Effect of One-Day Exposure to Heat Stress on Some Physiological Parameters in Sheep

A. H. Mohamed *, A. A. Abdel Hamid, E. M. Saudi, and S. S. Abel Ghfar

Animal Production Department, Faculty. of Agriculture, Al-Azhar University, Cairo, Egypt.

* Corresponding author E-mail: attiahabeb @azhar.edu.eg. (A. Mohmed)

ABSTRACT

Heat stress affects some physiological parameters especially in sheep but how long the animal takes to eliminate is unclear in the previous studies So, twenty dry-non pregnant Ossimi ewes were used to study the effect of one-day exposure to heat stress on some physiological parameters. Animals were divided equally into two groups (ten each)., The experimental ewes aged 3-4 years old and weighed 35-40 kg, The control group was kept under the shadow till the end of the experiment. The 1st group was exposed to heat stress for one day on the first day of the experiment. Cortisol, T3, PCV, and HB, were measured in the blood serum. Skin temperature, rectal temperature, and respiratory rate were determined. The results indicated that there was a significant *(P < 0.05)* increase in the exposed group in the level of cortisol on the 1st day of exposure to heat stress and continued till day 45 of the experiment. There was a significant *(P < 0.05)* difference between groups in the level T3. It was lower in the exposed group compared to control. PCV, HB were significantly decreased in the exposed group from day 0 till day 45. Skin temperature and respiratory rate were significantly increased in the in exposed group on day 0 only. It was clear that there was a latent effect to heat stress on some physiological parameters for Ossimi ewes.

Keywords: Heat stress, skin temperature, rectal temperature, respiration rate, cortisol hormone.

INTRODUCTION

Heat stress is known to change the homeostatic mechanism of animals causing high-oxygen consumption through the increase of respiration rate. This causes a reduction in erythropoiesis which in turn reduces the number of circulating erythrocytes and thus (PCV and HB) values (Sivakumar et al, 2010and Kumar et al, 2011). Triiodothyronine concentration in blood was significantly higher in the winter season compared to other seasons, (Minton, 1994). All the previous studies focused on comparing the exposed group with the unexposed group without discussing the time when exposed animals get free of the effect of exposure to heat stress. So, in this study, the latent effect of exposure of animals to heat stress was studied beside the effect of heat stress on animals compared to control groups.

MATERIALS AND METHODS

Study Location:

This experiment was carried out at the Animal production station in Nasr City, Cairo belonging to the Animal production department, Faculty of Agriculture, Al -Azhar University, Cairo, which provided standard laboratory chemicals and equipment required for this study. HB, PCV, and T3, Cortisol, ware analysis at F.O.P (Faculty of pharmacy).

Experimental animal and management:

The Egyptian sheep was used in this study, the initial Weight of 38±15 kg.

The animals were kept under similar management conditions, the animal was housed on the farm under ambient temperature (ranged from 28 to 35 C) in summer Light dark cycle that was maintained for about 12-hour. The animal was feeding in groups (individual) and was provided with international requirements according to the feeding system applied in the animal farm, the fresh water was provided. All animals were healthy and clinically free from diseases.

Experimental Outline:

The experiment was carried out during summer day 0 (July on 15th,2019), 45 (September 1st,2019), 90 (October on 15th,2019), and day 135 (December on 1st,2019). The experiment `started three months after receiving the animals. The animals were sheared immediately after receipt, in all experiments, rectal temperature was recorded at intervals simultaneously with measurements of physiological parameters.

Summer season:

In summer, a total of 20 animals were assigned into two groups each containing 10 Ossimi ewes as followed:

G1 Normal group (Control)

G2 Heat Exposed animals

The animals are exposed for one day in the heat stress on 15-07-2019 .Then the animals were followed up after exposure for four months to see the rates of change in the measures of physiological acclimatization

Climate measurements:

Measuring the air temperature at a distance of 1 meter from the surface of the land

Solar radiation temperature measurement

Humidity

These measurements were taken in seven periods during the day

Blood measurements:

Blood samples were obtained from sheep by withdrawing blood from the orbital venous plexuses using an injection. Samples were collected on two occasions, the first occasion for analysis HB and PCV, second samples collected, make centrifuged at 3000 rpm for 20 min to obtain serum. Serum was transferred to Eppendorf tube and stored at – 20 Co until subsequent analyses**,** Blood samples are taken three times daily at different intervals.

Animal measurements:

Measurement of respiratory rate per minute, Rectal temperature, and Skin temperature were taken in Seven periods during the day

Hormonal measurements:

T3 hormone in serum was measured by radio-immunoassay (RIA) (Bablok., 1988). In all these methods, the second antibody separation technique was utilized, Cortisol hormone in serum was measured by radio-immunoassay (RIA) (Turpeinen, 2013). In all these methods the second antibody separation technique was utilized.

Hematological parameters:

Samples were determined of Hemoglobin and Hematocrit Using Electronic DIAGON method according to (D-cell60).

Rectal temperature:

Rectal temperature was measured with a clinical thermometer (Model HI98509) inserted 1.5 cm in the rectum and taped to the tail for 1 minute. Rectal temperature was measured three times in the first experiment and the fourth and eighth weeks.

Statistical Analysis:

Data were subjected to analysis of variance using the General Linear Models procedure of SPSS software program package (SPSS, 2020, version 23.0). All percentages were first transformed to arcsine than analyzed to approximate normal distribution before ANOVA. Addition, significant differences among means determined by Duncan's multiple range test (Duncan, 1955) at 5% level of significance. two-way analysis of variance was used to study the effect of the days within each season i-e, and the exposure to heat stress.

The statistical model was as follows:

$$X_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + e_{ijk}$$

Where,

μ = is the mean of each trait.

α_i = is the effect of days within season on each trait.

β_j = is the effect of exposure to heat stress within season.

$\alpha\beta_{ij}$ = is the interaction between days within season and exposure to stress.

e_{ijk} = is the experimental error

RESULTS AND DISCUSSION:

Results in Table (1) showed that (on day 0 of the experiment) there was a significant difference ($p < 0.05$) between exposed and control groups in the level of cortisol in the blood serum. The level of cortisol was 22.89±0.92 ng/dl in the exposed group compared to 20.51±0.90 ng/dl in the control group. This result showed that the exposure of ewes to heat stress caused an increase in the level of cortisol. The level of cortisol in the exposed group was 2.38 ng/dl higher than in the control group.

Results in Table (1): also showed that (on day 45 of the experiment) there was a significant difference ($p < 0.05$) between exposed and control groups in the level of cortisol in the blood serum. The level of cortisol was 6.99±.27ng/dl in the exposed group compared to 6.37±.23 ng/dl in the control group. The level of cortisol in the exposed group was 0.62 ng/dl higher than in the control group.

In the same Table (Table1): it was clear that (on day 90 of the experiment) there was no significant difference between exposed and control groups in the level of cortisol in the blood serum. The level of cortisol was 8.96±.71ng/dl in the exposed group compared to 8.42±.60 ng/dl in the control group.

In addition: the same table showed that (on day 135 of the experiment) there was no significant difference between exposed and control groups in the level of cortisol in the blood serum. The level of cortisol was 4.57±.32 ng/dl in the exposed group compared to 4.51±.32 ng/dl in the control group.

It is obvious from the previous results that the exposure of ewes to heat stress showed a tremendous increase in the level of cortisol in the blood serum of the exposed ewes. This higher increase was on day 0 of exposer to heat stress compared to the control group after 44 days of the experiment (on day 45 of exposure to heat stress), The level of cortisol decreased with 15.93 ng/dl however, it was higher than the control group. On day 90, there was an increase in the level of cortisol in the blood serum of the exposed group with 1.97 ng/dl compared to 2.05 ng/dl for the control group but didn't reach significance. On day 135, there was a decrease in the level of cortisol in the exposed group with 4.39 ng/dl compared to 3.91 ng/dl for the control group, however, it didn't reach significance.

Results in Fig (1) showed that diurnal mean cortisol summer in 0,45,90 and 135 days, there is no significant difference inside the day between the exhibition and the control group, but inside each group, Cortisol levels are higher at 2 pm than the rest of the day.

According to the previous results, it was concluded that the exposure of ewes to heat stress increased the level of cortisol in the blood serum of the exposed ewes on 0 day of the experiment this effect lasted only for 45 days after exposure to heat stress, then it removed in the next periods (day90, day135) of the exposure to heat stress.

This result was similar to Gupta et al (2013), it showed that there was an increase in plasma concentration of cortisol from 25.27 to 40.57 nmol/L in heat-stressed goats.

Cwynar et al (2014), showed that there was a clear and highly significant difference ($p < 0.01$) in the cortisol in the blood between groups I (16.5°C) and II (30°C), and a significant difference ($p < 0.05$) between groups II (30°C) and III (50°C) in Polish Merino rams

Li, et al (2018) found that there were some significant differences between ram and ewe the cortisol of ram that was higher than that of ewe the plasma cortisol decreased with the increasing levels of THI only for the ewes ($P < 0.05$) under high-temperature environments in Small-tail Han sheep.

Results in Table (2) showed that (on day 0 of the experiment) there was a significant difference ($p < 0.05$) between exposed and control groups in the level of T3 hormone in the blood serum. The level of T3 Hormone was 140.70± 3.74 ng/dl in the exposed group compared to 150.53± 2.57 ng/dl in the control group. This result showed that the exposure of ewes to heat stress caused a decrease in the level of T3 Hormone. The level of T3 Hormone in the exposed group was 9.83 ng/dl lower than the control group.

Results in Table (2): it was clear that (on day 45 of the experiment) there was no significant difference between exposed and control groups in the level of T3 hormone in the blood serum. The level of T3 Hormone was 144.16±5.16 ng/dl in the exposed group compared to 156.80±4.98 ng/dl in the control group.

In the same Table (Table2), it was clear that (on day 90 of the experiment) there was no significant difference between exposed and control groups in the level of T3 hormone in the blood serum. The level of T3 Hormone was 145.63±3.93 ng/dl in the exposed group compared to 155.54±4.14 ng/dl in the control group.

In addition, the same table showed that (on day 135 of the experiment) there was no significant difference between exposed and control groups in the level of T3 hormone in the blood serum. The level of T3 Hormone was 146.71±4.22 ng/dl in the exposed group compared to 145.25±4.53 ng/dl in the control group.

It is obvious from the previous results that the exposure of ewes to heat stress showed a tremendous decrease in the level of T3 hormone in the blood serum of the exposed ewes. This higher decrease was on day 0 of exposure to heat stress compared to the control group after 44 days of the experiment (on day 45 of exposure to heat stress), The level of T3 Hormone increased by 3.46 ng/dl however, it was lower than the control group. On day 90, there was an increase in the level of T3 hormone in the blood serum of the exposed group with 1.47 ng/dl compared to decreased 1.26 ng/dl for the control group but didn't reach significance. On day 135, there was an increased in the level of T3 Hormone in the exposed group with 1.08 ng/dl compared decreased to 10.25 ng/dl for the control group, however, it didn't reach significance.

Results in Fig (2) showed that in diurnal mean T3 summer in 0,45,90 and 135 days, there is no significant difference inside the day between the exhibition and the control group, but inside each group Cortisol levels are higher at 8 am than the rest of the day

According to the previous results, it was concluded that the exposing ewes to heat stress decreased the level of T3 hormone in the blood serum of the exposed ewes on 0 day of the experiment, then it `was removed in the next periods (day45, day90, day135) of the exposure to heat stress.

This result was similar to Solouma (1999) who found that triiodothyronine averaged 149.40 ng/dl in stressed rams, while in rams kept normally it was 156.50 ng/dl. Heat stress caused a 4.75 % decrease in triiodothyronine.

Brown et al, (1984). It is important to mention here that heat stress causes significant decreases in serum thyroxin (T4), triiodothyronine (T3)

Gupta et al (2013), showed that T3 levels decreased from 4.55 and 21.27 to 3.21 and 16.70 nmol/L, respectively. There is a decline in T3 levels during short and long long-term exposure to solar radiation in goats.

Results in Table (3) showed that (on day 0 of the experiment) there was a significant difference (p ≥0.05) between exposed and control groups in the level of hemoglobin in the blood plasma. The level of HB was 12.93±0.68 ng/dl in the exposed group compared to 13.93±0.23 ng/dl in the control group. This result showed that the exposure of ewes to heat stress caused a decrease in the level of HB in the exposed group was 1 ng/dl lower than the control group.

Results in Table (3): it was clear that (on day 45 of the experiment) there was a significant difference (p ≥0.05) between exposed and control groups in the level of hemoglobin in the blood plasma. The level of HB was 12.43±0.19 ng/dl in the exposed group compared to 13.04±0.20 ng/dl in the control group. This result showed that the exposure of ewes to heat stress caused a decrease in the level of HB in the exposed group was 0.39 ng/dl lower than the control group.

Results in Table (3): it was clear that (on day 90 of the experiment) there was a significant difference (p < 0.05 between exposed and control groups in the level of hemoglobin in the blood plasma. The level of HB was 12.40±0.27 ng/dl in the exposed group compared to 13.43±0.24 ng/dl in the control group. This result showed that the exposure of ewes to heat stress caused a decrease in the level of HB in the exposed group was 1.03 ng/dl lower than the control group.

In addition, the same table showed that (on day 135 of the experiment), it was clear that (on day 90 of the experiment), there was a significant difference (p ≥0.05) between exposed and control groups in the level of hemoglobin in the blood plasma. The level of HB was 11.56±0.18 ng/dl in the exposed group compared to 13.43±0.24 ng/dl in the control group. This result showed that the exposure of ewes to heat stress caused a decrease in the level of HB in the exposed group was 0.51 ng/dl lower than the control group.

It is obvious from the previous results that the exposure of ewes to heat stress showed a tremendous decrease in the level of HB in the blood plasma of the exposed ewes. This lower decrease was on day 0 of exposer to heat stress compared to the control group after 44 days of the experiment (on day 45 of exposure to heat stress), The level of HB decreased with 0.50 ng/dl however, it was lower than the control group. On day 90, there was a decrease in the level of HB in the blood plasma of the exposed group with 0.03 ng/dl compared to 0.39 ng/dl for the control group. On day 135, there was a decrease in the level of HB in the exposed group with 0.84 ng/dl compared to 1.36 ng/dl for the control group.

Results in Fig (3) showed that diurnal Mean Hemoglobin summer in 0,45,90 and 135 days, there is no significant difference inside the day between the exhibition and the control group, but inside each group, Cortisol levels are higher at 8 am than the rest of the day

According to the previous results, it was concluded that the exposure of ewes to heat stress decreased the level of HB in the blood plasma of the exposed ewes on 0 days of the experiment this effect lasted for 135 days after exposure to heat stress

This result was similar to Nicolás-López et al (2021), showed that in our hair male lambs, Heat Stress decreased the number of erythrocytes and, consequently, hemoglobin values, although these hematological results could be explained by a simple hemodilution. It was clear that HS increases the arterial partial pressure of oxygen due to increased RR, a situation that causes erythrocyte lysis, low erythropoiesis, and, then, a decrease in erythrocyte count, hemoglobin.

Singh et al (2016) showed a significant decrease in Hb in all the three sheep breeds (Chokla, Magra, and Marwari) due to heat stress

Results in Table (4) showed that (on day 0 of the experiment) there was a significant difference ($p < 0.05$) between exposed and control groups in the level of PCV in the blood plasma. The level of PCV was 36.91±0.43 % in the exposed group compared to 39.23±0.70 % in the control group. This result showed that the exposure of ewes to heat stress caused a decrease in the level of PCV in the exposed group was2.32 % lower than the control group.

Results in Table (4): it was clear that (on day 45 of the experiment) there was a significant difference ($p \geq 0.05$) between exposed and control groups in the level of PCV in the blood plasma. The level of PCV was 35.31±0.60 % in the exposed group compared to 38.95±0.76 % in the control group. This result showed that the exposure of ewes to heat stress caused a decrease in the level of PCV in the exposed group was 3.64 ng/dl lower than the control group.

Results in Table (4): it was clear that (on day 90 of the experiment) there was a significant difference ($p \geq 0.05$) between exposed and control groups in the level of PCV in the blood plasma. The level of PCV was 34.43±0.72 % in the exposed group compared to 36.50±0.73 % in the control group. This result showed that the exposure of ewes to heat stress caused a decrease in the level of PCV in the exposed group was 2.07 ng/dl lower than the control group.

In addition, the same table showed that (on day 135 of the experiment) it was clear that (on day 90 of the experiment) there was a significant difference ($p \geq 0.05$) between exposed and control groups in the level of PCV in the blood plasma. The level of PCV was 34.20±0.65 % in the exposed group compared to 36.75±0.84 % in the control group. This result showed that the exposure of ewes to heat stress caused a decrease in the level of PCV in the exposed group was 2.55 % lower than the control group.

It is obvious from the previous results that the exposure of ewes to heat stress showed a tremendous decrease in the level of PCV in the blood plasma of the exposed ewes. This lower decrease was on day 0 of exposer to heat stress compared to the control group after 44 days of the experiment (on day 45 of exposure to heat stress). The level of PCV decreased by 1.60 % however, it was lower than the control group. On day 90, there was a decrease in the level of PCV in the blood serum of the exposed group with 0.88 % compared to 2.45 ng/dl for the control group. On day 135, there was a decrease in the level of PCV in the exposed group with 0.20 % compared to 0.25 ng/dl for the control group.

Results in Fig (4) showed that diurnal Mean PCV summer in 0,45,90 and 135 days, there is no significant difference inside the day between the exhibition and the control group, but inside each group, Cortisol levels are higher at 8 am than the rest of the day, and It was lowest at midday in both groups

According to the previous results, it was concluded that the exposure of ewes to heat stress decreased the level of PCV in the blood plasma of the exposed ewes on 0 days of the experiment this effect lasted only for 45 days after exposure to heat stress, then is removed in the next periods (day90, day135) of the exposure to heat stress.

This result was similar to Nicolás-López et al (2021) it, showed that in our hair male lambs, Heat Stress decreased the number of erythrocytes and, consequently, hematocrit values, although these hematological results could be explained by a simple hemodilution, keep in mind that HS also increases the arterial partial pressure of oxygen due to increased RR, a situation that causes erythrocyte lysis, low erythropoiesis, and therefore, a reduction hematocrit.

Singh et al (2016), showed a significant ($P \leq 0.05$) decrease in PCV% in all the three sheep breeds (Chokla, Magra, and Marwari) due to heat stress.

Results in Table (5) showed that although there was a significant difference ($p \geq 0.05$) among the rectal temperatures of exposed animals during the different days (day0, day45, day90, day135), it was biologically in the normal range. The rectal temperatures for exposed animals were 39.62±.083, 39.39±.030, 39.45±.031and 39.39±.044 for (day0, day45, day 90, day135) respectively

Results in Fig (5) showed that diurnal Mean Rectal temperature was not significantly different during the day, but the rectal temperature was at its highest in the middle of the day in both groups.

This result was similar to the mean rectal temperature of sheep in the literature may range between 38.3 & 41 ° C (Swenson and Reece, 1993; Shafie et al., 1994 and Shalaby et al., 1996. Aboul- Ela et al., (1987) reported that rectal temperature was significantly ($p < 0.01$) higher in Finnish Landrace under subtropical conditions of Egypt than in those raised in Finland. They attributed that to the difference in ambient temperature between the two regions. In Anglo Nubian goats, Shalaby and Johnson (1993) found that rectal temperature increased from 37.0 ° C to 39.3 ° C when the ambient temperature was increased from 25 ° C and 65 % RH to 35 ° C and 25 % RH. Also, Shafie et al., (1994) found that the increase in ambient temperature from 18 to 35ºC significantly caused an increase in the rectal temperature of sheep. Average rectal temperature under controlled temperature of 18 ° C and 35 ° C for 8 hour was 38.72 + 0.04 ° C and 39.07 + 0.03 °C, respectively. After 15.00h RT was 38.83 + 0.03 ° C and 39.11 + 0.03 ° C, respectively. Also, Hassanin et al., (1996) indicated that the rectal temperature of goats increased with heat stress.

Srikandakumar et al (2003) found that the rectal temperature is generally considered as a good indicator of deep body temperature even though there is considerable variation at different parts of the deep body core at different times of the day, showing that the basal rectal temperature was higher in Merino (39.5 ◦C) than Omani (39 ◦C) sheep during the period of cooler environment and heat stress increased the rectal temperature to 39.8 ◦C in Merino and to 39.7 ◦C in Omani sheep. However, the magnitude of the increase in rectal temperature in Omani sheep (0.7 ◦C) was higher than that of Merino sheep (0.3 ◦C).

Results in table (6) showed that during the day 0 of the exposure to heat stress there was a significant difference ($p \geq 0.05$) between the exposed and control group in skin temperature (°C). It was higher in the exposed group than the control group. It was 38.86±.15 °C in the exposed group compared to 38.09±.08 °C for the control group

Results in Table (6): it was clear that (on day 45 of the experiment) there was no significant difference between exposed and control groups in skin temperature (°C). It was 38.52±.21 °C in the exposed group compared to 38.60±.17 °C for the control group

Results in Table (6): it was clear that (on day 90 of the experiment) of the exposure to heat stress there was a significant difference ($p \geq 0.05$) between the exposed and control group in skin temperature (°C). It was lower in the exposed group than the control group. It was 38.42±0.18°C in the exposed group compared to 38.57±0.15°C for the control group

In addition, the same table showed that (on day 135 of the experiment) there was no significant difference between exposed and control groups in skin temperature (°C). It was 38.75±.13 in the exposed group compared to 39.00±.12 °C for the control group.

Results in the same table, table 6), also showed that there was a significant difference among skin temperature of exposed animals during the different periods (day0, day90,). Although the current results showed a clear difference among exposed animals in the mean of skin temperature during the different days of exposure to heat stress, it was noticed that the effect of heat stress on skin temperature in this experiment for 0 days declined after this period when exposed animals compared to the controlled animals during the same day.

Results in Fig (6) showed that diurnal Mean skin temperature has no significant difference during the day, but the skin temperature was at its highest in the middle of the day in both groups.

This result was similar to the mean skin temperature of local sheep ranged from 36.7 ° C to 38.2°C (Khalil et al., 1990; Ibrahim, 1994; Mohamed, 1996; Shalaby et al., 1996 and Abd El - Hafez. 1997). Singh et al., (1980) found that the averages of skin temperature were 34.6, 34.8, 35.0, 34.5, and 34.5 ° C for Malpura, 12 Rahmani x 12 Malpura, Rambouillet, Rambouillet x Chokla and Chokla sheep, respectively. They also reported that the increase in skin temperature with the increase in ambient temperature was an indicator of the direct effect of the environment. In India, Ghosal et al., (1981) reported that means of skin temperature at the mid-side were 39.1 °C and 37.4 ° C in Corriedale and Vali sheep.

Al-Haidary et al (2012) found that the value of skin temperature was significantly higher under hot summer conditions (38.13±0.10oC) in Najdi Sheep

Rashid et al (2013) found that Sheep exposed to short and long-term cyclic heat stress significantly increased skin temperatures when compared to the control group.

Results in table (7) showed that during the day 0 of the exposure to heat stress, there was a significant difference ($p \geq 0.05$) between the exposed and control groups in respiration rate (breaths/min). It was higher in the exposed group than the control group. It was 68.10±2.95

breaths/min in the exposed group compared to 46.4±0.85 breaths/min for the control group.

Results in Table (7): it was clear that (on day 45 of the experiment) there was no significant difference between exposed and control groups in respiration rate(breaths/min). it was 47.47±1.14 breaths/min in the exposed group compared to 50.75±1.69 breaths/min for the control group

Results in Table (7): it was clear that (on day 90 of the experiment) of the exposure to heat stress, there was a significant difference (p ≥0.05) between the exposed and control group in respiration rate(breaths/min). It was higher in the exposed group than the control group. It was 57.24±1.31 breaths/min in the exposed group compared to 50.74±1.03 breaths/min for the control group.

In addition, the same table showed that (on day 135 of the experiment) there was no significant difference between exposed and control groups in respiration rate (breaths/min). It was 36.57±0.99breaths/min in the exposed group compared to 34.9±0.80 breaths/min for the control group.

Results in the same table (table10) also showed that there was a significant difference among respiration rates of exposed animals during the different periods (day0, day45, day 90, day135). Although the current results showed a clear difference among exposed animals in the mean of respiration rate during the different days of exposure to heat stress. It was noticed that the effect of heat stress on respiration rate in this experiment for 0 days then declined after this period when exposed animals compared to the controlled animals during the same day.

Results in Fig (7) showed that diurnal Mean Respiration rates were no significant differences during the day, but the Respiration Rate was at its highest in the middle of the day in both groups.

This result was similar to (Tsigos and Chrouso, 2002). Khalifa et al., (1991) found that the normal means of RR were about 56.8, 53.0, and 34.0 breaths/min. in shorn, half-shorn, and unshorn sheep, respectively. El-Sherbiny et aL, (1983) found that when the ambient temperature was increased from 10 to 40aC, the respiration rate of goats was increased significantly. Shalaby (1985) reported that the RR of Rahmani and Ossimi ewes reached the maximum during summer at 2.00 pm. and 4.00 pm., which coincided with the hottest time of the day. Ghosh et al., (1993) reported that the overall average RR of goats was 29.09 ± 0.14 breaths/min., and it was significantly positively related to ambient temperature. Shafie et al, (1994) found in sheep that increasing ambient temperature from 18°C to 35°C increased (P<0.01) RR.

Srikandakumar et al (2003) found that the magnitude of the increase in respiratory rate was higher for Merino (78 units) than in Omani (31 units) sheep when they were subjected to heat stress.

Al-Haidary (2012) showed that the values of respiration rate were minimal early in the morning and peaked late in the afternoon in Najdi Sheep, the daily average values of RR were significantly elevated under hot summer conditions (74.04±2.05 breaths/minute).

Rashid et al (2013) found that Sheep exposed to short and long-term cyclic heat stress significantly increased respiratory rate when compared to the control group.

Cwynar et al (2014) showed that the respiration rate when he was the mean temperature (16.5°C,30°C, and 50°C) were significantly different. It should be noted that at 50°C a deepening of breaths at the expense of a reduction in their frequency was observed. in Polish Merino rams.

Al-Haidary (2004) showed that exposure sheep to heat stress resulted in a significant increase in rectal temperature (RT), this corresponded with a significant increase in respiratory frequency (RR) and skin temperature sites. The increase in RR is an attempt to increase respiratory vaporization and the higher skin temperature can be attributed partially to the fact that exposure to heat stress alters the blood flow and redistribution of blood flow and increase blood flow to the surfaces.

CONCLUSION

Exposure of animals to heat stress for one day caused a clear increase in the level of cortisol for forty-five days, then it declined to its normal level while the level of T3 decreased significantly on the first day, then it reached its normal level. Hemoglobin and PCV followed the same trend like T3. It is clear according to these results that there was latent effect resulted from the heat stress for one day that lasted for 45 days. Avoiding exposing animals to heat stress keep them in a good condition especially during the production processes.

REFERENCES

Abd El - Hafez, M.A.M. 1997: Effect of heat stress on fat tailed crossbred sheep. M.Sc. Thesis, Fac. Agric., Zagazig Univ., Zagazig, Egypt.

Aboul- Ela, A.M., Aboul- Naga, A.M., Shalaby, T.H., Maijala, K. 1987: Physiological response to climatic changes in Finnish Landrace ewes imported to Egypt and their half - sibs raised in Finland. Livestock Prod. Sci., 17: 179.

Al-Haidary, A.A. 2004:Physiological responses of Naimey sheep to heat stress challenge under semi-arid environments. International Journal of Agriculture and Biology, 2, 307-309.

Al-Haidary, A.A., Aljumaah, R.S., Alshaikh, M.A., Abdoun, K.A., Samara, E.M., Okab, A.B., Alfuraiji, M.M. 2012: Thermoregulatory and physiological responses of Najdi sheep exposed to environmental heat load prevailing in Saudi Arabia. Pak. Vet. J, 32(4), 515-519.

Bablok, W., Passing, H., Bender, R., & Schneider, B. (1988). A general regression procedure for method transformation. Application of linear regression procedures for method comparison studies in clinical chemistry, Part III. J Clin Chem Clin Biochem, 26(11), 783-790.

Brown, J.p., J.Malaval, M. C.Chapuy, P. D.Delmas, C.Edouard and P. J. Meunier, (1984). Serum bone GLA-protein: A specific marker for bone formation in postmenopausal osteoporosis. Lancet, 1:1091.

Burtis, C.A., Ashwood, E.R. 1999: Tietz Textbook of Clinical Chemistry. 3rd Edition, W. B. Saunders Co., Philadelphia, 29-150.

Cwynar, P., Kolacz, R., Czerski, A. 2014: Effect of heat stress on physiological parameters and blood composition in Polish Merino rams. Berliner und Munchener Tierarztliche Wochenschrift, 127(5-6), 177-182.

Duncan, D.B. 1955: Multiple ranges and Multiple F test. Biometrics, 1:11.

El - Sherbiny, A.A., Yousef, M.K., Salem, M.H., Khalifa, H.H., Abd El – Bary, H.T., Khalil, M.H. 1983: Thermoregulatory responses of a desert and non - desert goat breed. Al - Azhar J. Agric. Res. 4: 89.

Ghosh, N., Samanta, A.K., Roy, S.P., Maitra, D.N. 1993: Studies on the physiology responses and feed intake of Bengal goats under deep litter system of management. Indian J. Anim. Prod. and Manag., 9: 161.

Gindler, E.M., Westgard, J.O. 1973: Automated and manual determinations of albumin with bromocreosol green and a new surfactant. Clin. Chem, 6.

Gupta, M., Kumar, S., Dangi, S.S., Jangir, B.L. 2013: Physiological, biochemical, and molecular responses to thermal stress in goats. Int J Livest Res, 3(2), 27-38.

Hassanin, S.H., Abdalla, E.B., Tharwat, A.A., El sherbiny, A.A., Kotby, E.A. 1996: Effect of kidding season on some blood constituents, milk yield and milk composition of Egyptian Zaraibi goats. Monofia J. Agric. Res., Vol. 21 No. 2: 329.

Ibrahim, S.F.M. 1994: Effect of crossing Romanov with Rahmani sheep on some physiological and productive performance. M.Sc. Thesis, Fac. Agric., Al - Azhar Univ., Cairo, Egypt.

Khalifa, H.H., Khalil, M.H., Abd El – Bary, H.T. 1991: Significance of wool length on physiological responses to dehydration of Barki sheep. Al - Azhar J. Agric. Res., 14:45.

Khalil, M.H., Khalifa, H.H., El – Gabbas, H.M., Abdel – Fattah, M.S.H. 1990: The adaptive response to water deprivation in local and crossbred sheep. Egyptian J. Anim. Prod., 27: 195.

Kumar, M., Jindal, R., Nayyar, S. 2011: Influence of heat stress on antioxidant status in beetal goats. Indian Journal of Small Ruminant. 17(2): 178-181.

Li, F.K., Yang, Y., Jenna, K., Xia, C.H., Lv, S.J., Wei, W.H. 2018: Effect of heat stress on the behavioral and physiological patterns of Small-tail Han sheep housed indoors. Tropical animal health and production, 50(8), 1893-1901.

Minton, J.E. 1994: Function of the HPA axis and Sympathetic nervous system in models of acute stress in domestic farm animals. Jouranl of Animal Science.72: 1891.

Ghosal, A.K., Purohit, S.K., Goswami, A.K., Singh, L.B., Jatkar, R.R. 1981: Note in the physiological response and goat characteristics of Nali corriedole sheep during the canary season. Indian J. Anim., Sci., 51: 243.

Mohamed, S.G.A. 1996: Thermal stress and its relation to rumen function and some calorigenic hormones in sheep. Ph.D. Thesis, Fac. of Agric., Al - Azhar Univ., Cairo, Egypt

Nicolás-López, P., Macías-Cruz, U., Mellado, M., Correa-Calderón, A., Meza-Herrera, C.A., Avendaño-Reyes, L. 2021: Growth performance and changes in physiological, metabolic, and hematological parameters due to outdoor heat stress in hair breed male lambs finished in feedlot. International Journal of Biometeorology, 65(8), 1451-1459.

NRC National Research Council, 1988: Nutrient requirements of small ruminants (sheep, goats, cervids and new world camelids). National Research Council National Academy Press, Washington, DC.

Rashid, M.M., Hossain, M.M., Azad, M.A.K., Hashem, M.A. 2013: Long term cyclic heat stress influences physiological responses and blood characteristics in indigenous sheep. Bangladesh Journal of Animal Science, 42(2), 96-100.

Shafie, M.M., Murad, H.M., El – Bedawy, I.M., Salem, S.M. 1994: Effect of heat stress on feed intake, rumen fermentation and water turnover in relation to heat tolerance response by sheep. Egyptian J. Anim., Prod., 31: 317.

Shalaby, T.H., Salama, 0., Solouma, G. 1996: Physiological responses to climate changes in Rahmani imported Finn. Rams and their half sub - born to Rahmani recipient in Egypt. J. Anim. Prod., 33: 269.

Shalaby, T.H. 1985: Performance and adaptation of local sheep to varied environmental and managerial conditions. Ph.D. Thesis, Fac. Agric., Cairo Univ., Giza, Egypt.

Shalaby, T.H., Johnson, H.D. 1993: Heat loss through skin vaporization in goats and cows exposed to cyclic hot environmental conditions. Egyptian American Conf. Physiol. Anim. Prod., November 12-18, El Fayoum, Egypt, pp. 241.

Singh, K.M., Singh, S., Ganguly, I., Ganguly, A., Nachiappan, R.K., Chopra, A., Narula, H.K. 2016: Evaluation of Indian sheep breeds of arid zone under heat stress condition. Small Ruminant Research, 141, 113-117.

Sivakumar, A.V.N., Singh, G., Varshney, V.P. 2010: Antioxidants supplementation on acid base balance during heat stress in goats. Asian-Australian Journal of Animal Science. 23(11):1462-1468.

Solouma, G.M.A. 1999: Physiological adaptive response of small ruminants to environmental conditions. Ph.D. Thesis, Fac. Agric., Cairo Univ., Giza, Egypt.

Srikandakumar, A., Johnson, E.H., Mahgoub, O. 2003: Effect of heat stress on respiratory rate, rectal temperature and blood chemistry in Omani and Australian Merino sheep. Small Ruminant Research, 49(2), 193-198.

Swenson, M.J., Reece, W.O. 1993: Duke's physiology of domestic animals. Cornell Univ. Press, Ithaca, USA.

Tsigos, C., Chrouso, G.P. 2002: Hypothalamic pituitary - adrenal axis, neuroendocrine factors, and stress. J. Psychomatic Res. 53: 865.

Turpeinen, U., Hämäläinen, E. 2013: Determination of cortisol in serum, saliva and urine. Best Practice & Research Clinical Endocrinology & Metabolism, 27(6), 795-801.

Table 1: means ± standard errors of cortisol ug/dl in blood serum of two groups of ewes:

Exposure to heat stress / Days	Exposed	Control
Day 0	22.89±0.92[a]	20.51±0.90[b]
Day 45	6.99±.27[b]	6.37±.23[e]
Day 90	8.96±.71[c]	8.42±.60[c]
Day 135	4.57±.32[f]	4.51±.32[f]

Mean within each row with similar letters are not significantly different at $p \geq 0.05$

Table 2: means ± standard errors of Triiodothyronine (T3) ng/dl in blood serum of two groups of ewes:

Exposure to heat stress / Days	Exposed	Control
Day 0	140.70± 3.74[b]	150.53± 2.57[a]
Day 45	144.16±5.16[a]	156.80±4.98[a]
Day 90	145.63±3.93[a]	155.54±4.14[a]
Day 135	146.71±4.22[a]	145.25±4.53[a]

Mean within each row with similar letters are not significantly different at $p \geq 0.05$

Table 3: means ± standard errors of hemoglobin (HB) (g/dl) in the blood plasma of two groups of ewes:

Exposure to heat stress / Days	Exposed	Control
Day 0	12.93±0.68[b]	13.93±0.23[a]
Day 45	12.43±0.19[c]	13.04±0.20[b]
Day 90	12.40±0.27[c]	13.43±0.24[a]
Day 135	11.56±0.18[e]	12.07±0.21[d]

Mean within each row with similar letters are not significantly different at $p \geq 0.05$

Table 4: means ± standard errors of Packed cell volume (PCV) % in the blood plasma of two groups of ewes:

Exposure to heat stress / Days	Exposed	Control
Day 0	36.91±0.43[b]	39.23±0.70[a]
Day 45	35.31±0.60[b]	38.95±0.76[a]
Day 90	34.43±0.72[c]	36.50±0.73[b]
Day 135	34.20±0.65[c]	36.75±0.84[b]

Mean within each row with similar letters are not significantly different at p ≥0.05

Table 5: means ± standard errors of Rectal temperature (°C) of two groups of ewes:

Exposure to heat stress / Days	Exposed	Control
Day 0	39.62±.083[a]	39.54±0.04[b]
Day 45	39.39±.030[c]	39.56±.050[b]
Day 90	39.45±.031[d]	39.55±.046[b]
Day 135	39.39±.044[c]	39.51±.0.03[b]

Mean within each row with similar letters are not significantly different at p ≥0.05

Table 6: means ± standard errors of skin temperature (°C) of two groups of ewes:

Exposure to heat stress / Days	Exposed	Control
Day 0	38.86±0.15[a]	38.09±0.08[b]
Day 45	38.52±0.21[a]	38.60±0.17[a]
Day 90	38.42±0.18[b]	38.57±0.15[a]
Day 135	38.75±0.13[b]	39.00±0.12[a]

Mean within each row with similar letters are not significantly different at p ≥0.05

Table 7: means ± standard errors of respiration rate breaths/min of two groups of ewes:

Exposure to heat stress / Days	Exposed	Control
Day 0	68.10±2.95[a]	46.4±0.85[c]
Day 45	47.47±1.14[c]	50.75±1.69[c]
Day 90	57.24±1.31[b]	50.74±1.03[c]
Day 135	36.57±0.99[d]	34.9±0.80[d]

Mean within each row with similar letters are not significantly different at p ≥0.05

Table 8: means ± standard errors of Meteorological data of two groups of ewes:

Exposure to heat stress / Days	T1m °C		ST1.5cm °C	RH %	SR °C
Day 0	Exposed	32.70±0.55	40.57±0.87	46.01±1.2	29±3.11
	Control	33.15±0.19	31.28±0.12	46.01±1.2	29±3.11
Day 45	32.16±.0.22		32.4±0.19	50.32±1.74	26.7±2.81
Day 90	29.15±.19		29.42±0.20	66.71±0.97	24.85±2.61
Day 135	21.57±0.21		20.28±0.06	65.28±0.95	19.57±2.11

T1m: Temperature above (1 m) (°C), ST1.5cm: Soil Temperature depth (1.5cm) (°C)
SR: Solar Radiation Temperature (°C), RH: Relative Humidity %

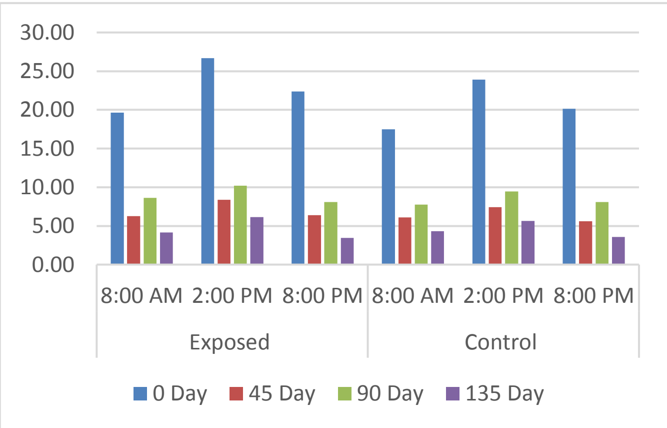

Figure 1: means of diurnal rhythm during the cortisol ug/dl in blood serum of two groups of ewes:

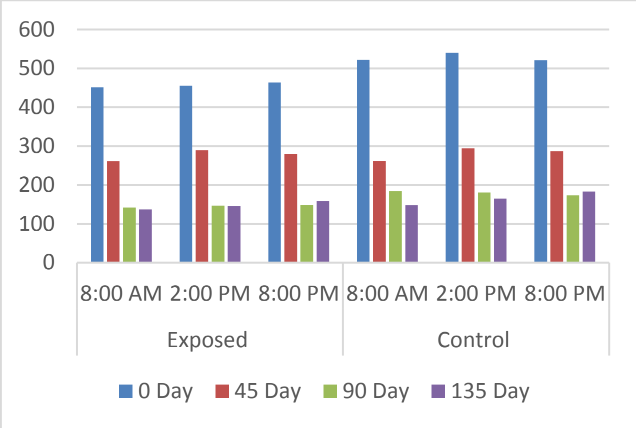

Figure 2: means of diurnal rhythm during the T3 ng/dl in blood serum of two groups of ewes:

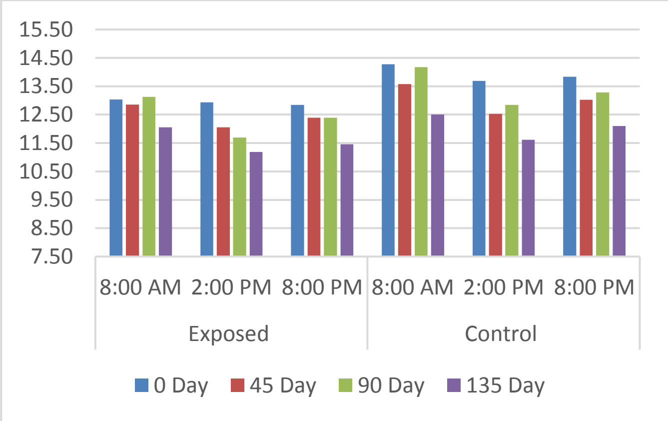

Figure 3: means of diurnal rhythm during the HB g/dl in blood plasma of two groups of ewes:

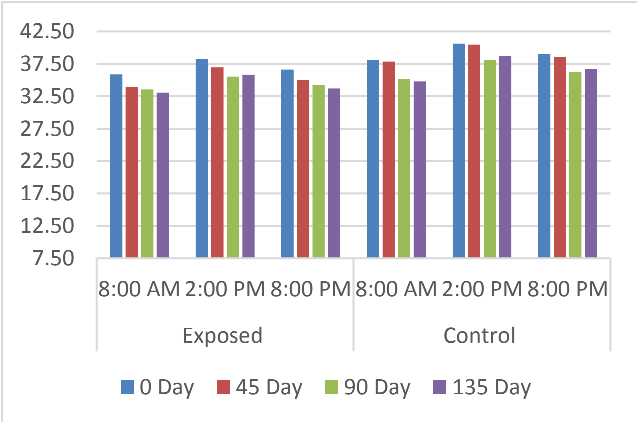

Figure 4: means of diurnal rhythm during the PCV % in blood plasma of two groups of ewes:

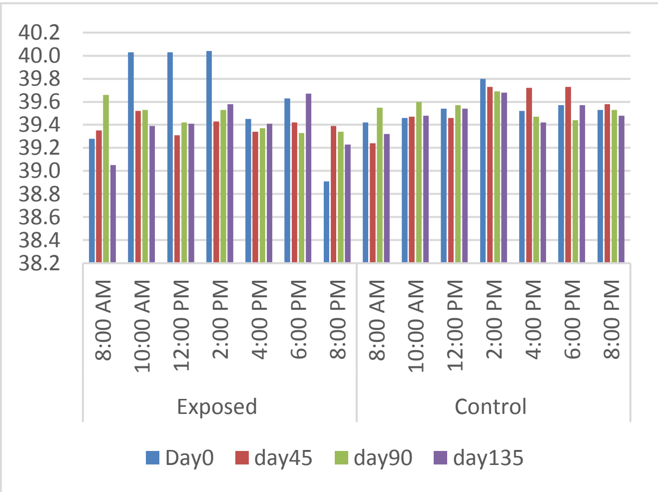

Fig (5): means of diurnal rhythm during the RT (°C) in of two groups of ewes:

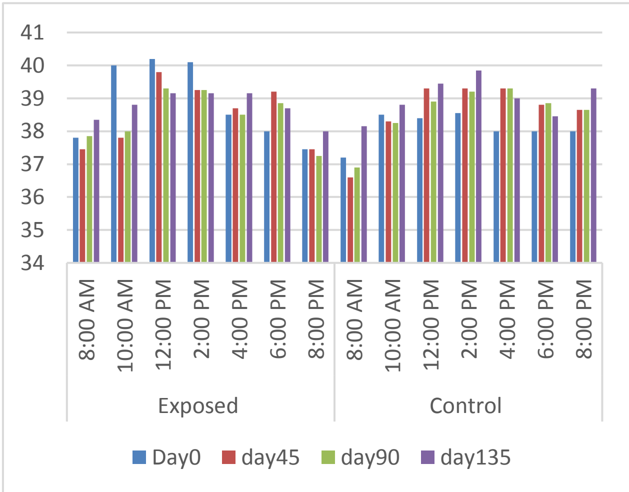

Fig (6): means of diurnal rhythm during the ST (°C) in of two groups of ewes:

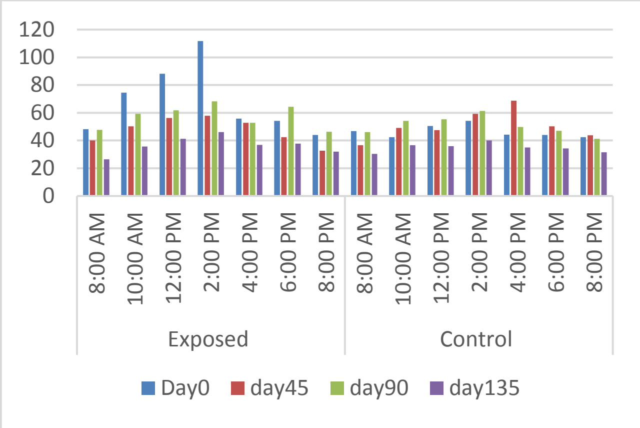

Figure 7: means of diurnal rhythm during the RR breaths/min in blood plasma of two groups of ewes:

تأثير التعريض للإجهاد الحراري لمدة يوم واحد على بعض المقاييس الفسيولوجية في الأغنام

عطية حبيب محمد*،عبد الحميد عبد الله عبد الحميد، الطاهر محمد سعودي،سيد سليمان عبد الغفار

قسم الإنتاج الحيوانى، كلية الزراعة، جامعة الأزهر، القاهرة، مصر

* البريد الإلكتروني للباحث الرئيسي:attiahabeb@azhar.edu.eg .

الملخص العربي

تم استخدام عشرين نعجة أوسيمي جافة غير حامل لدراسة تأثير التعرض للإجهاد الحراري ليوم واحد على بعض المقاييس الفسيولوجية. قسمت الحيوانات إلى مجموعتين بالتساوي ، كل مجموعة تتراوح أعمارها بين 3-4 سنوات ووزنها 35-40 كجم ، تم تغذية جميع النعاج على نظام غذائي مكتمل حسب (NRC 1988).بدأت التجربه في 15 يوليو 2019 وانتهت في 1 ديسمبر2019. المجموعة الأولى تعرضت للإجهاد الحراري لمدة يوم واحد في اليوم الأول من التجربة. بقيت المجموعة الضابطة تحت الظل من بداية التجربة حتى نهايتها. تم قياس الكورتيزول ، هرمون الغده الدرقيه ثلاثي اليود ، الهيماتوكريت ، الهيموجلوبين في مصل الدم. تم قياس درجة حرارة الجلد ودرجة حرارة المستقيم ومعدل التنفس. أشارت النتائج إلى وجود زيادة معنوية في المجموعة المعرضة في مستوى الكورتيزول في اليوم الأول من التعرض للإجهاد الحراري واستمرت حتى اليوم 45 من التجربة. كان هناك اختلاف معنوي بين المجموعات في مستوى هرمون الغده الدرقية ثلاثي اليود كان أقل في المجموعة المعرضة مقارنة بالمجموعة الضابطة، والهيموجلوبين والهيماتوكريت كانت أقل بشكل معنوي في المجموعة المعرضة من اليوم حتى اليوم 45 كانت درجة حرارة الجلد ومعدل التنفس أعلى بشكل ملحوظ في المجموعة المعرضة في اليوم الأول فقط.

الكلمات الاسترشادية: الإجهاد الحراري، درجة حرارة الجلد، درجة حرارة المستقيم، معدل التنفس، هرمون الكورتيزول.