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EFFECT OF HEAT STRESS ON SOME PRODUCTIVE AND PHYSIOLOGICAL TRAITS IN CHICKEN

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ABSTRACT: *This work was conducted at the poultry farm of the Faculty of Agriculture "Norfa Project" Menofiya University, Shebin El-Kom The aim of the investigation was to study the effect of heat stress on some physiological traits and consequently productive performance of two strains of chicken at 8 weeks post hatch. A total number of 276 birds were divided into two comparable groups. The first was exposed to the natural ambient temperature (control) (29-30c^{o}) and relative humidity of 55%, whereas, the second was exposed to heat stress (35- 37c^{o}) for six hours, 1 time weekly. Climatic chamber was used for adjustment of temperature and humidity of 65%. The treatments were continued up to 32 weeks. The chicks were fed ad-libitum, a starter ration (with crude protein 22.17 % and 2920 kcal/kg. M.E) and a layer ration (with crude protein 18.09% and 2790 kcal/kg. M.E). The most important results could be summarized as follows:*

1. *Body weight of either Norfa or Fayoumi of control group were higher than that of treated group.*
2. *Growth rate was higher in Fayoumi than in Norfa chickens during 4-20 weeks of age.*
3. *Age at sexual maturity was earlier in Norfa than Fayoumi chickens in control group but the reverse in treated group where Norfa was the latest age at sexual maturity among treated groups.*
4. *Average body weight at sexual maturity in Norfa chickens was heavier than that of Fayoumi when exposed to heat stress.*
5. *Average egg weight at sexual maturity was higher in the group treated when compared with control one.*
6. *Average egg number in the first three months of production increased in control group than that produced in treated group in Norfa and Fayoumi layers.*
7. *Average respiratory rate in Norfa pullets was higher in treated group than control group at all ages.*
8. *Average body temperature in Norfa pullets was increased in treated group than control one.*
9. *Effect of heat stress on antibody production: The present results indicated that females had higher antibody titers against SRBCs than males at 14-d post-immunization in Norfa and Fayoumi chickens before exposed to heat stress. The differences between sex were significant. However, in Fayoumi chickens, before exposure to heat stress, the antibody level was increased than Norfa chickens after injection of SRBCs. While after exposure to heat stress the most of antibody level against SRBC s was reduced in treated group than the control group in Norfa and Fayoumi chickens while male had higher antibody level than females in Norfa and Fayoumi.*

Key words: *Heat stress, body weight, growth rate, sexual maturity, egg production, rectal temperature, respiration rate and imnunity.*

INTRODUCTION

In hot climate regions a decline in poultry production is generally due to high temperature condition. When coupled with high humidity, it imposes severe thermal stress on poultry and leads to the depression of their performance. The economic losses from thermal stress are considerable; this problem is of primary concern to poultry breeders. Thermoregulation in birds encompasses a broad spectrum of physiological and behavioral responses. At high ambient

temperature, if birds can not maintain equilibrum between heat production and heat loss, some birds die due to hyperthermia. As a subtropical country, high mortality rate due to hyperthermia occurs in Egypt during heat waves (over 40 c°) in summer. Esa (2001) and Kalamah *et al.* (2002) demonstrated that the body weight of Norfa chickens decreased significantly after exposure to high temperature. Also, the body weight of Sinai chickens decreased significantly by heat stress (Samia, 2002). Melesse *et al.* (2011) studied the effect of long-term heat stress on performance traits in naked-neck chickens and commercial breeds. They stated that the average body weight depression in heat stressed commercial chickens was 10.9% at 20 week of age and 68 week. Recently, Soliman (2003) and Kalamah (2003) studied the average growth rate during different period of age in Norfa chickens exposed to heat stress. The averages were, in general, higher in the control than the heat stressed groups at 40 and 45 c° during periods (4 - 8 , 12 - 16 and 4 - 16 weeks of age). An opposite trend was noticed during 8 - 12 weeks of age for 45 c°. El-Abd (2005) showed that, the differences due to heat stress on growth rate during the periods 4 - 8 , and 8 - 12 weeks of age were not significant but at 12 - 16 weeks of age there were highly significant differences ($P < 0.01$), whereas at 16 - 20 weeks there were significant differences ($P < 0.05$) . The effect of heat stress on age at sexual maturity was studied by, VO *et al.* (1980) who reared Single Comb White Leghorn (14 days old) of both sexes under one ambient temperature of 21 c° or 29 c° or 35 c°. They found that age at sexual maturity was decreased as the temperature increased in males and it was significantly delayed at the highest temperature in females. Moreover, Renden and McDaniel (1984) reported that there were significant differences between control and heat stresed birds for age at sexual maturity, egg production, egg weight and fertility. Rozemboin *et al.* (2007) working with White Leghorn chickens exposed to heat stress and found that egg production was decreased with an average of 20 % after 2d of heat exposure and increased on d 11 of heat stress but remaining significantly lower than controls. Melesse *et al.* (2011) studied the effect of long-term heat stress on performance traits in naked-neck chickens and commerical breeds (New Hampshire and Lohmann white. The commerical hens showed significant ($p < 0.05$) performance reductions under thermal stress with respect to egg production (33%). Rozenboim *et al.* (2007) reported that egg weight declined during exposure to heat stress in White Leghorn chickens. Gharib (2006) reported that the high ambient temperature caused a reduction in egg mass per hen when exposed to high ambient temperature produced. Ziad (2006) reported that the effect of high temperature per se on rectal temperature was significantly higher in heat stress group in broilers. Lin *et al.,* (2008) found that when hens were exposed to 32c^{o} for 21 d at later laying stage, the body temperature was not significantly altered. Kalamah (2003) and Soliman (2003) reported that respiration rate was lower for the control group than those exposed to heat stressed groups at either 40 or 45$_{C}{}^{o}$. Broiler production under high temperature reduces the overall performance of the animals. The bird is in a state of stress when it normal homeostatic condition is altered, and as a result it cannot perform its regular physiological functions (Mumma *et al.*, 2006). Stress has a negative effect on the fowl's body physiology as reviewed by Bulmer and Gil (2008). Various factors can lead to stress and among them, environmental temperature has a pronounced effect on bird's performance (Bartlett and Smith, 2003).

MATERIALS AND METHODS

This work was carried out at the Poultry Research farm, Department of Poultry Production, Faculty of Agriculture, Minufiya University, Shebin el-kom to study the effect of some genetic and environmental factors on performance of chickens trough year 2004 – 2005.

Chicken Stock:-

Norfa strain was used in the present study as a synthetic local strain of chickens

developed at the Poultry Research farm, Department of Poultry Production, Faculty of Agriculture, Minufiya University, Shibin El-Kom. Abdou, (1996) presented in details the formation history of Norfa strain. Briefly, in 1980, one- day old pedigreed chicks of two selected strains of Single Comb White Leghorn were imported from Norway. The first strain selected for egg number (L2) and the second selected for egg weight (L7). In addition, pedigreed chicks from Fayoumi and White Baladi as local breeds were brooded and reared together with the imported chicks at the same time under the same environmental conditions. All possible combinations of crossing; random mating and developed the programs were applied to select and develop the Norfa strain chickens. This experiment was designed to investigate the effect of heat stress on some physiological parameters and productive traits in Norfa and Fayoumi chickens aged 8 weeks until 32 weeks of age during the period from 25/12/2004 until 25/8/2005. Conventional diet was offered ad libitum and fresh clean water was available all the experimental period. At 8 weeks post hatch, a total number of 276 birds were divided into two comparable groups. The first was reared under the natural ambient temperature (control) (29-30c^{o}) and humidity of 55%, the second was exposed to heat stress (35-37c^{o}) for six hours, 1 time weekly. Climatic chamber was used for adjustment of temperature and humidity of 65% and the treatments were continued up to 32 weeks. The chicks were fed ad- libitum, a starter ration (with crude protein 22.17 % and 2920 kcal/kg. M.E) and a layer ration (with crude protein 18.09% and 2790 kcal/kg. M.E).

1- Studied traits:-

Studied traits were determined for each treatment at both growing and laying periods.

1-1. Growing period.

Studied traits during growing period of birds consist of live body weight, growth rate, body temperature and respiration rate:

1-1.1. body weight:

Body weight (g) was recorded individually, at 4, 8, 12, 16 and 20 wk of age, for all treatments.

1.1.2. Growth rate:

Growth rate was measured for each bird during the periods from 4-8,8-12,12-16 and 16-20weeks by using the formula given, by, Brody, 1945.

$$R = \frac{W_2 - W_1}{1/2(W_1 + W_2)} \times 100$$

Where:

R: The rate of growth.

W_1: The first weight.

W_2: The second weight.

1.2: Laying period:

This period started from 20 to 32 wk of age. The study included the same experimental group of pullets applied in the growing period.

The studied traits in the laying period are:

1.2.1. Body weight at sexual maturity:

Birds were weighed individually when transferred to laying pens at 20 wk of age. The body weight was calculated to nearest gram for each bird.

1.2.2. Age at sexual maturity (SM):

Age at sexual maturity in days was recorded at first egg laid for each pullet for all experimental groups.

1.2.3 Egg production:

The following egg production traits were determined.

1.2.3.1 Egg production:

Egg production rate per group was calculated every 4 wk using the following equation:

$$\frac{number\ of\ eggs\ produced\ during\ 4wk\ period}{cumulate\ live number\ of\ daily\ live\ hens during\ the\ same\ period} \times 100$$

1.2.3.2 Egg number (EN):

Number of eggs laid during the period from the first egg at sexual maturity to end of the first three months after sexual maturity was recorded.

1.2.3.3 Egg weight (Ew):

Egg weight was measured to the nearest gram as an average weight during the first three months after sexual maturity.

1.2.3.4. Egg mass (EM):

Egg mass was determined by multiplying the egg number times average egg weight during the first three months after sexual maturity.

1.3.1. Body temperature and respiration rate:-

Body temperature and respiration rate were recorded weekly for each bird of each treatment before and after exposure to heat stress from 8 weeks of age to the 20 weeks of age.

Body temperature was obtained with a thermocouple thermo- meter inserted approximately 2 cm into cloaca.

Respiration rate was measured by counting the chest movement for one minute using a stop watch.

1.3.2. Immunization procedures:

Preliminary iso immunization by using sheep red blood cells SRBCs for birds at the end of experiment and birds were bled by wing puncture in heparinized vacationer tubes.

1.3.2.1. Preparation of SRBCs antigen:

The SRBCs were chosen as natural, non specific, non pathogenic and multi determinant immunizing antigen to elicit the antibody response in the chicken (Kundu et al., 1999). The SRBCs were obtained in a heparin solution from 5 Ossimi sheep breed and washed three times in phosphate buffer saline (PBS, PH 7.2). After washing the packed SRBCs were brought to a 2.5% v/v solution in the PBS and used for immunization.

1.4. Statistical analysis:

Results were subjected to statistical analysis according to the method of disproportionate analysis of variance due to (Snedecor and Cochran, 1967). Different means were tested for significance according to Duncan's test (Stell and Torries, 1960). The following models were used for analyzing body weight, growth rate, respiration rate, body temperature and immunity.

$$Y_{ijfk} = \mu + T_i + S_j + B_f + (T \times S)_{ij} + (T \times B)_{if} + (S \times B)_{jf} + (T \times S \times B)_{ijf} + E_{ijf}. \quad (1)$$

Y: observation

μ : General mean.

T_i: Treatment effect.

S_j : Sex effect.

B_f : Breed effect .

$(T \times S)_{ij}$: Interaction between treatments and sex.

$(T \times B)_{if}$: Interaction between treatments and Breed.

$(S \times B)_j$: Interaction between sex and Breed

$(T \times S \times B)_{ijf}$: Interaction between treatment, sex and breed.

E_{ijf} : Random effect.

$$Y_{ijk} = \mu + T_i + B_j + (T \times B)_{ij} + E_{ijk}. \quad (2)$$

Y_{ijk} : observation

U: overall means

T_i : Treatment effect.

B_j : Breed effect .

$(T \times B)_{ij}$: Interaction between treatments and Breed.

E_{ijk} : Random effect .

RESULTS AND DISCUSSION

Effect of heat stress on some productive traits:

Comparison between males and females of Norfa and Fayoumi chickens in body weight of growing periods:-

From Table (1) it was clear that, body weight averages of Norfa chickens were higher than that of Fayoumi in treated and control groups at all ages studied especially in control group. The difference between the two strain increased with the increase of age. In the treated group it was clear that, those of control group showed the highest

difference indicating that starting with natural ambient temperature (control) was more suitable for Norfa than Fayoumi strains. Breed difference was highly significant (P≤0.01) at all ages. The breed and sex interaction affecting body weight was highly significant (P≤0.01) at 4,8,12 and 20 weeks of age and it was not significant at 16 weeks of age the experiment. When comparing the two sexes in both strains it was clear that, males were heavier than females in both strains at all ages. The difference between the two sexes in body weight increased with the increase of age. The difference between sexes were higher in Norfa strain than that in Fayoumi at all ages The differences were higher in Fayoumi strain than Norfa in age 8 weeks. This result may indicate that the sex hormones are the main reason because Norfa chickens reach sexual maturity earlier which is accompanied with the increase of hormone secretion than Fayoumi chickens which mature later. The sex difference was significant at all ages. These results are not in agreement with those found by Kalamah (2003) who studied the temperature effect on body weight at different age from 4 up to 16 weeks of age. The temperatures were 40, 45c° and control. He stated that chicks exposed to 40 or 45c° had body weight lower than the control chicks at 8, 12 and 16 weeks of age.

Table (1): Effect of heat stress on body weight $\overline{X} \pm S.E$ for both sexes of Norfa and Fayoumi chickens.

Age	Breed	Sex	Treatment	Control
8 wks.	Norfa	Female	398.6 ± 5.6[a]	437.4 ± 10.5[a]
		Male	456.1 ± 8.6[b]	475.2 ± 10.7[b]
		Mean	427.3 ± 4.6[c]	456.3 ± 7.5[c]
	Fayoumi	Female	355.2 ± 5.9[a]	369.4 ± 7.4[a]
		Male	408.1± 4.2[b]	425.9 ± 7.3[b]
		Mean	381.6 ± 3.6[d]	397.6 ± 5.2[d]
12 wks.	Norfa	Female	595.5 ± 6.9[a]	637.4 ± 13.6[a]
		Male	654.4 ± 5.5[b]	694.6 ± 12.8[b]
		Mean	624.9 ± 4.4[c]	666.0 ± 9.3[e]
	Fayoumi	Female	539.9 ± 8.7[a]	547.1 ± 8.6[a]
		Male	609.5 ± 6.7[b]	641.0 ± 5.5[b]
		Mean	574.7 ± 5.5[d]	594.0 ± 5.0[f]
16 wks.	Norfa	Female	780.5 ± 7.1[a]	833.2 ± 13.7[a]
		Male	856.6 ± 5.7[b]	894.3 ± 11.6[b]
		Mean	818.5 ± 4.5[c]	863.7 ± 8.9[c]
	Fayoumi	Female	714.2 ± 8.7[a]	732 ± 5.6[a]
		Male	783.6 ± 6.4[b]	799.6 ± 11.1[b]
		Mean	748.9 ± 5.4[d]	765.8 ± 5.8[d]
20 wks.	Norfa	Female	925.1 ± 8.4[a]	1022.0 ± 10.2[a]
		Male	1096.7 ± 9.2[b]	1131.9± 9.5[b]
		Mean	1010.9 ± 6.0[c]	1076.9 ± 6.9[e]
	Fayoumi	Female	898.0 ± 8.9[a]	913.7 ± 11.4[a]
		Male	991.8 ± 5.6[b]	1006.0 ± 16.3[b]
		Mean	944.9 ± 5.2[d]	959.8 ± 9.7[f]

[a], [b], [c], [d] = values having the same superscript in each measured trait (according to sex, breed and treatment effect) are not differed significantly at P ≤ 0.05

Comparison between Norfa and Fayoumi in growth rate under the effect of heat stress:-

Table (2) represents the difference between Norfa and Fayoumi in growth rate. In younger ages (8-12 weeks of age), growth rate of Norfa chickens were higher than that in Fayoumi, while at (16-20) weeks of age the growth rate was higher in Fayoumi than in Norfa chickens in the treated group. At the total period of the experiment Fayoumi had higher growth rate than Norfa strain in treated and control group. This last result may be explained by the earlier sexual maturity in Fayoumi which may be the cause of this difference. The breed difference was highly significant in period (4-8 and 16-20 weeks) and not significant in the other periods. When comparing the two sexes in both strains it was clear that, in most cases of treated or control chicks the growth rate of males was higher than females at all ages. At all periods the growth rate of males was higher than females in treated group. The sex difference in growth rate was not significant at 4-8, 8-12, 12-16 and 4-20 weeks of age and highly significant at 16-20 weeks of age. The interaction between breed and sex was highly significantly at period 4-8 and 16-20 week of age.

El-Abd (2005) showed that, the differences due to heat stress on growth rate during the periods 4-8 and 8-12 weeks of age not significant but at 12-16 weeks of age there were highly significant differences ($p< 0.01$) and 16-20 weeks there were high significant differences ($p< 0.0.05$).

Table (2): Comparison between males and females of Norfa and Fayoumi chickens in growth rate% under the effect of heat stress. $\overline{X} \pm S.E$

Age Weeks	Breed	Sex	Treatment	Control
8 - 12	Norfa	Female	37.8 ± 1.7^{a}	44.8 ± 2.0^{a}
		Male	45.3 ± 1.9^{a}	46.7 ± 0.9^{a}
		Mean	41.5 ± 1.3^{b}	45.7 ± 1.1^{b}
	Fayoumi	Female	35.7 ± 0.9^{a}	39.0 ± 1.3^{a}
		Male	39.5 ± 0.9^{a}	43.4 ± 1.4^{a}
		Mean	37.6 ± 0.7^{b}	41.2 ± 0.9^{b}
12 - 16	Norfa	Female	26.6 ± 0.8^{a}	27.4 ± 0.8^{a}
		Male	27.7 ± 1.2^{a}	28.4 ± 0.7^{a}
		Mean	27.1 ± 0.7^{b}	27.9 ± 0.5^{b}
	Fayoumi	Female	24.8 ± 1.0^{a}	26.1 ± 1.3^{a}
		Male	28.1 ± 0.6^{a}	29.2 ± 1.0^{a}
		Mean	26.4 ± 0.6^{b}	27.7 ± 0.8^{b}
16 - 20	Norfa	Female	17.1 ± 0.6^{a}	21.4 ± 1.2^{a}
		Male	21.5 ± 1.1^{b}	24.5 ± 1.1^{b}
		Mean	19.2 ± 0.5^{c}	22.9 ± 0.8^{c}
	Fayoumi	Female	22.9 ± 0.6^{a}	23.5 ± 1.1^{a}
		Male	23.5 ± 0.6^{b}	25.4 ± 0.8^{b}
		Mean	23.1 ± 0.4^{d}	24.4 ± 0.7^{d}
4- 20	Norfa	Female	156.8 ± 1.4^{a}	160.6 ± 2.1^{a}
		Male	158.1 ± 1.6^{a}	160.5 ± 2.7^{a}
		Mean	157.4 ± 1.1^{b}	160.5 ± 1.7^{b}
	Fayoumi	Female	166.4 ± 0.7^{a}	170.9 ± 0.9^{a}
		Male	170.5 ± 0.5^{a}	172.0 ± 0.9^{a}
		Mean	168.4 ± 0.5^{c}	171.4 ± 0.7^{c}

$^{a, b, c, d}$ = values having the same superscript in each measured trait (according to sex, breed and treatment effect) are not differed significantly at $P \leq 0.05$

1-3-1 Age at sexual maturity:-

Table (3) represents the age at sexual maturity trait as affected by heat stress. In Norfa and Fayoumi layers the average age at sexual maturity was the earliest in control group where it was 144 days in Norfa and 147 days in Fayoumi whereas it was the latest in treated group in Norfa and Fayoumi (156 and 148 days, respectively). These results mean that using heat stress (35-37c°) at start of brooding latest delay the age at sexual maturity among the treated groups. Vo *et al.*(1980) reared Single Comb White Leghorn 14 days old of both sexes at one ambient temperature of 21c°, 29c°, 35c°. They found that age at sexual maturity was decreased as the temperature was increased in males and it was significantly delayed at the highest temperature in females. These results are in agreement with Soliman (2003) who reported that age at sexual maturity of control hens was significantly ($p \leq 0.01$) earlier than those of hens exposed to heat stress (40 and 45c°). El. Abd (2005) reported that hen exposure to ambient temperature of 22c° was earlier sexual maturity than exposed to 32 c°.

1-3-2 Body weight at sexual maturity:-

Table (3) represents the average body weight at sexual maturity as affected by heat stress. Body weight at sexual maturity was the highest in treated group for the two strains Norfa (1040 g.) and Fayoumi (890 g.). The lowest value in both value in both strains was in control group (1002 g.) for Norfa and (889 g.) for Fayoumi. From these results was clear that effective factor in body weight was the heat stress. Using 35-37 c° and humidity of (65%) for six hours 1 times weekly gave better body weight than control group. Soliman (2003) reported that body weight at sexual maturity of layers exposed to 40 or 45c° was highly significant ($p \leq 0.01$) in control group than that exposed to heat stress. These results were not in agreement with those obtained by El. Abd (2005) who found that body weight at sexual maturity was higher at 22 c° than 32c°. The differences in this respect were not significant.

1-3-3 Egg weight at sexual maturity:-

From Table (3) data demonstrate that the average of egg weight at sexual maturity of Norfa layer was the heaviest (38.3 g.) in control group while the lightest (36.9 g.) was in treated group. This difference was due to variation in starting temperature because when it was (35-37c°) and humidity (65%) it caused producing heavier laid eggs at sexual maturity whereas Fayoumi layers produced the heaviest eggs (36.6 g.) in control group and the lightest (33.0 g) in treated group. The difference was due to the heat stress because when exposing layers to 35-37c° from the start they produced heavier egg at sexual maturity than those exposed to natural ambient while Fayoumi layers produced the heaviest eggs (36.6 g.) when exposed to natural ambient temperature than those exposed to heat stress they produced lightest (33.0 g.). The averages of egg weight at sexual maturity of Norfa layers were the heaviest than those Fayoumi layers. These results were agreement with Soltan and Ahmed (1990) who showed that averages of egg weight were 37.4 and 39.5 g. for Fayoumi and Baladi. Sherif (1991) reported means of 33.2, 37.82, 37.81and 35.5 g. for Fayoumi, Norfa- selected EN, Norfa- selected EW and control lines, respectively. Enab (1991) found also averages of 30.7, 34.6 and 33.7 g. for Fayoumi, Norfa-selected and control lines. On the other hand Soliman (2003) reported that egg weight at sexual maturity had highly significantly ($p \leq 0.01$) in control group than that exposed to 40 or 45 c°.

Table (3): Effect of heat stress on sexual maturity (S.M.), body weight and Egg weight at sexual maturity $\overline{X} \pm S.E$ in Norfa and Fayoumi chickens.

Traits	Breed	Treatment	Control
Age at S.M (d)	Norfa	156.5 ± 0.6[a]	144.8 ± 2.3[a]
	Fayoumi	147.9 ± 1.7[a]	147 ± 3.2[a]
	Mean	152.9 ± 0.9[b]	146.1 ± 1.8[c]
Body weight at S.M (g)	Norfa	1040.2 ± 15.9[a]	1002.1 ± 17.7[a]
	Fayoumi	890.0 ± 14.7[b]	889.4 ± 22.1[b]
	Mean	977.5 ± 12.9[c]	945.7 ± 16.1[c]
Egg weight at S.M (g)	Norfa	36.9 ± 0.3[a]	38.3 ± 0.4[a]
	Fayoumi	33.0 ± 0.7[b]	36.6 ± 0.6[b]
	Mean	36.1 ± 0.4[c]	36.8 ± 0.4[c]

1-4 Egg production traits:-

1-4-1 Egg number:-

Table (4) represents the egg production traits as affected by heat stress in Norfa and Fayoumi layers. It is clear that, egg number produced by the two strains in the first 3 months of production increased in the control group than that produced in the treated group. In treated group it is clear that control group had the highest average egg number (51.04) egg per layer in Norfa and Fayoumi (39.3) egg per layer than treated group had the lowest average egg number in Norfa and Fayoumi (40.2 and 37.3) per layer respectively. In all groups the Norfa had higher average of egg number than Fayoumi layers. The some trend was clear in average eggs/day/layer where the Norfa and Fayoumi layers in control group had the highest average while in treated group had the lowest average in Norfa and Fayoumi respectively. The Norfa layers had higher average/layer/day than Fayoumi layers in all treated groups and control group. These results were agreement with Soliman (2003) found that egg number during the first 90 days of laying greater than those hens exposed to heat stress at either 40 or 45c°. El- Abd (2005) found that layers exposed to 22c° gave egg production significantly higher ($p \leq 0.05$) than that exposed to 32c°.

1-4-2 Egg weight:-

Heat stress also causes consistent reductions in egg weight and shell thickness in laying hens. From Table (4) it was shown that the average egg weight in 3 months was nearly the same in treated and control groups of Norfa layers. These results indicated that heat stress used had small effect on egg weight in Norfa layers. In Fayoumi layers, the treatment of heat stress affected was nearly the same control group. In all groups, the Norfa layers produced heavier eggs than Fayoumi layers. These results were not in agreement with Gharib (2006) found that the exposure of hens to high temperature ranging from 40-42c° and 65-70% relative humidity (five hours daily for seven consecutive days) results indicated that, hen day egg weight was significantly lower on the other hand, Rozenboim *et al.* (2007) reported that egg weight declined during exposure to heat stress in white Leghorn chickens.

Table (4): Effect of heat stress on some egg production traits in Norfa and Fayoumi chickens, ($\overline{X} \pm S.E$).

Bread	Traits	Average egg No/ hen/ 3 months	Average egg Weight/ hen/ 3 months	Average egg Mass/ hen/ 3 months
Norfa	Treatment	40.2 ± 0.3[a]	41.6 ± 0.2[a]	1660.6 ± 11.2[a]
	Control	51.04 ± 0.3[c]	43.2 ± 0.3[c]	2202.36 ± 15.6[c]
Fayoumi	Treatment	37.3 ± 0.3[b]	37.1 ± 0.3[b]	1387.5 ± 16.9[b]
	Control	39.3 ± 0.2[d]	38.2 ± 0.3[d]	1501.76 ± 13.7[d]

[a], [b], [c], [d] = values having the same superscript in each measured trait (according to sex, breed and treatment effect) are not differed significantly at P ≤ 0.05

1-4-3 Egg mass:-

Because this represent the most important character of production and activity of the reproductive system, it must be well discussed from Table (4) it was shown that egg mass produced by a layer through the first 3 months was higher in control group than in the treated group in Norfa layers. In Fayoumi layers the opposite was true as the layers in control group produced the highest egg mass than treated group. In Norfa treated groups produced the lowest egg mass/layer in 3 months (1660.6 g.) while in Fayoumi layers control group produced the highest value of egg mass per layer through 3 months (1501.8 g.). These results showed that egg mass produced by a layer through 3 months was higher in control group of Norfa than of Fayoumi layers. These results were agreement with Gharib (2006) reported that the high ambient temperature caused a reduction in egg mass hens when exposed to high ambient temperature produced significantly lower egg mass.

c) Effect of sex and heat stress for both of Norfa and Fayoumi chickens on respiration rate:-

I) Between strains:

From Table (5) it was noticed that average respiration rate of Norfa was slightly higher than that in Fayoumi strain in treated group and mostly at all ages (8,12,and 16 weeks of age). While at 20 weeks of age the average respiration rate of Fayoumi was slightly higher than that in Norfa strain in treated group. Breed difference was significant at 8 and 16 weeks of ages, but it was not significant at 12 and 20 weeks of ages. Treatment difference was significant at 8 weeks of age, but it was highly significant at 12, 16 and 20 weeks of ages. These results were in agreement with those obtained by Soliman (2003) who found that respiratory rate was differ significant ($p \leq 0.01$) between heat stress and control groups. The same trend was noticed in both males and females, as respiration rate of Norfa was mostly higher than that in Fayoumi in both sexes at 8 and 12 weeks of ages. At 16 and 20 weeks of ages , females of Norfa strain were higher than in females of Fayoumi strain but males in Fayoumi were higher slightly than males in Norfa strain in treated group. Interaction between breed and sexes was highly significantly at 16 weeks of age.

II) Between sexes:-

It was noticed that respiration rate of females was higher than that of males in young ages (8 and 12 weeks o ages) in treated group in Norfa and Fayoumi strains. In 16 and 20 weeks of age, the difference was not clear and sometimes the respiratory rate of males was higher than that in females in Fayoumi strain. Females of Norfa strain were higher than that in males at 16 and 20 weeks of age in treated group. The sex difference was highly significant in both Norfa and Fayoumi strains at 8 weeks of age. But it was not significant at 12, 16 and 20 weeks of age in Norfa and Fayoumi). This result was in disagreement with that obtained by Barbosa Filho (2006) who reported that exposure of laying hens to (26c° and 60% RH or 35c° and 70% RH) caused of respiratory frequency (RF) of birds reared in litter system was 160-180 movement min and 180-200 movement min in caged birds. The (RF) of birds under thermal stress was 260-280 and 300-320 movement min of birds in litter and cage systems.

Table (5): Effect of sex and heat stress for both of Norfa and Fayoumi chickens on respiratory rate. $\overline{X} \pm S.E$

Ages	Breed	Sex	Treatment	Control
8 wks.	Norfa	Female	83.6 ± 2.9[a]	61.2 ± 0.9[a]
		Male	76.6 ± 2.1[b]	59.2 ± 1.3[b]
		Mean	79.3 ± 1.6[c]	60.2 ± 0.8[e]
	Fayoumi	Female	81.8 ± 1.0[a]	70.8 ± 0.3[a]
		Male	74.0 ± 1.7[b]	64.4 ± 0.9[b]
		Mean	77.9 ± 1.5[d]	67.6 ± 0.9[f]
12 wks.	Norfa	Female	75.8 ± 2.7[a]	64.6 ± 1.3[a]
		Male	70.1 ± 2.5[a]	66.6 ± 1.3[a]
		Mean	72.3 ± 1.9[b]	65.6 ± 0.9[c]
	Fayoumi	Female	71.3 ± 2.5[a]	66.0 ± 1.7[a]
		Male	69.4 ± 3.1[a]	66.0 ± 1.1[a]
		Mean	70.4 ± 2.0b	66.0 ± 0.9c
16 wks.	Norfa	Female	80.4 ± 4.1[a]	64.5 ± 1.1[a]
		Male	69.9 ± 2.6[a]	64.4 ± 1.1[a]
		Mean	73.8 ± 2.5[b]	64.4 ± 0.7[d]
	Fayoumi	Female	66.4 ± 2.2[a]	62.8 ± 1.5[a]
		Male	72.7 ± 2.8[a]	63.6 ± 1.2[a]
		Mean	69.5 ± 2.0[c]	63.2 ± 0.9[e]
20 wks.	Norfa	Female	74.2 ± 1.5[a]	66.1 ± 0.6[a]
		Male	70.1 ± 1.4[a]	65.6 ± 0.9[a]
		Mean	71.7 ± 1.1[b]	65.8 ± 0.6[c]
	Fayoumi	Female	71.0 ± 0.5[a]	63.6 ± 1.2[a]
		Male	73.1 ± 2.7[a]	65.1 ± 0.9[a]
		Mean	72.0 ± 1.6[b]	64.3 ± 0.7[c]

[a, b, c, d, e, f] = values having the same superscript in each measured trait (according to sex, breed and treatment effect) are not differed significantly at P ≤ 0.05

Effect of sex and heat stress for both of Norfa and Fayoumi chickens on rectal temperature:-

Table (6) represent the effect of heat stress on rectal temperature in Norfa and Fayoumi chickens in both sexes at different ages from 8 to 20 weeks of age. It was noticed that, the average body temperature for treated group was higher than males in all ages (8, 12, 16 and 20 weeks of age) in Norfa chickens. Mean while, in Fayoumi layers the average body temperature in females was nearly similar to body temperature in males. The averages body temperature was significantly higher between sexes (p≤0.01) in ages 12 and 16 weeks of ages. While the average body temperature in treated group were higher than control group in Norfa and Fayoumi chickens when exposed to layers heat stress (35-37c°). There were highly significant differences (p≤0.01). between heat stress and natural ambient temperature. These results agreement with Rozenboin *et al.* (2007) found that White Leghorn layers that were exposed to 12 h h/d for 15 d to 42±3c° (heat stress) caused a significant elevation in body temperature during the 12 h of heat stress exposure.

The effect of heat stress on antibody response level in Norfa and Fayoumi chickens after exposure to heat stress:-

Table (7) the high temperature causes inhibition of the synthesis of T and B lymphocytes and suppression of phagocytic activity of blood leukocytes. The primary antibody level against SRBCs was

increased gradually after the primary injection and reached its maximum level at 14-d post- immunization (4.1 for females and 5.5 for males) in treated group. This declined gradually to reach the lowest level than control group (5.0 for females and 6.9 for males) in Norfa chickens. While in Fayoumi chickens the primary antibody level against SRBCs was increased gradually after the primary injection and reached its maximum level at 14-d post- immunization in females (2.4) in treated group than control group (3.3) but in males the primary antibody level against SRBCs was increased in control group than treated group. The present results indicated that the males had higher antibody titers than females. These results are in agreement with Leitner *et al.* (1992) and Paramentier *et al.* (1996) in chickens they reported that differences in antibody titers between males and females were not significant at 7,14 and 21-d post injection. However, the present results showed that most of antibody level against SRBCs was increased in control group than treated one in females and males in Norfa and Fayoumi chickens while antibody level increased in males and lowest in females in all treated group. This immune suppression has been attributed to an increase in the incorporation of endogenously produced ACTH and corticosteroids into lymphoid cells, which in turn causes the suppression of cell proliferation factors. (Atta, 1996) and Mashaly *et al.* (2004) who found that antibody production was significantly inhibited in hens in the heat stress group. Heat stress was also reported to cause a reduction in antibody production in young chickens (Zulkifi *et al.,* 2000).

Table (6): Effect of sex and heat stress for both of Norfa and Fayoumi chickens on rectal temperature. $\overline{X} \pm S.E$

Age	Breed	Sex	Treatment	Control
8 wks.	Norfa	Female	42.1 ± 0.02^{a}	41.8 ± 0.04^{a}
		Male	41.9 ± 0.05^{a}	41.7 ± 0.04^{a}
		Mean	42.0 ± 0.03^{b}	41.7 ± 0.03^{c}
	Fayoumi	Female	41.9 ± 0.01^{a}	41.8 ± 0.04^{a}
		Male	41.9 ± 0.02^{a}	41.7 ± 0.02^{a}
		Mean	41.9 ± 0.01^{b}	41.7 ± 0.01^{c}
12 wks.	Norfa	Female	42.2 ± 0.02^{a}	41.8 ± 0.04^{a}
		Male	41.9 ± 0.04^{b}	41.7 ± 0.02^{b}
		Mean	42.1 ± 0.02^{c}	41.7 ± 0.03^{e}
	Fayoumi	Female	41.9 ± 0.02^{a}	41.7 ± 0.04^{a}
		Male	41.9 ± 0.02^{b}	41.8 ± 0.04^{b}
		Mean	41.9 ± 0.01^{d}	41.7 ± 0.01^{f}
16 wks.	Norfa	Female	42.1 ± 0.02^{a}	41.9 ± 0.01^{a}
		Male	41.9 ± 0.02^{b}	41.8 ± 0.02^{b}
		Mean	42.1 ± 0.02^{c}	41.8 ± 0.01^{e}
	Fayoumi	Female	41.9 ± 0.01^{a}	41.8 ± 0.02^{a}
		Male	41.9 ± 0.03^{b}	41.7 ± 0.02^{b}
		Mean	41.9 ± 0.02^{d}	41.7 ± 0.01^{f}
20 wks.	Norfa	Female	42.1 ± 0.01^{a}	41.9 ± 0.01^{a}
		Male	41.9 ± 0.02^{a}	41.8 ± 0.02^{a}
		Mean	42.0 ± 0.01^{b}	41.8 ± 0.01^{b}
	Fayoumi	Female	41.9 ± 0.02^{a}	41.9 ± 0.04^{a}
		Male	41.9 ± 0.02^{a}	41.8 ± 0.02^{a}
		Mean	41.9 ± 0.02^{b}	41.8 ± 0.02^{b}

^{a,b,c,d,e,f} = values having the same superscript in each measured trait (according to sex, breed and treatment effect) are not differed significantly at P ≤ 0.05

Table (7): Effect of heat stress on the immunity in Norfa and Fayoumi chickens, ($\overline{X} \pm S.E$).

		Before exposure		After exposure	
Breed	Sex	Treatment	Control	Treatment	Control
Norfa	Female	6.6 ± 1.6[a]	8.7 ± 2.7[a]	4.1 ± 0.9[a]	5.0 ± 0.2[a]
	Male	4.6 ± 1.7[b]	5.0 ± 1.9[b]	5.5 ± 1.9[a]	6.9 ± 0.4[a]
	Mean	5.6 ± 1.2[c]	6.8 ± 1.8[c]	4.8 ± 0.9[b]	5.9 ± 0.2[b]
Fayoumi	Female	11.7 ± 2.0[a]	11.9 ± 0.8[a]	2.4 ± 1.0[a]	3.3 ± 0.2[a]
	Male	6.0 ± 1.1[b]	11.7 ± 4.2[b]	3.3 ± 1.6[a]	5.9 ± 3.2[a]
	Mean	8.8 ± 1.3[c]	11.8 ± 2.5[c]	2.8 ± 0.8[b]	4.6 ± 1.6[b]

[a], [b], [c] = values having the same superscript in each measured trait (according to sex, breed and treatment effect) are not differed significantly at P ≤ 0.05

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تأثير الإجهاد الحراري على بعض الصفات الإنتاجية والفسيولوجية في الدجاج

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الملخص العربي

الهدف من هذه التجربة هو دراسة تأثير الإجهاد الحراري على نوعين من الدجاج لمعرفة الاستجابة الفسيولوجية والأداء الإنتاجي لمجموعتين من الدجاج وأجريت هذه الدراسة بمزرعة الدواجن التابعة لقسم إنتاج الدواجن بكلية

الزراعة جامعة المنوفية بشبين الكوم. أخذ عدد ٢٧٦ كتكوت من الكتاكيت النورفا والفيومي من أربع أسابيع حتى ٣٢ أسبوع من العمر. عند ٨ أسابيع قسمت إلى مجموعتين المجموعة الأولى تتعرض لظروف البيئة الطبيعية من النورفا والفيومي والمجموعة الثانية استخدمت غرف الأقلمة لتعريضها للإجهاد الحراري على درجة ٣٥-٣٧ م° ونسبة رطوبة ٦٥% لمدة ٦ ساعات في اليوم مرة واحدة أسبوعياً واستمرت التجربة لمدة عشرين أسبوع وتم حساب كل من وزن الجسم، معدل النمو، والعمر عند النضج الجنسي، وإنتاج البيض، وزن البيض، كتلة البيض أثناء الثلاث شهور الأولي بعد النضج الجنسي وقياس درجة حرارة الجسم ومعدل التنفس خلال فترة الرعاية وكذلك قياس المناعة في نهاية التجربة.

أهم النتائج المتحصل عليها:-

١. وزن الجسم لكل من النورفا والفيومي في المجموعة الكنترول أثقل من المجموعة المعاملة عند كل الأعمار المختلفة أثناء فترة الرعاية.
٢. معدل النمو يكون مرتفع في دجاج الفيومي مقارنة بالنورفا أثناء الفترة من ٤-٢٠ أسبوع من العمر.
٣. العمر عند النضج الجنسي يكون مبكرا في دجاج النورفا مقارنة بالفيومي في المجموعة الكنترول ولكن بالعكس في المجموعة المعرضة للإجهاد الحراري يكون دجاج النورفا متأخر في النضج الجنسي في المجموعة المعاملة.
٤. متوسط وزن الجسم عند النضج الجنسي في دجاج النورفا أثقل من الفيومي عند التعرض للإجهاد الحراري .
٥. متوسط وزن البيض عند النضج الجنسي يكون أثقل في المجموعة المعاملة بينما يقل في المجموعة الكنترول.
٦. متوسط عدد البيض خلال الثلاثة شهور الأولى من إنتاج البيض يزيد في المجموعة الكنترول مقارنة بالبيض المنتج من المجموعة المعاملة في دجاج النورفا والفيومي.
٧. متوسط معدل التنفس في دجاج النورفا عالي في المجموعة المعاملة مقارنة بالمجموعة الكنترول في كل الأعمار.
٨. متوسط درجة حرارة الجسم في دجاج النورفا تزيد في المجموعة المعاملة مقارنة بالمجموعة الكنترول.
٩. تأثير الإجهاد الحراري علي تكون أجسام مناعية مضادة من كرات دم الأغنام الحمراء: الإناث لها مقدرة علي تكوين أجسام مضادة عالية عن الذكور بعد ١٤ يوم من الحقن بكرات دم الحمراء للغنم في دجاج النورفا والفيومي قبل التعرض للإجهاد الحراري وهذا الاختلاف بين الجنسين كان معنويا حيث أن دجاج الفيومي قبل التعرض للإجهاد الحراري كان مستوي تكوين الأجسام المضادة أزيد عن الدجاج النورفا بعد الحقن بكرات الدم الحمراء للأغنام بينما بعد التعرض للإجهاد الحراري. إن أغلب مستوي تكوين أجسام مضادة من لكرات الدم الحمراء للأغنام يقل في المجموعة المعاملة مقارنة بالمجموعة المقارنة في دجاج النورفا والفيومي بينما مستوي الأجسام المناعية المضادة زاد في الذكور وانخفض في الإناث في كل من النورفا والفيومي.