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Impact of thermal stress during early embryogenesis on hatching traits, physiological responses and productive performance of Matrouh chickens.

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Abstract

This study aimed to evaluate the impact of thermal manipulations during early embryogenesis on hatching traits, physiological responses and productive performance of Matrouh chickens. A total of 675 eggs were divided as follow as (3groups×3replicates×75 eggs). In the control group, eggs were incubated at 37.5°C and 50–55% RH from 0 until hatching. Eggs in the 2nd and 3rd groups were daily exposed to (40.0°C and35°C) for (E5-E7) days for 3 hours. The highest hatchability (%) was recorded in control, followed by the 35°C and 40°C groups. The EEM(%) in the (40°C) significantly increased compared with those in the(control and 35°C) groups. The cloacal temperatures for chicks produced from eggs exposed to 40°C were significantly increased than those in the control and low groups. The chicks body weight at 1day, 8and 16wks of age in the high group were significantly decreased compared with those of the control and low groups. It could be concluded that the hatchability(%)and body weight for chicks produced from eggs exposed to (37.5°C and 35°C) improved significantly compared with those in (40°C) incubation temperatures group. It could be recommended that the short term low thermal stress during early embryogenesis improve chick weight for Matrouh chicks.

Keywords: Thermal stress, early embryogenesis, hatching traits , Matrouh chickens.

Introduction

The chicken embryos, as mammals, are poikilothermic and have limited ability to regulate their body temperature by controlling their heat production during incubation (Romjin and Lokhorst, 1955). In general, incubating eggs requires four main factors: temperature, turning, humidity, and ventilation. Abuoghaba., (2017). The incubating temperature is an essential factor for the normal development of chicken embryos (Yalçin *et al*., 2007), which significantly affect chick quality and post-hatch growth performance (Lourens *et al*., 2005).Therefore, thermal manipulation can be defined as exposing embryos to high or low temperatures during embryogenesis to increase their ability to adapt to a hot or cold environment by altering the thermo tolerance of chickens post hatch (Shinder *et al*., 2011). During the incubation phase, eggshell temperature plays an important role in embryo development, hatchability, and the performance of chickens (Molenaar *et al*., 2011), which is affected by the pattern of air flow around the egg since the eggshell is considered a thermal barrier in the determination of the actual embryo temperature. (Peebles et al,. 2012). The optimal incubation temperature to achieve the highest hatchability with the best chick quality at hatch for chicken eggs from setting up to 19 days amounted to 37.5°C (Narinç *et al*., 2016).In the early phase of embryonic development, the heat transfer occurs from the surrounding air in the incubator to the embryos, provided that the temperature of the embryos is less than the egg temperature (Pulikanti *et al*., 2011).

It's known that higher temperatures tend to advance early embryonic development, while lower temperatures retard the progression of development, while elevated temperatures have a less dramatic impact on developmental speed than lower ones (Romanoff, 1960).

The low eggshell temperatures (36.6°C) during early days (0-10) of incubation) decreased the percentage of hatched eggs set by about 4% compared to a normal temperature 37.8°C (Joseph *et al*., 2006). Similarly, (Lourens *et al*., 2005) reported that the highest hatchability was obtained for eggs exposed to constant eggshell temperature of 37.8°C, and the hatched chicks were able to maintain a higher body temperature after hatching than the other incubation temperature (36.5°C and40°C) .

Embryos from the lower incubating temperature had higher yolk weights, and plasma triglyceride levels, which may indicate a slowed metabolism of lipids and carbohydrates (Willemsen *et al*., 2011).

Another factor affecting the productive and reproductive performance of chickens is the genotype and breed (Abuoghaba *et al*., 2018). Matrouh chicken was developed from a cross between the White Leghorn and Dokki-4 for six generations using systems of breeding coupled with selection (Mahmoud *et al*., 1974).

Although there are many studies that evaluated the impact of thermal stress during incubation on the hatching traits and productive performance of chickens, only a few experiments dealt the impact of thermal stress on the hatching traits and performance of native and developed Egyptian chickens, especially under Upper Egypt climatic conditions. Therefore, this study was designed to evaluate the impact of thermal stress during early embryogenesis on hatchability, productive performance of Matrouh 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. It aimed to investigate the effect of thermal stress during early embryogenesis on hatchability, physiological responses, and productive performance of the Matrouh chicken local strain.

1.Experimental design

A total of 675 fertile Matrouh eggs were produced from hens at 42 wk. old, which were purchased from the Animal Production Research Institute, Agricultural Research Center, Egypt. They were equally distributed into 3 thermal treatments, each of 3 replicates (75 eggs/ each replicate). All eggs were incubated at 37.8°C and 55–60% relative humidity from one day to 18 days of incubation and considered as the control group, while those in the 2nd and 3rd groups were daily exposed to 35 or 40 °C for 3 hours (from 12 PM to 3 PM) during 3 successive days throughout the period from (5 to 7 days of incubation). Through the last three days of incubation, all eggs were daily exposed to at 37.5°C and 55–60% relative humidity.

2.Studied traits

2.1. Incubation traits:

2.1.1. Eggshell conductance (relative water loss %):-

Eggshell conductance (egg weight loss) is calculated as the difference in egg weight before placement and on day 7 of incubation and expressed as a percentage of the initial egg weight. Eggs containing dead embryos and unfertile eggs were excluded from the calculation for the percentage of egg weight loss. (Aygun and Sert 2013).

2.1.2. Embryonic mortality (early, intermittent and late) percentages: -

The percentage of dead after piping (DAP, %) was measured as follows: (Number of piped eggs)/(Number of total set eggs) × 100, while embryonic mortality (EM, %) was calculated as follows: (Number of dead chick embryos) / (Number of total eggs) × 100, which were classified as early (1–7d), intermittent (8–14d), and late (15–21d) of incubation.

2.1.3. Hatchability(%):-

The hatchability of set eggs (HSE,%) was estimated as (number of hatched chicks)/(number of total eggs) × 100. (Molenaar *et al*., 2011).

2.Chick quality traits:-

After 12 hours from hatch, 45 dry chicks (3 treatments × 3 replicates × 5 chicks) were used to determine chick quality traits. Chick weights were measured by using a digital balance at ±0.1 g precision. Chick length (cm) was measured from the tip of the beak to the tip of the middle toe by placing the chick face down on a flat surface and straightening the right leg (Hill, 2001). The chickens were slaughtered by cervical dislocation to determine the weight and percentages of the heart, intestine, gizzard, and liver.

3. Physiological responses: -

After 12 hours from hatch, 45 chicks (3 groups × 3 replicates × 5 chicks) were used to determine the temperature degrees of the head, wing, back, shank, and cloaca of the chicks measured by using an infrared thermometer and then recorded. The body surface temperature (BST/°C) was 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). The chick cloacal temperatures (°C) were measured to the nearest 0.1°C by inserting a digital thermometer 1 cm deep into the cloaca at one day of hatch.

4. Productive traits:-

4.1. Body weight:

The birds were weighed at hatch, 2^{nd}, 4^{th}, 6^{th}, 8^{th}, 12^{th}, and 16^{th} week of age as well as at sexual maturity by using the nearest 1 gram.

4.2. Body weight gain (g):

Total and daily body weight gain was calculated according to the following equation= Daily body weight gain = (Bw2- BW1) / Period in days. Where: BW1 is the weight at the beginning of the period. BW2 is the weight at the end of the same period.

4.3. Feed consumption (g):

Daily feed consumption was recorded and calculated every week as follows:- Daily feed consumption = (The initial feed (g) –The final feed (g) / Summation of the live bird number all over the experimental period.

4.4. Feed conversion ratio (g feed/g gain):

Daily feed consumption was recorded and calculated every week as follows: - Daily feed consumption = (The initial feed (g) –The final feed (g) / Summation of the live bird number all over the experimental period.

4.5. Mortality rate:

During the experimental period, dead birds were record daily for each replicate and calculated as follows: Mortality rate %=(Initial chicks number - final chicks number)/ Initial chicks number ×100.

5. Statistical analysis:

The obtained data were statistically analyzed by using GLM, produced by the statistical analysis systems (SAS, 2004). Duncan's new multiple ranges tests (Duncan, 1955) were used to determine significant differences between treatment means. The following linear model was applied:Eij = □ + Tj + ei j

Where, Yij= Observation measured,□= Overall mean,Tj= Effect of thermal treatment (j = 1, 2 and 3), Eij= Random error component was normally distributed assumed.

Results and Discussions

Impact of thermal manipulations during early embryogenesis on hatching traits of Matrouh chickens:-

From the results illustrated in Table 1, it could be noted that the RWL (%) was significantly increased in the 2nd group (40°C) compared with those in the 1st (control) and 3rd (35°C) groups, while at EW8d was insignificantly affected. The significant increase in RWL (%) in the 2nd group may be due to increase water evaporation from eggshell from the eggs exposed to high incubation temperature. These results agreed with those of Sgavioli *et al*., (2015), who found that the egg weight loss were significantly increased by rising the incubation temperature, which recorded higher weight loss in the eggs incubated at high temperature (39°C) as compared with those incubated at normal temperature (37.5°C). In contrast, the results of Yalçın *et al*., (2012) showed that the RWL (%) from Ross broiler breeder eggs daily exposed to (36.6°C) for 6 hours from 10th to 18th day of incubation was not affected as compared with that of the control group. Similarly, the findings of Elsayed *et al*., (2016) who found no significant differences in RWL% between ostrich eggs, daily exposed to 38.5ºC and 45% RH for 3 hours from 35 to 37 days of incubation and control group (37.8ºC).

The obtained results showed that the highest hatchability (%) was recorded in1st group (37.5°C), followed by the 3rd group (35°C), while the lowest one was observed in the 2nd group (40°C) with significant effect. The significant decrease in the hatchability (%) in the 2nd group may be due to increased water loss and insufficient egg contents needed to embryos development (Abuoghaba *et al*., 2021). These findings agreed with those of Narinç *et al*., (2016), who found that the hatchability(%) in Ross 308 broiler breeder eggs exposed to (39.5ºC) during incubation period was significantly decreased compared with those in the control group. As the same trend, the findings of Abuoghaba., (2017) showed that the hatchability (%) of fertile broiler eggs exposed daily to chronic (40°C) incubation temperature for 3 hours was significantly decreased as compared with the control group. Also, Morita *et al*., (2009) recorded a decrease in the hatchability rates in broiler eggs exposed to high incubation temperature than those under normal incubation temperature. The results in Table1, the EEM (%) and piped eggs in the 2nd group (40°C) significantly increased compared with those in the 1st (Control) and 3rd (35°C) groups, while the percentages of IEM, LEM and culled chicks were not affected. The significant increase in the early embryonic mortality for embryos in the eggs exposed to high incubation temperature (40°C) may be attributed to insufficient heat loss from the egg, which consequently affecting the embryos homeostasis or due to excessive water loss from the eggs causing high late embryonic mortality (%) may be due to dehydration (Ono *et al*., 1994).

These results agreed with those of Al-AlSardary and Mohammad (2016) who found a significant increase in the EEM (%) for broiler eggs manipulated with (38.8ºC) during early embryogenesis (1- 5days) of incubation than those of the control group. Similarly, Abuoghaba, (2017) found a significant increase in early embryonic mortality in broiler eggs exposed to 40°C for 3 hours during 6-8 days of incubation as compared with those of the control group. Contrarily, Molenaar *et al*., (2011) found no significant difference between thermal manipulation (39.5ºC) in incubation period for early and late mortality percentages in Ross-Cobb (500) than those in control group. Also, Yassein *et al*., (2014) found that the early embryonic mortality (1-7d) and un-hatched chicks (before and after piping) percentages were insignificantly affected in thermal and control group.

Table1. Impact of thermal manipulations during early embryogenesis on hatching traits of Matrouh chickens

Traits		Thermal manipulations groups			SEM	P-Value
		1st group (Control/37.5ºC)	2nd group (HIT/40ºC)	3rd group (LIT/35ºC)		
Initial egg weight(g)		51.78	51.31	51.53	0.23	0.440
Eggweightat8d(g)		50.65	48.82	50.36	0.48	0.106
RWL(%)		2.18[b]	4.87[a]	2.27[b]	0.51	0.033
Hatchability(%)		74.67[a]	62.67[b]	73.78[a]	3.12	0.039
Embryonic mortality (%)	EEM(%)	2.22[b]	5.78[a]	3.56[ab]	0.81	0.048
	IEM(%)	2.22	4.44	2.67	0.63	0.132
	LEM(%)	2.67	4.44	2.67	0.68	0.217
Piped egg(%)		5.33[b]	8.88[a]	5.33[b]	0.81	0.050
Culled chicks(%)		4.89	7.56	4.44	1.50	0.375
Infertile egg(%)		8.00	6.22	7.56	2.57	0.881

[A,b]Meanswithdifferentsuperscriptsinthesamerowaresignificantlydifferent(P≤0.05).RWL=Relativewaterloss,EEM=Earlyembryonicmortality,IEM=Intermittentembryonicmortality,LEM=Lateembryonicmortality

Impact of thermal manipulations during early embryogenesis on physiological responses of Matrouh chickens at hatch

The results in Table 2 showed that the head, back, shank and cloacal temperatures for chicks produced from eggs exposed 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 an increase 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 significantly increased with increasing 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 (41.25°C) for females under thermo neutral condition (23°C and 60% RH). Also, the results of Sgavioli *et al*., (2015) showed that the body surface temperature for newly hatched chicks incubated at different incubation temperature was not affected.

Table 2. Impact of thermal manipulations during early embryogenesis on physiological responses of Matrouh chickens at hatch

Traits		Thermal manipulation groups			SEM	P-Value
		1st group (Control/37.5ºC)	2nd group (HIT/40ºC)	3rd group (LIT/35ºC)		
Body organ temperatures	Head Temp.(ºC)	37.07[b]	38.09[a]	36.80[b]	0.26	0.018
	Back Temp.(ºC)	37.17	37.90	36.95	0.38	0.150
	Wing Temp.(ºC)	36.84	37.39	36.72	0.28	0.329
	Shank Temp.(ºC)	36.60[b]	36.93[a]	36.57[b]	0.02	0.001
	Cloacal Temp.(ºC)	38.21[b]	39.27[a]	38.15[b]	0.19	0.037
Body surface temp.(ºC)		36.83	37.35	36.73	0.29	0.330

[A,b] Means with different superscripts in the same row are significantly different($P \leq 0.05$).

Impact of thermal manipulations during early embryogenesis on hatchling quality traits of Matrouh chickens

The results in Table 3 showed that the weight at hatch for chicks produced from eggs exposed to 37.5°C (control) and 35°C (low) groups were significantly increased than those in the high (40°C) group. The significant increase in chick weight at hatch in the 1st and 3rd groups may be due to the increase uptake of the embryo yolk sac, which provides the chick require nutrients during the first few days of life (Meijerhof, 2009). These findings agreed with those of Joseph *et al*., (2006), who found that the chicks weight at hatch produced from eggs after exposure to low (36.6ºC) incubation temperature during the early incubation (0 to 10d) was significantly increase, which is primarily due to a larger yolk sac weight compared with control group. In contrast, Abuoghaba, (2017) found that the broilers chick weight at hatch produced from eggs daily exposed to chronic thermal stress (40°C) for 3 hours during early (6-8d) embryogenesis was significantly increased compared with control group (37.8°C).The obtained results showed that the chick length was not affected by the thermal manipulations.

Table 3. Impact of thermal manipulations during early embryogenesis on hatchling quality traits of Matrouh chickens

Traits		Thermal manipulation groups			SEM	P-Value
		1st group (Control/37.5ºC)	2nd group (HIT/40ºC)	3rd group (LIT/35ºC)		
CWAH(g)		34.23[a]	32.11[b]	33.91[ab]	0.47	0.046
Chick length(cm)		15.49	14.27	15.43	0.67	0.432
Internal organs	Spleen(%)	0.11	0.06	0.10	0.02	0.274
	Heart(%)	0.96[ab]	1.21[a]	0.89[b]	0.07	0.038
	Intestine(%)	3.45	1.83	3.29	0.73	0.329
	Gizzard(%)	7.21[a]	4.98[b]	7.17[a]	0.42	0.033
	Liver(%)	4.92	3.46	4.88	0.93	0.507

[A,b]Meanswithdifferentsuperscriptsinthesamerowaresignificantlydifferent(P≤0.05).CWAT(g)=Chickweightathatch

Referring to internal organs, the heart (%) for chicks produced from eggs subjected to high thermal stress (40°C) was significantly increased compared with those under normal (37.5°C) and low (35°C) incubation temperature groups. The significant increase in heart percentage for stressed chicks may be due to the higher vulnerability and occurrence of metabolic disorders related to cardiovascular development, which reflects the considerable fall in heart percentage for chickens in the chronic group Leksrisompong *et al*., (2007). The incubation temperature manipulations resulted in heart hypoplasia, indicating that high incubation temperatures may affect heart weight. Therefore, heart hypoplasia reduces oxygen supply to the tissues and may consequently impair body development (Sgavioli *et al*., 2014). The results of Molenaar *et al*., (2011) indicated that broilers produced from eggs incubated at high temperatures presented a higher incidence of ascites during the growing period compared with those incubated at normal temperatures. The obtained results showed that the gizzard (%) in the 2nd group (40°C) was significantly decreased, while the spleen and liver percentages were not affected. This decrease in gizzard (%) may be attributed to retarded liver development, which probably prejudiced the energetic metabolism, and consequently the development and survival of the embryo mainly prior to the incubation period.These findings agreed with those of Sgavioli *et al*., (2014), who found that the gizzard (%) was significantly lower for chicks produced from the eggs incubated at 39°C as compared with 37.5°C.

These results agreed with Maatjens *et al*., (2014), who found that the intestine and liver weights suppressed in chicks after exposure to high incubation temperatures (38.9◦C) compared with those in the control group. Also, the results of Abuoghaba, (2017)showed that the intestine (%) for chicks was not affected under different thermal manipulations.

Impact of thermal manipulations during early embryogenesis on productive performance in Matrouh chickens

1. Body weight(g)

The results illustrated in Table 4 showed that the chicks body weight at one day old, 6, 8, 12 and 16 weeks of age in the 2nd (40°C) group were significantly decreased compared with those of 1st (control/37.5°C) and 3rd (low/35.0°C) groups. The significant decrease in stressed chick weights may be due to the decrease metabolic rates for chick and duck embryos when the internal egg temperature exceeded 40.0°C during early incubation period (Janke *et al*., 2002). These results agreed with those of Hulet *et al*., (2007), who found that the changes in the eggshell temperature during the incubation period significantly affected chick weight at hatch. Also, Lourens e*t al., (*2005),who found a significant decrease in the body weight for commercial broilers chicks exposed to 36.7°C (1 week) and 38.9°C (3 weeks) compared to control group. The obtained results showed that the chick body weights at 2nd and 4th weeks of age were not affected by thermal manipulations.

Table 4. Impact of thermal manipulations during early embryogenesis on body weight in Matrouh chickens

Ages ↓ week (g)	Thermal manipulations groups			SEM	P-Value
	1st group (Control/37.5ºC)	2nd group (HIT/40ºC)	3rd group (LIT/35ºC)		
One day (g)	33.85[a]	32.17[b]	33.63[a]	0.336	0.045
2nd	186.78	162.75	181.36	10.74	0.351
4th	293.33	232.79	285.02	32.51	0.439
6th	371.44[a]	320.52[b]	369.70[a]	6.121	0.007
8th	633.33[a]	501.66[b]	616.83[a]	18.43	0.014
12th	1038.33[a]	871.66[b]	1006.35[a]	25.60	0.021
16th	1325.00[a]	1148.33[b]	1308.44[a]	19.05	0.005

[A, b] Means with different superscripts in the same row are significantly different (P≤0.05).

2. Body weight gain

The findings in Table 5 showed that the daily and total body weight gain during (0-8), (0-16) for chicks in the 2nd group (40.0°C) were significantly decreased compared with those in the 1st (control) and 3rd low (35°C) groups. This significant decrease in chicks body weight gain may be due to the decrease live body weight. These results agreed with those of Abuoghaba (2017), who found a significant decrease in Hubbard broilers body weight gain under thermal manipulations compared with the control group. Also, the findings of Magda *et al*., (2015) showed a significant decrease body weight gain for Matrouh chicks exposed to thermal group (42-43°C) after hatch compared with those in the control group (37.5°C) at the 2th week of age. In contrast, Joseph *et al*., (2006) found that the body weight gain in Ross broiler chicks exposed to 36.6°C during early incubation phase significantly decreased as compared with those in control group. The obtained results showed that the daily and total body weight gain during the periods from 0-4, 4-8, 8-12 and 12-16 weeks of age were insignificantly influenced by thermal manipulations.

Table 5. Impact of thermal manipulations during early embryogenesis on body weight gain in Matrouh chickens

Traits	Ages (week)	Thermal manipulations groups			SEM	P-Value
		1st group (Control/37.5°C)	2nd group (HIT/40°C)	3rd group (LIT/35°C)		
Daily weight gain	0-4	9.26	7.16	8.98	1.17	0.460
	4-8	12.14	9.60	11.85	1.07	0.293
	8-12	14.46	13.21	13.91	1.24	0.788
	12-16	10.24	9.88	10.79	1.06	0.838
	0-8	10.70[a]	8.38[b]	10.41[a]	0.33	0.015
	0-16	11.53[a]	9.97[b]	11.38[a]	0.18	0.005
Total weight gain	0-4	259.28	200.48	251.16	32.78	0.460
	0-8	599.48[a]	469.50[b]	583.20[a]	18.66	0.015
	0-16	1291.15[a]	1116.16[b]	1274.80[a]	19.27	0.005

[A, b] Means with different superscripts in the same row are significantly different (P≤0.05).

4.3. Daily and total feed consumption

From results in Table 6, the daily and total feed consumption for chicks produced from eggs exposed high incubation temperature (40°C) during 0-4, 0-8 and 0-16 weeks of age was significantly decreased compared with those under37.5°C (control) and 35ºC (low) groups. The significant decrease in feed consumption could be attributed suffered dehydration that negatively affected subsequent growth and mortality, thus this factor may have played some role in the lower feed consumption and higher mortality in the post hatch period (Wyatt *et al*., 1985). These results are disagreed with those of Ismail *et al*., (2016), who found a significant increase in feed consumption for Mamoura chickens produced from eggs subjected to thermal stress (39ºC) as compared with the control group. Also, the results of Al Sardary and Mohammad (2016) showed a significant increase in feed consumption for Evan broiler subjected to 39.5°C for 4 hours during embryogenesis than those in the control group. No significant differences were found during the period from 4-8, 8-12 and 12-16 weeks of age in TFC and DFC between different thermal manipulation groups.

Table 6. Impact of thermal manipulations during early embryogenesis on daily and total feed consumption in Matrouh chickens

Traits	Ages (week)	Thermal manipulation groups			SEM	P-Value
		1st group (Control/37.5ºC)	2nd group (HIT/40ºC)	3rd group (LIT/35ºC)		
Daily feed consumption	0-4	26.55[a]	21.01[b]	26.37[a]	0.79	0.013
	4-8	40.18	33.75	37.68	2.14	0.217
	8-12	57.26	55.12	56.07	1.32	0.164
	12-16	62.50	59.82	65.18	2.08	0.300
	0-8	33.36[a]	27.38[b]	32.02[ab]	1.21	0.026
	0-16	46.62[a]	42.42[b]	46.32[a]	0.80	0.024
Total feed consumption	0-4	743.40[a]	588.28[b]	738.36[a]	21.27	0.013
	0-8	1868.44[a]	1533.28[b]	1793.04 [a]	68.06	0.068
	0-16	5221.44[a]	4751.04[b]	5188.40[a]	89.30	0.024

[A, b] Means with different superscripts in the same row are significantly different (P≤0.05).

4. Feed conversion ratio

From the results in Table 7, the daily feed conversion ratio for the chicks produced from the eggs exposed to high (40°C) thermal group was remarkably increased during the period from (0-8) and (0-16) than those produced from eggs in (35ºC) and (37.5°C) groups allover experimental period. These findings agreed with Ismail *et al*., (2016), who found a significant increase in feed conversion ratio in Mamoura chickens subjected to thermal groups (39ºC) compared with control group. Also, the results of Al Sardary and Mohammad (2016) showed a significant increase feed conversion ratio in Evan broiler subjected to thermal manipulations (39.5°C) for 4 hours during embryogenesis compared with control group. Similarly, Abuoghaba, (2017)found a significant increase in feed conversion ratio in Hubbard broilers produced from eggs exposed to thermal group (40°C) than those in control group.

Referring to mortality rate, the obtained results showed that the mortality rate for chicks in the 2nd group was significantly increased compared with those in the 1st and 3rd groups. The increase mortality rate may be due to decrease viability and decrease immunity in the chicks exposed to high thermal stress. These results agreed with those of Yalcin *et al*., (2009), who found that the increase of incubating temperatures from 37.5 to 39.0°C during the last three days of incubation led to accelerated embryonic development and increased mortality rates as compared to the control group.

Table 7. Impact of thermal manipulations during early embryogenesis on daily feed conversion and mortality rate in Matrouh chickens

Traits	Ages (week)	Thermal manipulation groups			SEM	P-Value
		1st group (Control/37.5ºC)	2nd group (HIT/40ºC)	3rd group (LIT/35ºC)		
Daily feed conversion	0-4	2.86	2.93	2.93	0.43	0.979
	4-8	3.30	3.51	3.17	0.20	0.549
	8-12	3.95	4.16	4.03	0.34	0.971
	12-16	6.10	6.05	6.05	0.88	0.913
	0-8	3.11	3.26	3.05	0.18	0.780
	0-16	4.06	4.25	4.10	0.10	0.499
Mortality rate (%)		6.43[b]	8.88[a]	6.35[b]	0.482	0.034

A, b Means with different superscripts in the same row are significantly different (P≤0.05).

Conclusions

From these findings could be concluded as follow:-

i. The RWL (%), EEM (%) and piped eggs in the 2nd group (40°C) were significantly increased compared with those in the 1st (Control) and 3rd (35°C) groups.

ii. The highest hatchability (%) was recorded in1st group (37.5°C), followed by the 3rd group (35°C), while the lowest one was observed in the 2nd group (40°C) with significant effect.

iii. The head, back, shank and cloacal temperatures for chicks produced from eggs exposed 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.

iv. The weight at hatch for chicks produced from eggs exposed to 37.5°C (control) and 35°C (low) groups were significantly increased than those in the high (40°C) group .

v. The heart (%) for chicks produced from eggs subjected to high thermal stress (40°C) was significantly increased, while the gizzard (%) in the 2nd group (40°C) was significantly decreased compared with those under normal (37.5°C) and low (35°C) incubation temperature groups.

vi. The chicks body weight at one day old, 6, 8, 12 and 16 weeks of age in the 2nd (40°C)group were significantly decreased compared with those of 1st (control/37.5°C) and 3rd (low/35.0°C) groups.

vii. The body weight gain during (0-8), (0-16) in the 2nd group (40.0°C) were significantly decreased compared with those in the 1st (control) and 3rd low (35°C) groups.

viii. The feed consumption for chicks produced from eggs exposed high incubation temperature (40°C) during 0-4, 0-8 and 0-16 weeks of age was significantly decreased compared with those under 37.5°C (control) and 35ºC (low) groups.

ix. The feed conversion ratio in the chicks produced from the eggs exposed to high (40°C) thermal group was remarkably increased during the period from (0-8) and (0-16) than those produced from eggs in (35ºC) and (37.5°C) groups allover experimental period.

x. The mortality rate for chicks in the 2nd group was significantly increased compared with those in the 1st and 3rd groups.

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الملخص العربي

تأثير الإجهاد الحرارى خلال مرحلة النمو الجنيني المبكر على صفات الفقس ، الاستجابات الفسيولوجية و الأداء الإنتاجي لدجاج المطروح

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هدفت هذه التجربة الى دراسة تأثير التعرض المبكر للإجهاد الحرارى خلال مرحلة النمو الجنيني المبكر على صفات الفقس و الأداء الإنتاجي لدجاج المطروح.اشتملت هذه الدراسة على عدد 675 بيضة قسمت تباعا إلى(3 مجموعات × 3 مكررات × 75 بيضة). في المجموعة الأولى الكنترول تم تعريض البيض لدرجة حرارة التفريخ (37.5 و 50-55 % رطوبة نسبية) من اليوم الأول حتى الفقس . البيض في المجموعة الثانية والثالثة تم تعريضه لـ (الحرارة المرتفعة 40 م° و الحرارة المنخفضة 35 م°) لمدة 3 ايام (5-7 يوم من التفريخ لمدة 3 ساعات). أعلى نسبة فقس فى مجموعة الكنترول ، تلتها مجموعات (35م°و 40م°) . النفوق الجنيني المكبر ازداد معنويا (40م°) مقارنة بمجموعات (الكنترول و35م°). ازدادت معنوياً درجة حرارة المجمع فى الكتاكيت الناتجة من البيض المعرض ل (40م°) مقارنة بمجموعة الكنترول و المنخفضة. انخفض معنوياً وزن الكتاكيت الناتجة من البيض المعرض لدرجات الحرارة المرتفعة خلال مرحلة التفريخ عند عمر الفقس،8 و16 أسبوع مقارنة بمجموعة الكنترول و المنخفضة.

نخلص من هذه الدراسة ان نسبة الفقس ووزن الجسم من الكتاكيت المنتجة من البيض المعرض لدرجة حرارة (37.5 م° و35 م°) تحسن معنويا مقارنة بمجموعة (40م°) خلال التفريخ. لذلك نوصى باستخدام المعالجة قصيرة المدى باستخدام الحرارة اثناء التطور الجنيني المبكر خلال التفريخ لتحسين وزن الجسم لدجاج المطروح.

الكلمات المفتاحية: الإجهاد الحرارى، النمو الجنيني المبكر ، صفات الفقس ، دجاج المطروح.