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Effects of Electric Field During Incubation of Eggs on the Hatchability and Post-Hatch Performance of Meat Chickens

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Abstract: The effects of electric field (EF) during incubation of eggs on hatchability traits, and post-hatch performance, nutrient utilization and carcass characteristics of meat chickens were investigated in 2 trials. Eggs from a meat-type breeder flock were incubated under EF of 30kV/m, 60Hz during the first 18 d of incubation as compared with the control incubation treatment (C). Chicks hatched from the two incubation treatments (EF and C) were fed *ad libitum* and their performance was monitored. Measurements were made of hatchability, hatchability failures, chick hatching weight (CHWT), length of incubation, post-hatch performance (weight gain (WTG), feed consumption, and feed conversion ratio (FCR)), and nutrient utilization (apparent nitrogen retention and nitrogen corrected metabolizable energy of birds at 30 d of age), and carcass characteristics of sexed birds at 40 d of age. EF incubation of eggs significantly ($P < 0.05$) increased per cent of hatchability, per cent of hatching chicks by 468 hour of incubation, CHWT and reduced embryo deaths, pips with life embryos, length of incubation and percentage of hatched chicks at 492 plus 504 of incubation by approximately 11.0, 428, 2.4, 56, 86, 5.1 and 98%, respectively. EF birds had a higher ($P < 0.05$) WTG than the C birds, when they were placed with feed and water after hatching, but not when birds were held without feed and water to the end of incubation period. EF incubation of eggs did not significantly influenced feed intake, FCR, and nutrient utilization of birds. Carcass of the EF birds had higher ($P < 0.01$) proportion of drumstick (g/kg eviscerated carcass (EC)), and lower proportions of edible offal (liver plus heart plus gizzard, g/kg live weight (LWT) and thigh (g/kg EC) when compared with those of the C birds. Carcass of male birds had significantly ($P < 0.01$) higher proportion of drumstick (g/kg EC), and lower proportion of edible offal (g/kg LWT) than female birds. In the EF group, female birds had significantly ($P < 0.01$) higher LWT and carcass neck plus back (g/kg EC), and lower EC (g/kg LWT) and carcass breast (g/kg EC) than males birds. However in the C group, male birds had a higher LWT than female birds. Whilst, sex of birds of the C group did not significantly influence EC (g/kg LWT), and carcass breast and back plus neck (g/kg EC). It is concluded that the incubation of eggs under EF of 30kV/m, 60Hz increased hatchability of eggs, and chick hatching weight, reduced incubation time of eggs and altered carcass characteristics of birds. EF incubation of eggs increased weight gain of birds when hatched chicks were placed with feed and water after hatching. EF incubation of eggs did not altered feed efficiency, and nutrient utilization of meat chickens.

Key words: Electric field; hatchability; broiler performance, nutrient utilization, carcass characteristics

Introduction

Successful incubation environment depends on maintaining favorable conditions for hatching fertile eggs. The incubation environment of eggs is known to influence the growth of embryos, hatchability traits of eggs, and the morphology, physiology, and behavior of chickens (Wilson, 1991; Decuypere and Mitchels, 1992; Shafey and Al-Mohsen, 2002; Shafey, 2004; Shafey *et al.*, 2005). The environmental factors that are most critical to the normal development of the embryo are those that occur during the incubation and hatching processes. These factors include incubation temperature, humidity, egg orientation, egg turning, ventilation, and sanitation (Wilson, 1991). These factors are within the control of automated incubators. However, research on incubation environment shown that there are other environmental factors, which can influence the development, and growth of embryos and hatchability traits of incubated eggs. The inclusion of light into the internal environment of incubators has been reported to improve the growth of chicken embryos, hatchability traits of eggs and post-hatch performance of chickens (Shafey and Al-Mohsen, 2002; Shafey, 2004). In addition, Shafey *et al.* (2005) found that the exposure of chicken eggs to electric field (EF) of 30 kV/m, 60Hz, during incubation increased embryonic growth, and hatchability traits, and reduced the length of incubation of layer-type breeder eggs (Shafey *at al*., 2005, 2006b). Shafey *et al.* (2006a,b) suggested that incubation environment of eggs influenced the metabolism, heat production and growth of embryos and consequently hatchability traits and length of incubation. The incubation period needed for chicken eggs to produce a complete embryo might depend on incubation environment (Shafey and Al-

Mohsen, 2002; Shafey *et al.*, 2006b). Therefore, alteration in incubation environment influences the metabolism and growth of embryos with consequent impact on post-hatch performance of growing chickens, and that may be through changes in the efficiency of nutrient metabolism and utilization. Data on the effects of EF during incubation on the hatchability traits, and post-hatch performance of meat chickens are not available. This study was designed to examine the effects of EF during incubation of eggs on the hatchability traits, post-hatch performance, nutrients utilization and carcass characteristics of meat chickens.

Materials and Methods

A total of 288 eggs of comparable weight (WT, 63.19 ± 0.4) from a meat-type breeder flock (Ross, Al-Wady Poultry Farms, Riyadh, Saudi Arabia) at the age of 33 wk were used in the first trial. Eggs were assigned to 24 replicates of twelve eggs. Twelve replicates were randomly assigned to each of the two incubation treatments [control (C) and EF], and distributed into the incubator trays. Eggs were set in a Maino, force-draft incubator (Model II, Maino Enrico, Co., Rome, Italy) and incubated at 99.5^{o}F and 55% relative humidity. The egg compartment of the incubator (85 cm deep, 50.5 cm width and 83.5 cm height) was divided into two compartments with a frame of thin sheet of wire mesh for the EF and C treatments. Two aluminum plates were fitted face to face on the sidewalls of the EF compartment of the incubator. The distance between the two plates was 50 cm. Each plate was fitted with a cable and connected to a step up electric transformer (Cat. No. 721-411, Jefferson Electric Company, Illinois, USA) to convert 110 V to 15000 volt. The frame of wire mesh was used to eliminate the electric wave from crossing into the compartment of the C treatment. Additionally, a three wire grounded power plug was used for the EF compartment, so that the earth pin of the plug carried any extra current to earth potential and consequently eliminated any current to cross into the C compartment. The EF was on constantly during the first 18 day (d) of the incubation period. The level of EF was 30 Kv/m at 60 Hz. Eggs were turned every 2 hours (h). Eggs from the two incubation treatments were transferred to separate hatching trays on d 19 of incubation, for chick identification at hatch. The hatching tray was divided into individual hatching compartments using thin sheets of wire mesh. The hatching compartment was set at 98.6oF and 65% relative humidity until the end of d 21 of incubation. Eggs were examined by candling at d 6 and d 12 of incubation and infertile eggs and eggs containing dead embryos were removed. Early dead embryos were counted from d 1 to d 12 of incubation. Late dead embryos were counted from d 12 to the end of d 21, when incubation ended. Pips (unhatched eggs with live or dead chicks) and late dead embryos (unhatched eggs with unbroken shell) were counted at the end of incubation. Hatching time was recorded every 12 h. Per cent hatchability was calculated on the basis of the number of hatched chicks as a percentage of the number of fertile eggs per treatment. Chicks were removed for placement every 12 h intervals from 468 to 504 h of incubation and hatching WT were recorded to the nearest 0.1 g. A total of 72 chicks from each incubation treatment were assigned to twelve replicates of six birds per each incubation treatment. There was enough number of hatched chicks from the EF treatment by 468 h of incubation. Therefore, EF chicks were allocated to their replicates. Whilst, there was not enough number of hatched chicks from the C treatment until 492 h of incubation. Therefore chicks hatched at 468, 480, and 492 h (18, 25, and 29 chicks, respectively) were collected after hatching and allocated to their replicates. Lighting was incandescent and continuous throughout the experiment period. Birds were offered a commercial starter diet (21% protein and 3100 metabolizable energy (ME) kcal/kg, Arasco, Riyadh, Saudi Arabia) to 21 d, followed by a commercial finisher diet (19% protein and 3200 ME kcal/kg, Arasco, Riyadh, Saudi Arabia) until the termination of the experiment at 40 d of age. Feed and fresh water were available *ad libitum* at all times. At the end of the experiment, birds were sexed and six birds per incubation treatment per sex were randomly selected and processed at King Saud University Plant to determine processing yields and carcass quality.

Excreta samples were collected from three randomly selected replicates of birds from each incubation treatment, for every 12 h in the last two d of the fifth wk of the experiment. Feed and excreta samples were oven dried at 80^{o}C and finely ground prior to analysis. Nitrogen in both feed and excreta was determined by Kjelhahl procedure (AOAC, 1990), gross energy by using an adiabatic bomb calorimeter, and acid insoluble ash (AIA) by AOAC (1990). The calculations of nutrient utilization as described by Scott *et al.* (1982) were as follow:

Apparent nitrogen retention (ANR) = 100-(100 X F* X F**)

F* = % AIA in diet / % AIA in excreta

F** = N in Excreta (mg/g) / N in diet (mg/g)

Nitrogen corrected apparent metabolizable energy (AME_n) = Energy per g diet - Excreta energy per g diet + 8.22 X mg N retained per g diet

Excreta energy per g diet = Energy per g excreta X F*

N retention (mg/g diet) = N in diet (mg/g) - N in excreta (mg/g) X F*

The incubation trial was repeated 12 wk from the end of the first trial with the same number of comparable WT eggs (67.8 ± 0.9 g, Mean ± SEM). The hatching chicks from the two incubation treatments were removed from their hatching compartments for placement at the end of incubation period of 21 d, as is practice in the industry.

A total of 72 chicks from each incubation treatment were assigned to twelve replicates of six birds per each incubation treatment as in trial 1. Birds were offered a commercial starter diet to 21 d, followed by a commercial finisher diet until the termination of the experiment at 35 d of age. Diets were similar to those fed in the first trial.

Measurements of per cent hatchability and hatchability failures (pips with live embryos, pips with dead embryos, early dead embryos, late dead embryos), performance of chickens (WT gain (WTG), feed consumption, feed conversion ratio (FCR=feed intake (g) / WTG (g)), were determined in trials 1 and 2 . Hatching time and chick hatching WT (CHWT), nutrient utilization (Apparent nitrogen retention (ANR), nitrogen corrected metabolizable energy (AME_n), and carcass composition were determined in trial 1.

There was no significant difference between the two trials in the effect of EF on the hatchability traits of eggs, so data from trials 1 and 2 were combined together for final analysis. Data were arranged in a 2 x 2 factorial arrangement for incubational treatment (C and EF), and trial as main effects and their two-way interactions fitted into the model. All per cent data were transformed using arc sine square root percentage transformation before analysis. Two-sample t-test were used to compare means of the two incubation treatments (C and EF) for egg WT, CHWT, hatching time, nutrient utilization and performance of chickens. Data from carcass composition were arranged in 2 x 2 factorials with two incubation treatments (C and EF) and sex of birds as main effects and their two-way interactions fitted into the model. A difference with a probability of $P<0.05$ was considered significant. When significant variance ratios were detected, differences between treatment means were tested using the least significant difference (LSD) procedure. All statistical analysis was performed using the Statistical Analysis System (SAS Institute, 1985).

Results

The effects of incubation treatment on the hatchability and hatchability failures, CHWT, post-hatch performance of trial 1 and 2, nutrient utilization and carcass composition are shown in tables 1 to 6, and on the per cent of hatched chicks and length of incubation are shown in Fig. 1 and 2, respectively. EF incubation of meat chicken eggs significantly ($P < 0.01$) increased hatchability, percent of hatching chicks at 444, 456 and 468 h of incubation, and carcass proportion of drumstick (g/kg of eviscerated carcass (EC), CHWT expressed as a percentage of egg WT or as an absolute WT ($P < 0.05$), WTG of chicks during the 40 d experimental period when they were placed with feed and water after hatching (Trial 1, Table 3), but not when they were held without feed and water to the end of incubation period (Trial 2, Table 4), and ($P<0.01$) reduced per cent of hatching chicks at 492 and 504 h of incubation, length of incubation (489.2 *vs.* 464.1 h of incubation, Fig. 2), edible offal (liver plus heart plus gizzard, g/kg of live body WT (g/kg LWT)) at 40 d of age, and ($P<0.05$) embryo deaths (early and late), pips with live embryos, carcass proportions of thigh (g/kg EC) when compared with those of the C treatment. Male birds had significantly ($P < 0.01$) higher carcass proportion of drumstick (g/kg EC), and lower carcass edible offal (g/kg LWT) than those of females at 40 d of age. There was no significant effect of incubation treatment of eggs on pips with dead embryos, feed consumption, FCR, ANR, AME_n, carcass abdominal fat (g/kg LWT), and carcass proportions of wings, breast, and neck plus back (g/kg EC). There was no significant difference between the two incubation trials in the percentage of hatchability, or hatchability failures.

There was significant ($P < 0.01$) interaction between incubation environment of eggs and sex of birds on LWT, and carcass proportions of breast, and neck plus back (g/kg EC) and EC (g/kg LWT, $P < 0.05$) at 40 d of age. Male chickens had significantly ($P < 0.01$) higher LWT than female chickens hatched from eggs incubated under the C treatment. Whilst, female chickens had a higher LWT than male chickens hatched from eggs incubated under the EF treatment. EC (g/kg LWT) and carcass proportion of breast (g/kg EC) were significantly heavier, and carcass proportion of neck plus back (g/kg EC) was lighter in male chickens when compared with those of female chickens hatched from eggs incubated under the EF treatment. However, there was no significant different between sexes of chickens hatched from eggs incubated under the C treatment in EC (g/kg LWT), and carcass proportions of breast, and neck plus back (g/kg EC). There was no significant interaction between the incubation treatment of eggs and trial on hatchability and hatchability failures.

Discussion

Results from this study indicate that incubation of eggs under the EF environment of 30 Kv/m at 60 Hz increased the hatchability percentage, and CHWT of meat-type breeder eggs by approximately 11.0, and 2.4%, respectively when compared with eggs incubated under the C environment (Table 1 and 2). The improvement in hatchability of eggs incubated under EF was mainly due to its significantly lower hatchability failures of embryo deaths and pips with live embryos by approximately 60.3% when compared with eggs incubated under the C environment. In addition, EF environment of incubation initiated hatching very early with increased per cent of hatching chicks within 468 h of incubation and cumulative hatchability at 480 h of incubation by approximately 428 and 170.3%, respectively, and reduced the per cent of hatching chicks in the last 24 h of incubation period and length of incubation by

Table 1: Mean per cent of hatchability and hatchability failures of meat-type breeder eggs incubated under control and electric field (EF) environments[1]

Main effect means		Hatch of fertile eggs (%)	Early embryo deaths (%)	Late embryo deaths (%)	Pips with live embryos (%)	Pips with dead embryos (%)
Incubation treatment (T)						
Control	(24)	84.5±2.5	6.6±1.1	6.3±1.2	2.2±0.8	0.4±0.4
EF	(24)	93.8±1.2**	3.1±0.8*	2.6±0.9*	0.3±0.3*	0.2±0.2
Trial (R)						
Trial 1	(24)	90.9±2.0	4.6±1.1	3.1±1.0	1.0±0.5	0.4±0.4
Trial 2	(24)	87.4±2.3	5.1±1.0	5.8±1.2	1.5±0.7	0.2±0.2
Source of variation		Probability				
T		**	*	*	*	NS
R		NS	NS	NS	NS	NS
T X R		NS	NS	NS	NS	NS

[1]Values are Means ± SEM of the number of replicates given in parentheses. [2]Eggs obtained from flock at the age of 33 and 48 weeks for trials 1 and 2, respectively. *Significantly different at (P<0.05). **Significantly different at (P<0.01). NS: Not significantly different (P>0.05).

Table 2: Chick hatching weight express on an absolute and percentage basis (chick hatching weight*100/egg weight) of meat-type breeder eggs incubated under the control and electric field (EF) environments[1]

Incubation environment		Egg weight (g)	Chick weight (g)	Chick weight (%)
Control	(24)	63.25±0.41	43.58±0.33	68.91±0.30
EF	(24)	63.12±0.42	44.65±0.42*	70.75±0.51**
t-Test		NS	*	**

[1]Values are Means ± SEM of the number of replicates given in parentheses. *Significantly different at (P<0.05). **Significantly different at (P<0.01). NS: Not significantly different (P>0.05).

Table 3: The effects of electric field (EF) during incubation of eggs on the post-hatch performance of meat chickens between 1 and 40 days of age (Trial 1)[1]

Incubation environment	Weight gain (g)	Feed intake (g)	FCR[2]
Age 1-26 day			
Control	787.5±22.9	1227.4±33.9	1.56±0.018
EF	855.8±20.2*	1337.9±38.7	1.54±0.012
SEM[3]	21.5	34.5	0.02
Age 27-40day			
Control	841.9±26.1	1550.8±39.9	1.84±0.022
EF	915.6±18.2*	1673.6±53.6	1.82±0.038
SEM[3]	23.2	48.5	0.03
Age 1-40 day			
Control	1629.4±46.33	2780.4±75.1	1.70±0.009
EF	1771.5±28.01*	3002.6±80.6	1.69±0.025
SEM[3]	38.7	74.1	0.02

[1]Means ± SEM of 12 replicates. [2]FCR = Feed conversion ratio (Feed intake/Weight gain). [3]SEM=Standard error of mean. *Significantly different at (P<0.05).

approximately 98 and 5.1 % when compared with those of the C incubation environment (Fig. 1 and 2). Whilst, eggs incubated under the C treatment showed a delay to initiate hatching and a slower increase in hatchability with a lower per cent of hatching chicks within 468 h of incubation when compared with the EF treatment (15.1 *vs.* 80%). Similar findings were reported in an earlier study (Shafey *et al.*, 2006b), in which EF incubation of layer-type breeder eggs improved hatchability and CHWT, and reduced the early embryo deaths, and length

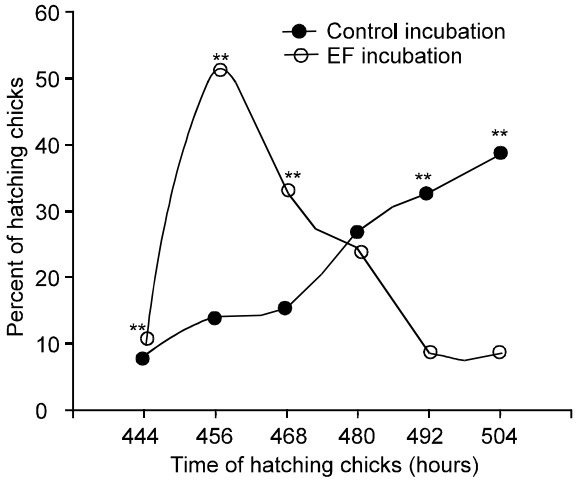

Fig. 1: Percent of hatching chicks of meat-tye breedr eggs incubated under control and electric field (EF) environments

** Significant difference (P<0.01) t-Test for 444, 456, 468, 492 and 504 hours of hatching times were t = -6.662, P = 0.01, t = 9.42, P = 0.01, t = -2.99, P = 0.01, t = 6.69, P = 0.01 and t = 15.57, P = 0.01, respectively

of incubation by approximately 19.6, 1.7, 62.1 and 2.1%, respectively. The improvement in the hatchability traits of the EF group was related to the acceleration in embryonic growth (Shafey *et al.*, 2005), and increased temperature of the internal incubation of eggs (Shafey *et al.*, 2006a,b).

Results from the post-hatch performance of chickens indicated that EF chickens that were removed from the incubator immediately after hatching had significantly higher WTG during the 40-d experimental period than those hatched under the C incubation treatment (Trial 1). EF exposure of chicken eggs during incubation increased feed intake of hatched chickens, albeit non-significantly, without any significant influence on FCR. Whilst, EF chickens that were held in the incubator to the end of the incubation period of 21 d, as is practiced in the industry, regardless of the difference in hatching time

Table 4: The effects of electric field (EF) during incubation of eggs on the post-hatch performance of meat chickens between 1 and 35 days of age (Trial 2)[1]

Incubation environment	Weight gain (g)	Feed intake (g)	FCR[2]
Age 1-21 day			
Control	668.3±3.8	1096.2±12.8	1.65±0.033
EF	677.0±14.7	1104.0±32.5	1.63±0.039
SEM[3]	14.2	24.7	0.036
Age 22-35 day			
Control	930.3±23.9	1647.7±19.3	1.78±0.050
EF	939.2±15.1	1660.8±26.8	1.77±0.013
SEM[3]	20.0	23.3	0.037
Control	1598.7±23.6	2744.0±27.1	1.72±0.023
EF	1616.2±28.0	2764.8±53.1	1.71±0.021
SEM[3]	25.9	42.2	0.022

[1]Mean ± SEM of 12 replicates. [2]FCR = Feed conversion ratio (Feed intake/Weight gain). [3]SEM=Standard error of mean.

Table 5: Apparent nitrogen retention (ANR) and nitrogen corrected apparent metabolizable energy (AME_n) at 30 days of age of meat chickens hatched under the control (C) and electric field (EF) environmets[1]

Incubation environment	ANR[2]	AME_n[3]
Control	67.80±1.82	3148.64±72.36
EF	71.87±0.99	3249.25±40.14

[1]Mean ± SEM of 3 replicates. [2]ANR = 100 - (100 X F* X F**).
F* = % acid insoluble ash (AIA) in diet / % AIA in excreta
F** = N in Excreta (mg/g) / N in diet (mg/g)
[3]AME_n = Energy per g diet - Excreta energy per g diet + 8.22 X mg N retained per g diet
Excreta energy per g diet = Energy per g excreta X F*
N retention (mg/g diet) = N in diet (mg/g) -N in excreta (mg/g) XF*

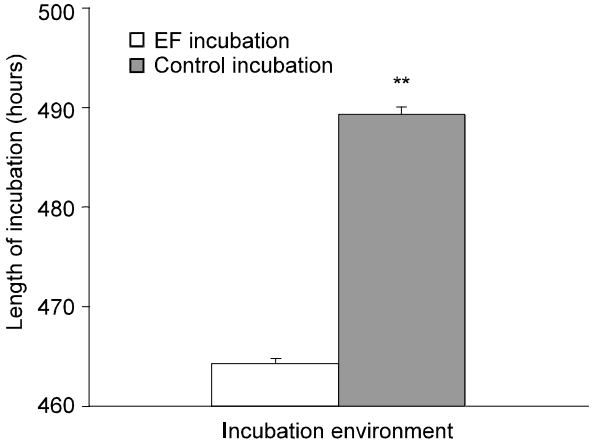

Fig. 2: Average length of incubaion of meat-type breeder eggs incubated under control and electric field (EF) environments

Significant difference (P<0.01)
t-Test for average incubation perios was t = 24.48, P = 0.01

of approximately 25.1 h between the two incubation treatments (489.2 and 464.1 for the C and EF incubation treatments, respectively), did not differ significantly in WTG, feed intake and FCR from those chicks that were hatched under the C incubation treatment (Trial 2). It seems that the inconsistency in the performance of chickens between the two trials is related primarily to the placement time of hatching chickens. These results suggest a delay between hatching and placement of EF chickens has a negative impact on their growth performance. This caused a delay in access to feed and water and that influenced post-hatch performance of EF chickens in the second trial. This suggestion is supported by the finding that holding time in the incubator has been attributed to WT loss in the poult and chick and that was still present at market age (Hager and Beane, 1983; Nir and Levanono, 1993, Pinchasov and Noy, 1993; Halevy *et al.*, 2000), decreased residual yolk sac nutrient content and increased mortality (Vieira and Moran, 1999). Immediate feeding post-hatch has been shown to increase WT of birds when compared to poults with delayed access to feed (Noy and Sklan, 1999).

Studies on prenatal exposure of laboratory animals and human to EF revealed that there was a large amount of contradiction in the literature. Portet and Cabanes (1988) found no effect for EF on growth and development of rabbits when they were exposed to a 50-Hz EF (50-kV/m) for 16 h/d in the last 2 wk of gestation and for 6 wk after birth. In contrast, Marino *et al.* (1976) reported decreased WTG in mice prenatally and postnatally exposed to vertical (15-kV/m) or horizontal (10-kV/m) EFs. Burack *et al.* (1984) suggested that prenatal development of rats was retarded by exposure to a 60Hz, 80 kV/m EF. However, Shafey *et al.* (2005) found that the exposure of chicken eggs to EF during incubation increased embryonic growth and CHWT (Shafey *et al.*, 2006a). Our results were in agreement with Fernie and Bird (1999) who reported that electric and magnetic fields (EMFs) exposure increased WTG and feed intake in birds. Similar results were reported in monkeys (Grisset and Lotz, 1985), laboratory rodents (Marino, 1990), and adult mammals such as domestic cattle (Burchard *et al.*, 1996). Conflicting experimental results found in the literature may have been related to sensitivity of animals to EF and EMF exposures, and different experimental conditions such as the type and strength of EF and EMF exposure experienced in some studies.

Incubation treatment influenced carcass composition of chickens. EF incubation of eggs increased the proportion of drumstick and reduced the proportion of thigh (g/kg EC), and edible offal (g/kg live WT) of birds at 40-d of age. These changes in body composition were not achieved by alteration in the efficiency of nutrient utilization. EF incubation of eggs caused a non-significant increase in ANR and AME_n of meat chickens by approximately 6 and 3.2 %, respectively. Sex of bird affected proportion of edible offal (g/kg live WT) and drumstick (g/kg EC) in the carcass. These differences

Table 6: Effect of electric field (EF) during incubation on carcass composition of meat chickens at 40 days of age[1]

	Incubation environment (T)							
	Control		EF		Probability			
Body composition	Male	Female	Male	Female	T	Sex	TxSex	LSD[2] (P<0.05)
Live body weight (g)	1966.3±42.1[a]	1809.2±64.1[bc]	1715.3±38.5[c]	1893.2±44.4[ab]	NS	NS	**	142.8
g/kg live body weight								
Abdominal fat	12.2±1.1	12.0±1.4	10.1±1.1	13.6±2.2	NS	NS	NS	4.4
Edible offal[3]	47.8±0.9	55.3±2.5	40.1±0.6	49.8±1.3	**	**	NS	4.5
Eviscerated carcass	724.5±5.6[b]	734.1±5.3[ab]	751.3±7.2[a]	731.5±6.9[b]	NS	NS	*	18.6
g/kg eviscerated carcass								
Thigh	170.5±7.2	182.5±7.5	156.5±6.8	163.9±4.6	*	NS	NS	19.6
Drumstick	137.0±2.8	128.1±2.9	149.6±3.9	134.4±2.4	**	**	NS	9.0
Wings	112.3±3.3	117.7±3.0	119.2±2.7	115.4±3.9	NS	NS	NS	9.6
Breast	271.2±16.9[ab]	301.7±13.7[a]	302.9±5.8[a]	265.4±7.3[b]	NS	NS	**	34.8
Neck plus back	308.9±18.6[ab]	270.0±8.8[b]	271.8±8.6[b]	320.8±13.5[a]	NS	NS	**	38.3

[1]Mean ± SEM of 6 replicates. [2]Least significant difference (P<0.05). [3]Edible offal =liver plus heart plus gizzard. NS: Not significantly different (P>0.05). *Significantly different at (P<0.05). **Significantly different at (P<0.01). [a,b]Means within raw followed by different superscripts are significantly different (P<0.05).

probably arise from metabolic differences between sexes. Merkley *et al.* (1980) found significant differences between sexes in the yield of all carcass parts. The effects of sex on carcass composition of chickens were reported by Merkley *et al.* (1980), Leeson, (1995), Lazzari and Paganini (1999), Shafey *et al.* (2001), and Rondelli *et al.*, (2003). Carcass composition of males and females is not entirely controlled by the same genes. There are probably genes common to both sexes and gene specific for each sex (Shafey *et al.*, 2001). The interaction between incubation environment of eggs and sex of bird on carcass composition at 40 d of age suggested that EF incubation of eggs affected carcass composition of sexed birds, differently. EF female birds had higher LWT, and carcass proportion of neck plus back (g/kg EC), and lower EC WT and carcass proportion of breast (g/kg EC) than those of EF male birds. Whilst, male birds hatched under the C incubation treatment had higher LWT than those of female birds hatched under C incubation treatment. These results may suggest that EF incubation of eggs influenced gene expression of chickens and consequently carcass composition. These findings confirmed that incubation environment of eggs can have significant effects on embryonic growth, hatchability and subsequent post-hatch performance of chickens. In conclusion, these data suggest that the exposure of chicken eggs during incubation to EF of 30 kV/m at 60 Hz improved body weight gain and altered carcass composition of meat chickens at 40 d of age, without significantly affecting feed consumption, feed conversion ratio, dietary nitrogen retention and nitrogen-corrected apparent metabolizable energy.

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