 39ºC for 4 hours during the incubation phase than those of chicks in the control group (37.8ºC). Similarly, Abuoghaba, (2017) found a significant increase in Hubbard broilers chick weight and length after exposure to high incubation temperature (40°C) as compared with those (37.5°C) group. Joseph *et al.,* (2006) noted that a low (36.6 $^{o}$C) incubation temperature during the early stage (0 to 10d) of incubation increased chick weight at hatch, which is primarily due to a larger yolk sac weight as compared to the control group. Also, Sgavioli et al., (2015) showed that the egg weight loss significantly increased with the increasing of the incubation temperature, which revealed higher weight loss in the eggs incubated at high temperature at (39°C) as compared with those incubated at normal incubation temperature (37.5°C). In contrast, the results of Yalçın *et al.,* (2012) showed that the RWL (%) from Ross broiler breeder eggs after exposure to 36.6°C for 6 hours from 10$^{th}$ to 18$^{th}$ day of incubation was not affected as compared with those of the control group. Similarly, the findings of Elsayed et al., (2016) who found insignificant differences in RWL% between ostrich eggs exposed daily to 38.5ºC and 45% RH for 3 hours during the period from 35 to 37 days of incubation as well as the control group (37.8ºC). The obtained results showed that the lowest hatchability (%) was recorded the in 2$^{nd}$ group (40°C), as compared with those of 3$^{rd}$ at (35°C) and the 1$^{st}$ group (control). The increase of relative water loss and insufficient egg contents needed to embryos development this may be the reason of the reduction in hatchability (%) in the group (40°C), Abuoghaba et al., (2021). These agreed with those of Aksoy et al., (2016), who showed that the hatchability (%) in Ross 308 broiler breeder eggs exposed to 39.5°C during incubation period was significantly decreased as compared with those of the control group. Similarly, the findings of Morita *et al.,* (2009) showed a decrease in the hatchability rates in broiler eggs exposed to high incubation temperature than those under normal incubation temperature. Also, Abuoghaba (2017) documented that the hatchability (%) of broiler eggs which were exposed daily to (40°C) for 3 hours decreased significantly as compared to that of the with the control group. The percentages of EEM and LEM in the 2$^{nd}$ group (40°C) were significantly increased as compared with those in the 1$^{st}$ and 3$^{rd}$ groups. This significant increase may be due to the increase high incubation temperature which led to cause quickly growth embryos as well as embryos are very sensitive to environmental conditions Zhu *et al.,* (2015), another explanation was stated Morita et al., (2010) who found that the excessive water loss by the eggs and consequent dehydration. These results agreed with Al-Sardary and Mohammad (2016), who found a significant increase in the early mortality rate for broiler eggs after exposure to thermal manipulation at (38.8ºC) during the early embryogenesis (1-5 days) of the incubation than those of the control group. The late mortality rate for ostrich embryos produced from eggs exposed to thermal stress (38.5ºC and 45% RH) for 3 hours in days (35 to 37) of incubation was significantly increased as compared to that of the control group according to Elsayed et al., (2016) .The Ew8d (g), RWL (%), IEM (%), Piped (%) and culled chicks (%) were not affected by the thermal manipulations effect. The interaction between strain and thermal manipulations didn't significant effect on hatching traits.

Table 1. Impact of strain, thermal manipulations and their interaction on hatching traits

| Traits<br>Groups | IEW (g) | EW8d (g) | RWL (%) | Hatchability (%) | CWH (g) | RCWH (%) |
|---|---|---|---|---|---|---|
| Effect of strain (S) | | | | | | |
| Dokii-4 | 50.49[b] | 48.76 | 4.29 | 72.53[a] | 33.20[b] | 65.18[b] |
| Golden Montazah | 51.16[a] | 49.25 | 3.72 | 66.67[b] | 35.03[a] | 68.48[a] |
| SEM | 0.04 | 0.21 | 0.41 | 0.88 | 0.22 | 0.43 |
| Effect of thermal manipulations (TM) | | | | | | |
| 1st group (Control37.5ºC) | 50.95[b] | 49.13 | 3.57 | 72.13[a] | 34.46[a] | 67.63[a] |
| 2nd group (HIT/40ºC) | 51.17[a] | 48.62 | 4.98 | 63.47[b] | 33.07[b] | 64.64[b] |
| 3rd group (LIT/35ºC) | 51.03[ab] | 49.26 | 3.47 | 73.20[a] | 34.82[a] | 68.22[a] |
| SEM | 0.05 | 0.26 | 0.50 | 1.08 | 0.27 | 0.52 |
| Probability | | | | | | |
| S | 0.008 | 0.126 | 0.356 | 0.001 | 0.002 | 0.003 |
| TM | 0.001 | 0.219 | 0.106 | 0.001 | 0.002 | 0.001 |
| Interaction (S×TM) | 0.056 | 0.533 | 0.995 | 0.342 | 0.380 | 0.150 |

A, b Means with different superscripts in the same column are significantly different (P≤0.05).IEW (g) = Initial egg weight, EW8d= Egg weight at 8days, CWH (g) = Chick weight at hatch, RCW (%) = Relative chick weight and RWL (%) = Relative water loss. S= Strain, TM= Thermal manipulations, S×TM= interaction

Table 2. Impact of strain, thermal manipulations and their interaction on embryonic mortality rates

| Traits | Embryonic mortality (%) | | | Piped egg (%) | Culled chicks (%) | Infertile (%) |
|---|---|---|---|---|---|---|
| | EEM (%) | IEM (%) | LEM (%) | | | |
| Effect of strain (S) | | | | | | |
| Dokii-4 | 4.27[b] | 4.18 | 3.82[b] | 3.82 | 5.24 | 6.13 |
| Golden Montazah | 5.96[a] | 5.24 | 5.00[a] | 4.80 | 6.93 | 5.42 |
| SEM | 0.34 | 0.38 | 0.27 | 0.32 | 0.76 | 0.31 |
| Effect of thermal manipulations (TM) | | | | | | |
| 1st group (Control37.5 ºC) | 4.40[b] | 4.40 | 3.90[b] | 4.27 | 5.47 | 5.47 |
| 2nd group (HIT/40ºC) | 6.67[a] | 5.60 | 5.73[a] | 4.93 | 7.07 | 6.53 |
| 3rd group (LIT/35ºC) | 4.27[b] | 4.13 | 3.60[b] | 3.73 | 5.73 | 5.33 |
| SEM | 0.42 | 0.47 | 0.35 | 0.39 | 0.93 | 0.37 |
| Probability | | | | | | |
| S | 0.006 | 0.077 | 0.016 | 0.056 | 0.146 | 0.132 |
| TM | 0.004 | 0.109 | 0.003 | 0.142 | 0.454 | 0.091 |
| S×TM | 0.967 | 0.789 | 0.806 | 0.962 | 0.897 | 0.214 |

A, b Means with different superscripts in the same column are significantly different (P≤0.05). EEM % = Early embryonic mortality, IEM % = Intermittent embryonic mortality and LEM % = Late embryonic mortality. S= Strain, TM= Thermal manipulations, S×TM= interaction

**Effect of strain, thermal manipulations and their interaction on philological body reactions**

Regarding strain effect, the data presented in Table 3, showed no significant differences between two strains in the temperatures of head, back, wing, shank and body surface temperature expect the cloacal temperature, which significantly increased in the Golden Montazah than that of Dokii-4 strain. This significant increase may be due to the difference in thermoregulation ability of heat production or heat loss under genetic control (Uneo and komiyama, 1987). These results agreed with those of Youssef *et al*., (2014), who found that the body temperature in Golden Montazah significantly increased compared with those of Fayoumi and El-Salam chicken strain.

Table 3. Impact of strain, thermal manipulations and their interaction on physiological body reactions

| Traits | Body organ temperatures | | | | | BST (ºC) |
|---|---|---|---|---|---|---|
| | Head (ºC) | Back (ºC) | Wing (ºC) | Shank (ºC) | Cloacal (ºC) | |
| Effect of strain (S) | | | | | | |
| Dokii-4 | 37.48 | 37.70 | 37.33 | 37.03 | 39.34[b] | 37.31 |
| Golden Montazah | 37.68 | 37.87 | 37.39 | 37.24 | 39.72[a] | 37.41 |
| SEM | 0.10 | 0.12 | 0.13 | 0.16 | 0.12 | 0.09 |
| Effect of thermal manipulations (TM) | | | | | | |
| 1st group (Control37.5 ºC) | 37.53[ab] | 37.75 | 37.20[b] | 37.00[ab] | 39.45[ab] | 37.23[b] |
| 2nd group (HIT/40ºC) | 37.83[a] | 37.99 | 37.70[a] | 37.52[a] | 39.83[a] | 37.70[a] |
| 3rd group (LIT/35ºC) | 37.38[b] | 37.62 | 37.17[b] | 36.89[b] | 39.30[b] | 37.17[b] |
| SEM | 0.12 | 0.15 | 0.15 | 0.19 | 0.14 | 0.11 |
| Probability | | | | | | |
| S | 0.183 | 0.335 | 0.757 | 0.366 | 0.033 | 0.458 |
| TM | 0.046 | 0.225 | 0.043 | 0.048 | 0.042 | 0.006 |
| S×TM | 0.940 | 0.992 | 0.992 | 0.926 | 0.508 | 0.984 |

[A, b] Means with different superscripts in the same column are significantly different (P≤0.05). BST= Body surface temperature. S= Strain, TM= Thermal manipulations, S×TM= interaction.

With regard thermal manipulations, the obtained results showed that the temperatures of head, wing, shank, cloacal and body surface chickens produced from eggs after exposure to high thermal stress in the 2nd group (40°C) were significantly increased than those in the 1st (37.5°C) and 3rd (35°C) groups. The significant increase in the head, shank and cloacal temperatures may be due to the adverse effect of high incubation temperature, which led to the increased in the chick's physiological body reactions. These findings agreed with those of Abuoghaba (2017), who found that the cloacal temperature in broiler chicks produced from eggs after exposure to thermal stress increased significantly with the increasing of the incubation temperatures. Similarly, Vesco *et al.*, (2021) found that the body temperature in female quails subjected to continuous heat stress (32°C and 60% RH) was significantly higher (42.70°C) than that of females (41.25°C) for under that of thermo neutral condition (23°C and 60% RH). In contrast, the results of Sgavioli *et al.*, (2015), showed that the body surface temperature for newly hatched chicks produced from eggs incubated at different incubation temperature was not affect. There was no significant effect due to interaction between strain and thermal manipulations on philological body reactions.

# CONCLUSION

From these findings could be concluded as follow

1. The IEW (g), CWH (g), RCW (%), EEM and LEM (%) in Golden Montazah strain significantly increased, while the hatchability decreased significantly as compared with those of the Dokii-4 strain. The EW8d, RWL, IEM, PE and CC insignificantly affected between strains.
2. The cloacal temperature in the Golden Montazah increased significantly as compared to the Dokii-4 strain.
3. The CWH and RWL in the 2nd (40°C) were significantly lower as compared with those of the 1st (control) and 3rd (35°C) groups. The lowest hatchability (%) was recorded the in 2nd group (40°C), compared with those of 3rd (35°C) and the 1st group (control).The percentages of EEM and LEM significantly increased in the 2nd group

(40°C), compared with those of 3rd (35°C) and the 1st group (control). The Ew8d, RWL, IEM, Piped and culled (%) were not affected with thermal manipulations.

4. The temperatures of external organs which include (head, wing, shank, and body surface), as well as cloacal temperature for chickens which were produced from eggs exposed to high thermal stress in the 2nd group (40°C) increased significantly than those in the 1st (37.5°C) and 3rd (35°C) groups.
5. No significant effect in all studied traits due to the interaction between strain and thermal manipulations.

## REFERENCES

Abuoghaba, A.A. (2017). Impact of spraying incubated eggs submitted to high temperature with ascorbic acid on embryonic development, hatchability, and some physiological responses of hatched chicks. Can. J. Anim. Sci. 97: 172–182.

Abuoghaba, A.A.; Ragab, M.A.; Shazly, S.A.; Kokoszy´nski, D. and Saleh, M. (2021). Impact of treating hatching eggs with curcumin after exposure to thermal stress on embryonic development, hatchability, physiological body reactions, and hormonal profiles of Dokki-4 Chickens. Animals, 32 : 11-20.

Aksoy, T.; Narinç, D; Erdoğan, S. and Tahtabiçen, E. (2016). Effects of thermal manipulations during embryogenesis of broiler chickens on developmental stability, hatchability and chick quality. Animal. 8: 1328-1335.

Ali, M.N.; Hassan, M.S.; Abd El-Ghany, F.A. and Awadein. N. B. (2012). Using natural antioxidants with or without sulphate to improve productive and reproductive performance of two local strains at late egg production period. International Journal of Poultry Science. 4: 269-282.

Al- Sardary, S. and Mohammad, S.h. (2016). Effect of thermal manipulation during embryogenesis on hatching traits. International Journal of Agricultural Science 1: 2-7.

Alsobayel, A. A; Alganad , B. Y. and AlAbdullatif, A.A. (2012). Effect of age and sex ratio on fertility and hatchability of baladi and leghorn laying hens. The Journal of Animal & Plant Sciences. 1: 15-19.

Aygun, A., and Sert, D. (2013). Effects of pre storage application of propolis and storage time on eggshell microbial activity, hatchability, and chick performance in Japanese quail (Coturnix coturnix japonica)eggs. Poult.Sci.92: 3330–3337.

Duncan, D.B. (1955). Multiple range and multiple F tests Biometrics,11:1–42.

Elsayed, N.A.M.; Alkomy, A. E.; Alsaadany, A.S. and Hassan, E.Y. (2009). New suggested schemes for incubation temperature and their effect on embryonic development and hatching power. Asian Journal of Poultry Science, 3: 19-29.

Elsayed , M.A. (2016). Effects of thermal manipulation during late incubation period on post-hatch thermo tolerance in ostrich. Czech J. Anim. Sci. 9: 421–431.

French, N.(1997). Modeling incubation temperature: the effects of incubator design, embryonic development, and egg size. Poultry Sci., 76:124-133.

Hulet, R.; Gladys, G.; Hill, D.; Meijerhof, R. and El-Shiekh, T. (2007). Influence of eggshell embryonic incubation temperature and broiler breeder flock age on post hatch growth performance and carcass characteristics. Poult. Sci. 86:408–412.

Ismail , I. I.; Rizk, Y.S.; Nasra, B.; Awadien, F.; Tawfeek, A. and El-Wardany,I. (2016) . Effects of short-term thermal manipulation During late embryogenesis on hatching traits and post hatched subsequent performance of Mamoura strain chicks. J. Animal and Poultry Prod., Mansoura Univ. 7: 145 - 151.

Joseph, N. S.; Lourens, A. and Moran, E. T. Jr. (2006). The effects of suboptimal eggshell temperature during incubation on broiler chick quality, live performance, and further processing yield. Poult. Sci. 85:932–938.

Kosba, M.A. and Abd El-Halim, H. A. H. (2008). Evaluation of the Egyptian local strains of chinks. Egypt. Poult. Sci. 28: 1239-1251.

Molenaar, R.; Van den Anker, I.; Meijerhof, R.; Kemp, B. and Van den Brand, H. (2011). Effect of eggshell temperature and oxygen concentration during incubation on the developmental and physiological status of broiler hatchlings in the perinatal period. Poult. Sci. 90:1257–1266.

Morita,V.S.; Boleli, I.C. and Cargnelutti Filho, A. (2009).Hematological values and body, heart and liver weights of male and female broiler embryos of young and old breeder eggs. Braz. J. Poult. Sci.11:7–15.

Morita, V. D. S.; Boleli, I. C. and de Oliveira, J. A. (2010). Hematological and incubation parameters of chicks from young breeders eggs: variation with sex and incubation temperature. International Journal of Poultry Science.6: 606-612.

Osman, A. M. R.; Abdel Wahed, H. M. and Ragab, M. S. (2010). Effects of supplementing laying hens diets with organic selenium on egg production, egg quality, fertility and hatchability. Egypt. Poult. Sci.30: 893-915.

Richards, S.A. (1971). The significance of changes in the temperature of the skin and body core of the chicken in the regulation of heat loss. J. Physiol. 216:1–10.

Romanoff, A. L.; Smith, L. L. and Sullivan, R. A. (1938). Biochemistry and Biophysics of the Developing Hen's Egg.III. Influence of Temperature. Cornell University Agricultural Experiment Station Memoranda. 2016:1–42.

SAS Institute. (2004). SAS/STAT user’s guide. Version 9.1. SAS Institute Inc., Cary, NC. Broiler chickens. Poult. Sci. 89:1905-1914.

Sgavioli ,S.; Matos Júnior, J.B.; Borges, L.L.; Praes, M.F.F.M.; Morita V.S.; Zanirato, G.L.; Garcia, R.G.and Boleli, I.C. (2015). Effects of ascorbic acid injection in incubated eggs submitted to heat stress on

Taha, A. E. ; Abd El-Ghany, F. A. and Sharaf, M. M. (2013). Strain and sex effects on productive and slaughter performance of developed local Egyptian and Canadian chicken’s strains. J. Animal and Poultry Prod., Mansoura Univ. 5: 297– 319.

Uneo, T. and Komiyama, T.( 1987).Genetic variation in tolerance to extreme thermal environments in White Leghorn chickens. Jpn. Poult. Sci. 24:1–7.

Vesco, A. P. D.; Thaís, P.S. ; Eliane ,G.; Angélica de, S. K.; Claudson, O. B.; Leandro,T.B and Susan,J. L. (2021). Effect of prenatal ambient temperature on the performance physiological parameters, and oxidative metabolism of Japanese quail (Coturnix coturnix japonica) layers exposed to heat stress during growth. Sci Rep. 11: 9809.

Wilson, H.R. (1991).Physiological requirements of the developing embryo: Temperature and turning. Chapter 9. Pages 145-156 in: Avian Incubation. S.G. Tullet, ed. Butterworth-Heinemann, London, UK.

Yalçın, S.; Çabuk, M.; Bruggeman, V.; Babacanoğlu, E.; Buyse, J.; Decuypere, E. and Siegel, P.B. (2008). Acclimation to heat during incubation: 3. Body weight, cloacal temperatures, and blood acid base balance in broilers exposed to daily high temperatures. Poultry Science. 87: 2671-2677.

Yalçın, S.; Özkan, S.; Siegel, P.; Yenisey, Ç. and Akşit, M. (2012). Manipulation of incubation temperatures to increase cold resistance of broilers: Influence on embryo development, organ weights, hormones and body composition. Journal of Poultry Science. 49: 133-139.

Yalçın , S.; Sezen, Ö. and Tahir, S.(2022). Incubation temperature and lighting: Effect on embryonic development, post-hatch growth, and adaptive response. Front. Physiol. 13:1-16.

Youssef, S. F.; Yassein, D. M.; El-Bahy, N. M and Faddle, A. A. (2014). A comparative studies among Golden Montazah, El-salam and Fayoumi chickens. 1-response to acute heat stress as early heat conditioning procedure. Egypt. Poult. Sci, 34: 1075-1097.

Zhu, Y. W. L.; Lu, W. X. ; Li, L. Y.; Zhang, C. Ji. X.; Lin, H. C.; Liu, J.; Odle, A. and Luo. X. G. (2015). Effect of dietary manganese on anti-oxidant status and expression levels of heat-shock proteins and fac-tors in tissues of laying broiler breeders under normal and high environmental temperatures. Br. J. Nutr. 114:1965–1974