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# Effect of L-carnitine and high incubation temperature on pre and post hatch performance of Fayoumi chicks

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## Abstract

This study was carried out to evaluate the pre and post hatching performance of Fayoumi chicks produced from eggs exposed to high incubation temperature and sprayed with L-Carnitine. A total number of 600 eggs were used and randomly distributed into four groups, each group consisted of three replicates of 50 eggs. The first group served as control without any treatment (C), the second (T1) was exposed to high incubation temperature (40$^{o}$) for 3 hours daily, the 3$^{rd}$ and 4$^{th}$ groups (T2 and T3, respectively) were exposed to high temperature (40$^{o}$) for 3 hours at 6$^{th}$, 7$^{th}$ and 8$^{th}$ of incubation period, and sprayed with L-Carnitine at levels 25 and 50ml /Liter, respectively. Hatchability traits, live body weight (LBW), body weight gain (BWG), feed consumption (FC), feed conversion ratio (FCR) and carcass traits of chicks hatched in all treated group were studied during the period from 0 to 12 weeks of age. Results revealed that LBW, BWG, FC and FCR were significantly ($P<0.05$) improved in T2 and T3 groups. Chicks in T2 group had the higher ($P<0.05$) relative weights of liver, gizzard and spleen. From these results, it could be concluded that spraying of L-carnitine at level 25 ml/L after exposure to high incubation temperature (40$^{o}$) during the 6$^{th}$, 7$^{th}$ and 8$^{th}$ days of incubation for three hours daily from 12 pm to 3 pm markedly improved chick performance post hatching compared with other groups.

*Keywords*: L-carnitine, incubation, temperature, Fayoumi chicks.

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## 1. Introduction

Fayoumi chickens first appeared in Egypt thousands of years ago, and as a result of their upbringing in the woods, they developed a high immunity that allowed them to withstand harsh weather circumstances. Fayoumi chickens are a native breed that can withstand a variety of climates, including high temperatures and a drop in temperature during the winter season (Vicari and Calogero, 2001). The most important physical factor impacting embryo growth and hatchability is reported to be temperature (Yalçin and Siegel, 2003). Excessive heat inside incubator may reduce hatching efficiency (Boleli and Queiroz, 2012), as well as may affect chick growth after hatching (Tona *et al.,* 2008). High incubation temperature speeds up embryo metabolism, increases oxygen absorption, and increases carbon dioxide production, necessitating cardiovascular and/or haematological adaptations in the embryo (Sgavioli *et al.,* 2016). There are some literatures provided relevant information on the effects of variations of incubation temperature in broilers (Loyau *et al.,* 2013; Selim *et al.,* 2012) and in layers (Walstra *et al.,* 2010). L-carnitine acts as an antioxidant that ultimately results in a decrease in reactive oxygen species by removing excessive levels of intracellular acetyl-CoA that induces mitochondrial reactive oxygen species production (Agarwal *et al.,* 2005). In animals, L-carnitine can be made from lysine and methionine; however, L-Carnitine synthesis in chicken embryos is limited (Zhai *et al.,* 2008). Supplementing L-carnitine to chicken embryos may be helpful due to rapid development, a high energy demand, and a low amount of L-carnitine production. Physical elements that influence incubation include temperature and humidity in the environment, airflow, and egg turning (Kingori, 2011). The main objectives of this study are evaluation the effects of L-Carnitine spray and high incubation temperature on Fayoumi chick's performance, and some carcass traits.

## 2. Materials and methods

### *2.1 Location and the objectives of the study*

This study was carried out at Animal Production Research Station, Poultry Branch, Malawi, Minia, Egypt, during the period from March to July 2020. The main objectives were to study the effects of spraying Fayoumi breeder eggs with L-carnitine and high incubation temperature during the embryogenesis on hatchability, embryonic mortality on chick's performance, carcass traits as well as determine some blood parameters.

### *2.2 Experimental design*

A total number of 600 eggs were obtained from Fayoumi breeder flock aged 48 weeks. All eggs were weighed at collection day and allocated into four groups (150 eggs/group) with three replicates (50 eggs) per each. The average eggs weight was equal in all groups (47.00 g ±0.13). All eggs were

placed in an automatic incubator that provides optimal incubation conditions for 18 days. The first eggs group was incubated under standard incubation temperature (37.8ºC) and relative humidity (60%) and served as control. Eggs in the 2nd (T1), 3rd (T2) and 4th (T3) group were transferred at 6th, 7th and 8th day of incubation period to another incubator provide high incubation temperature (40ºC) for 3 hours (from 12 pm to 3 pm). Subsequently, eggs in the T2 and T3 groups were sprayed with L-carnitine at levels 25 and 50 ml/liter, respectively. At day 18 of incubation, all egg groups were transferred to the hatchery to complete the hatching process for 3 days at 37.3ºC and 80% relative humidity. After the complete batch of chicks hatched, all hatched chicks were recorded, wing banded and individually weighed. All chicks were housed from hatch day to 12 weeks of age in floor pens at the same space in open house under similar hygienic and normal environmental conditions with natural ventilation. All chicks were fed the same stander diet which was available allover experimental period, with the same feeder space. Also, fresh tap water available all time through the normal waterers. Feed and water were offered to the bird's *ad-libitum* during the experimental period. The composition and analysis of the diets are shown in Table (1). L-carnitine provided as hard gelatin capsules by Arab Company for Pharmaceuticals and Medicinal Plants.

Table (1): The composition and chemical analysis of the diets.

| Ingredients | Starter (%) (0-4 weeks) | Grower (%) (5-12 weeks) |
|---|---|---|
| Yellow corn (8.5%CP) | 55.45 | 60.65 |
| Soybean meal (44% CP) | 33.34 | 27.83 |
| Corn Gluten (60%CP) | 3.00 | 3.20 |
| DL – Methionine | 0.24 | 0.24 |
| L-Lysine-Hcl | 0.18 | 0.24 |
| Soybean Oil | 3.66 | 3.83 |
| Di-phosphate calcium | 1.64 | 1.58 |
| Premix* | 0.30 | 0.30 |
| Choline chloride | 0.10 | 0.10 |
| Limestone | 1.66 | 1.61 |
| NaCl | 0.35 | 0.30 |
| Sodium bicarbonate | 0.08 | 0.12 |
| Total | 100 | 100 |
| Chemical analysis** | | |
| Metabolizable energy (kcal/kg died) | 3033 | 3108 |
| Crude protein (%) | 21.50 | 19.70 |
| Ether extract (%) | 2.65 | 2.70 |
| Crude fiber, (%) | 3.02 | 2.94 |
| Lysine (%) | 1.30 | 1.20 |
| Methionine (%) | 0.61 | 0.59 |
| Calcium (%) | 1.00 | 1.00 |
| Available phosphorus (%) | 0.50 | 0.48 |

*Each 3 kg of Vit. and Min. premix contains 100 million IUVit A, 2 million IU Vit. D3, 10 g Vit. E, 1 g Vit. K3, 1 g Vit B1, 5 g Vit. B2, 10 mg Vit. B12, 1.5 g Vit. B6, 30 g Niacin, 10 g Pantothenic acid, 1g Folic acid, 50 mg Biotin, 300 g Choline chloride, 50 g Zinc, 4 g Copper, 0.3 g Iodine, 30 g Iron, 0.1 g Selenium, 60 g Manganese, 0.1 g Cobalt, and carrier. $CaCO_3$ to 3000 g. **Calculated according to NRC (1994).

### *2.3 Studied traits*

#### *2.3.1 Hatchability traits*

All eggs were candled, and all clear eggs or early dead embryos were removed from the trays, opened, and examined macroscopically at the $7^{th}$ and $18^{th}$ days of incubation and those with evidence of living embryos were transferred from the incubation trays to the hatcher trays. All un-hatched eggs were removed from the hatcher and broken for macroscopic examination to determine embryonic mortality. Fertility percentage was calculated as the number of fertile eggs per 100 eggs set for each replicate and hatchability percentage was calculated as the number of hatched chicks per 100 fertile eggs. Chicks were weighed after hatching by small scales.

#### *2.3.2 Chick's growth performance*

Chicks were individually weighed at one day-old and 12 weeks of age (end the experimental period) and recorded to the nearest gram to determine live body weight (LBW). Body weight gain (BWG) was calculated by subtracting the initial weight from final weight. Feed consumption (FC) of each replicate was recorded during experimental period. Feed conversion ratio (FCR) was calculated as the amount of feed (g) required for producing one gram of body weight gain. Dead chicks during the experimental period were recorded daily from. Mortality rate was calculated for the entire experimental period and expressed as percentage at different ages of birds.

#### *2.3.3 Carcass criteria*

At the end of study, nine birds were randomly obtained from each group, then weighed and slaughtered. After complete bleeding, birds were scaled, defeathered and eviscerated. The internal organs (liver, heart, gizzard and spleen) were weighed and expressed as a percentage of live body weight.

### *2.4 Statistical analysis*

The experiment was arranged in a complete randomized design. Then one way ANOVA was employed using the SPSS procedure (SPSS 16, 2010). The differences among groups were evaluated by Duncan's (Duncan's, 1955) multiple comparison tests. Differences were considered statistically significant at ($P \leqslant 0.05$). Statistical analysis of traits presented as percentages was carried out for arcsine values of their estimates. All obtained data were analyzed using the following model:

$$Yij = \mu + Si + eij$$

Where: Yij= an observation, $\mu$ = overall mean, Sj = effect of treatment, eij = random error.

## 3. Results and discussion

### *3.1 Hatchability traits*

Data in table (2) showed that percentages

of hatchability, embryonic mortality were significant (P<0.05) better in T2 and T3 groups compared with T1 and control groups. Data revealed that there was a tendency to increase in hatching weight in T2 and T3 but the differences were not significant (P>0.05) between two groups. However, fertility, hatch chick weight, piped eggs, and dead-in-shell were not significantly (P>0.05) affected by high incubation temperature (40$^{o}$C) or spraying L-carintine at different levels (25 or 50 ml/L). Our findings are in agreement with results observed by Shafey *et al*. (2010) who reported that *in ovo* administration of L-carnitine had not significant effects on piped eggs and hatching weight. As well as Al-Daraji and Tahir (2014) reported that dietary supplementation of L-carnitine significantly increased hatchability and decreased the embryonic mortality during incubation. Also, Abdel-Azeem *et al*. (2016) indicated that spraying eggs with L-carnitine solution at 6 g/L positively affected hatchability rate and embryonic mortality for Cobb broiler breeder. However, the results achieved herein disagreed with finding of Zahi *et al*. (2008) who reported that *in ovo* injection of L-carnitine for White Leghorn had not significant effects on hatchability.

Table (2): Effect of L-carnitine and high incubation temperature on hatchability traits.

| Traits | Treatment | | | | Sig. |
|---|---|---|---|---|---|
| | C | T1 | T2 | T3 | |
| Fertility (%) | 94.50±3.57 | 95.24±3.20 | 96.34±4.33 | 96.06±3.54 | NS |
| Hatchability (%) | 81.33$^{b}$±4.66 | 81.03$^{b}$± 2.40 | 85.30$^{a}$± 3.05 | 84.59$^{a}$± 2.40 | * |
| Hatch chick weight (g) | 38.18±1.39 | 37.93±1.86 | 39.71±1.17 | 39.40±1.28 | NS |
| Embryonic mortality (%) | 3.35$^{a}$±0.13 | 3.62$^{a}$±0.57 | 2.20$^{b}$±0.57 | 2.17$^{b}$±0.57 | * |
| Piped eggs (%) | 3.76±0.88 | 4.00±0.57 | 3.52±0.66 | 3.60±0.88 | NS |
| Dead in shell (%) | 6.06±1.85 | 6.60±1.05 | 5.32±0.33 | 5.70±0.57 | NS |

$^{a, and\ b}$ Means with different superscripts in the same column are significant different (p<0.05). NS= not significant. *= Significant. C= Control. T1= high temperature. T2= high temperature + 25 ml L-carnitine/L. T3= high temperature + 50 ml L-carnitine/L.

Salmanzadeh *et al*. (2013) found that injection of L-carnitine into eggs of turkey breeder hens on day 5 of incubation significantly reduced the hatchability of fertilized eggs. The beneficial effect of L-carnitine in decreasing embryonic mortalities may be due to embryonic tissues contain high amounts of polyunsaturated fatty acids, which are essential components of cell membrane phospholipids (Rabie and Szilagyi, 1998), polyunsaturated fatty acids are susceptible to lipid peroxidation caused by free radical, which are produced by mitochondria because of the high metabolic rate of rapidly developing embryos (Surai, 1999). L-Carnitine may work as an antioxidant to scavenge free radical and reducing oxidative stress during embryogenesis (Deniz and Turkmen, 2007), thereby reducing embryonic mortality.

*3.2 Chick's growth performance*

Table (3) shows the effects of spraying eggs with different doses of L-carintine and exposure to high temperature during embryogenesis on chick's growth performance. Results indicated that final body weight FBW, BWG, FC and FCR were significantly (P<0.05) improved in T2 and T3 groups as compared to T1 and control groups. The present study revealed that there were no significant (P>0.05) differences among all groups in mortality rate during the growth period (0-12 weeks of age). The obtained results are in harmony with findings shown by Keralapurath *et al*. (2010) who observed no significant effect of *in ovo* injection with L-carnitine on mortality rate of broiler chicks.

Table (3): Effect of L-carnitine and high incubation temperature on post-hatch performance.

| Trait | Treatments | | | | Sig. |
|---|---|---|---|---|---|
| | C | T1 | T2 | T3 | |
| Initial body weight (g) | 38.18±1.39 | 38.93±1.86 | 39.71±1.17 | 39.40±1.28 | NS |
| Final body weight(g) | $1470.4^{b}$±39.9 | $1507.9^{b}$±47.4 | $1597.3^{a}$ ±21.9 | $1587.7^{a}$ ±2.3 | * |
| Body weight gain(g) | $1432.2^{b}$±13.2 | $1468.9^{b}$±14.1 | $1557.6^{a}$ ±12.4 | $1548.4^{a}$ ±22.1 | * |
| Feed consumption (g) | $4753.2^{c}$±42.1 | $4808.5^{b}$±55.8 | $4853.2^{a}$ ±42.1 | $4859.4^{a}$ ±59.1 | * |
| Feed conversion ratio (g feed/ g gain) | $3.32^{a}$±0.16 | $3.27^{b}$±0.17 | $3.11^{c}$ ±0.13 | $3.13^{c}$ ±0.13 | * |
| Mortality (%) | 1.52±0.23 | 1.37±0.20 | 1.28±0.13 | 1.60±0.27 | NS |

$^{a,b}$ , $^{c}$ Means with different superscripts in the same column are significantly different (P< 0.05). NS= not significant. *= Significant. C= Control. T1= high temperature. T2= high temperature + 25 ml L-carnitine/L. T3= high temperature + 50 ml L-carnitine/L.

Also, Rabie *et al*. (2015) reported that *in ovo* injection with L-carnitine resulted in significant improvements (P<0.05) in BW, BWG and FCR of broiler chicks during the growth period. On the other hand, Keralapurath *et al*. (2010) observed that *in ovo* injection with L-carnitine had not significant effect on FC and FCR. In addition, Rabie *et al*. (2015) revealed that *in ovo* injection with L-carnitine had not significant effect (P>0.05) on FC for broiler chicks during the growth period. However, Zhang *et al*. (2010) found that added L-carnitine linearly reduced FC and BWG of broiler chicks compared with their control counterparts. An increased post hatch weight was the only indication that these nutrients had passed through the shell and was ultimately accessible to the embryo. The improvement in BW and BWG in T2 and T3 may be attributed to the high hatchling weight. Havenstein *et al*. (2003) demonstrated that the weight of newly hatched chickens is an important predictor of marketing weight. This finding is confirmed by Wilson (1991) who stated that each 1g of increase in hatchling weight resulted in 8 to 13g increase in BW at marketing age. Shafey *et al*. (2012) reported that *in ovo* feeding improves the growth and feed efficiency of hatched chicks. Spraying eggs with L-carnitine could improve the nutritional and health status of the embryo and enhance nutrient uptake, increase in

activity of the intestinal enzymes and post hatch growth due to the role of nutrients to increase size and surface area of the intestinal villi (Tako *et al*., 2004) thereby improvement in performance post hatching.

*3.3 Carcass traits*

Results presented in table (4) showed that the relative weights of carcass and heart were not significantly (P > 0.05) affected by high incubation temperature (40$^{o}$C) or spraying L-carintine at different levels (25 or 50ml/L). However, data showed that chicks in T2 group had significant (P<0.05) higher relative weights of liver, gizzard and spleen compared with other groups. Similar results were obtained by Zhang *et al*. (2010) who found that supplementation of L-carnitine in diet had no effect on the percentages of carcass. In addition, Keralapurath *et al*. (2010) observed no significant effect for the *in ovo* injection of L-carnitine on carcass percentage. Also, Salmanzadeh *et al*. (2012) found that relative weight of gizzard was markedly increased in chickens treated *in ovo* with L-carnitine. As well as, Abdel-Fattah and Shourrap (2012) indicated that L-carnitine treatment significantly increased spleen relative weight comparable to control group.

Table (4): Effect of L-carnitine and high incubation temperature on carcass traits.

| Traits | Treatments | | | | Sig. |
|---|---|---|---|---|---|
| | C | T1 | T2 | T3 | |
| Carcass (%) | 76.59±2.48 | 76.47±3.33 | 76.04±2.98 | 76.93±3.17 | NS |
| Liver (%) | 2.34$^{b}$±0.58 | 2.42$^{b}$±0.33 | 2.73$^{a}$±0.38 | 2.31$^{b}$±0.41 | * |
| Heart (%) | 0.57±0.04 | 0.60±0.08 | 0.61±0.07 | 0.56±0.07 | NS |
| Gizzard (%) | 2.05$^{b}$±0.23 | 2.02$^{b}$±0.24 | 2.59$^{a}$±0.23 | 2.06$^{b}$±0.22 | * |
| Spleen (%) | 0.63$^{b}$±0.06 | 0.59$^{c}$±0.05 | 0.72$^{a}$±0.06 | 0.66$^{b}$±0.07 | ** |

$^{a,b\ and\ c}$ Means with different superscripts in the same column are significantly different (P< 0.05). NS= not significant. *= Significant. **= highly significant. C= Control. T1= high temperature; T2= high temperature+25ml L-carnitine/L; T3= high temperature+50ml L-carnitine/L

Moreover, Rabie *et al*. (2015) who revealed that *in ovo* injection with L-carnitine had not significant effect (P>0.05) on relative weights of carcass and heart for broiler chicks during the growth period. In contrast, they reported *that in ovo* injection with L-carnitine resulted in significant reduction (P<0.05) in relative weights of liver and gizzard of broiler chicks during the growth period. Also, Arslan and Tufan (2018) revealed that adding of L-carnitine had not significant effect on percentages of spleen and gizzard of broilers.

## 5. Conclusion

From obtained results, it can be concluded that using of L-carnitine at level 25 ml/L by spraying method after exposure to high temperature (40$^{o}$C) during the 6$^{th}$, 7$^{th}$ and 8$^{th}$ days of

incubation for three hours daily from 12 pm to 3 pm improved chick performance post hatching compared with other groups.

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