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# IMPACT OF HEAT STESS EXPOSURE ON SOME REPRODUCTIVE AND PHYSIOLOGICAL TRAITS OF RABBIT DOES

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## SUMMARY

*Effect of heat stress throught the first and second parities of NZW doe rabbits on some reproductive and physiological traits was evaluated. Fourty four parturitons (22 in each parity) were used in this study. Parturitions in each parity were divided into two main groups, each group of 11 ones. The first group was maintained at 21.9±0.9 °C and 46.1±2.7 RH % (20.8 THI, comfort conditions) and served as a control (C) group. The second one was exposed for about 8 h. to cyclic ambient temperature of 37.1±0.5 °C and 44.8±2.2 RH % (33.2 THI, severe heat stress conditions) from 13:00 to 21:00. Then, the temperature was lowered to the temperature in the rabbitry of control group from 21:00 to 13:00. Results obtained showed that high temperature cuased a significant increase ($P<0.05$ or 0.01) in respiration rate; rectal and skin temperature values (126.8 breaths/min., 39.6 and 38.5 ˚C, resp.) as compared with those maintained under comfort conditions (112.0, 38.5 and 38.2, resp.). Number of services per conception was increased while litter size significantly decreased ($P<0.05$ or 0.01) for heat stressed does compared with those of does kept in comfort conditions. Gestation period was not significantly affected by ambient temperature treatment. Number of services per conception of does at second parity were higher ($P<0.01$) than those at first one. Heat stressed does showed an acute decrease (- 24 to - 29 %) in milk yield compared to does reared in comfort conditions. High ambient temperature significantly decreased ($P<0.01$) hemoglobin concentration, red and white blood cell counts compared with those of does maintained under comfort conditions. Interaction effects between ambeint temperature and parity order on the studied parameters were mostly insignificant, however, differences among interaction groups were significant ($P<0.05$) only for number of services per conception and gestation period. Does at the second parity, which maintained in hot temperature had the highest value of number services per conception, while those of the first parity in comfort conditions were the lowest one. Most of the studied traits were correlated significantly by a valuable magnitude, especially the thermo-respiratory traits that negatively correlated with litter size and blood hematological traits and positively correlated with number of services per conception, while each of litter size and milk yield were positively correlated with blood hematological traits. Histological features showed that heat stress had a deleterious effect on the histological statues of ovaries and uteruses of rabbit does. These results indicate that high ambient temperature was of bad effects on most of the reproductive and physiological traits of rabbit does. Consequently, rabbit breeders must use the available methods to alleviate the heat stress on their animals during periods of hot conditions, particullary during summer months in Egypt.*

***Keywords: Doe rabbits, heat stress, reproductive traits, hematological traits, milk yield***

## INTRODUCTION

Most obvious limitation to rabbit production in regions with a hot climate is the susceptibility of this species to heat stress (Ondruska *et al*., 2011). Rabbit does are very sensitive to heat stress, which is considered as an important factor influencing their fertility. Thus, rabbit producers try to reduce the effect of hot season especially under intensive system of production by optimizing the environmental conditions like temperature, humidity, ventilation and lighting regime. Heat stress is defined, as a stress inflicted by a wide range of environmental conditions that induce a state of physiological problems within animal's body, making animals be unable to regulate their heat homeostasis passively. This mainly occurs when animals are exposed to high ambient temperatures, high humidity, low wind speed, and high direct and indirect solar radiation (Willmer *et al*., 2000). Rabbits, as a homoeothermic animal, can regulate the heat input and output of their bodies using physical, morphological, biochemical, and behavioral processes to maintain a constant body temperature (Marai and Habeeb, 1994). The thermo-neutral zone temperature in rabbits is around 18–21 °C (Marai and Habeeb, 1994). High temperatures, as encountered in Egypt and in many other countries during summer represent a major constraint factor for rabbit production, which negatively affect feed intake; feed utilization; water metabolism; reproductive traits; blood parameters; enzymatic reactions and hormonal secretions, in addition to protein, energy and mineral imbalances (Habeeb *et al*., 1996; Fouad, 2005 and Okab *et al*., 2008). Moreover, hot climate negatively affects the quality of oocytes and the process leading to the correct formation of meiotic chromosomes, as represented by the decreasing of telophase I and metaphase II (Hamam *et al.*, 2001). Al-Katanani *et al.* (2002) reported that the proportion of oocytes and cleaved embryos that developed to blastocysts was lower in the warm season than that in the cool season. Short exposure of pre-implantation rabbit embryos to elevated temperatures (41.5ºC and 42.5ºC) *in vitro* reduced embryo development (Makarevich *et al.*, 2006). Marai and Rashwan (2004) also revealed that the doe is capable of producing 10 litters a year, but in a hot climate, it has only 4 or 5 litters. Xiccato *et al*. (2004) found that the litter size increased with parity order, while the average weight of kits born alive decreased. Therefore, this study aimed to evaluate the effect of heat stress and parity order upon some reproductive and blood hematological parameters and some histological features of New Zealand White rabbit does.

## MATERIAL AND METHODS

The present work was carried out in the Rabbitry of Poultry and Animal Production Departments, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. A total of 44 parturition (22 in the first parity and 22 in the second one) for clinically healthy does of NZW rabbits aged 6 months and of 3.38±0.65 kg mean body weight were used in this trial. Does were divided into two comparable groups where the first (control) group was maintained at comfort conditions (air temperature 21.9 ± 0.9 °C, RH: 46.1 ± 2.7 % and THI: 20.8 ± 0.8), meanwhile the second group was exposed to heat stress treatment (HSG) for about 8 h. to cyclic ambient temperature with an elevated 37.1 ± 0.5 °C and 44.8 ± 2.2 RH % (33.2 ± 0.5 THI, hot) from 13:00 to 21:00 using heaters in rabbit's house followed by exposure to the normal air temperature as in the control group from 21:00 to 13:00.

The temperature-humidity index (THI) was estimated using the equation modified by Marai *et al*. (2001) as follows:

$THI = db\ ^0C - [( 0.31 - 0.31\ RH) (db\ ^0C - 14)]$

Where db $^0$C = dry bulb temperature in Celsius and RH = RH % /100.

Obtained values of THI were classified as follows:

<22.2= absence of heat stress, 22.2 - <23.3 = moderate heat stress, 23.3 - <25.6= severe heat stress and 25.6 and more = very severe heat stress.

Does were housed in a conventional building provided with sided electric fans for regular forced air ventilation. They were individually kept in flat-deck wired cages (59 x 55 x 29 cm) provided with feeders; automatic drinkers and a nest box (40 × 32 × 29 cm) for kindling and nursing bunnies up to weaning. Cages and nest boxes were cleaned regularly and disinfected before each kindling. Dropped urine and feces on rabbitry's floor were cleaned every day in the morning. All rabbits were reared under the same managerial conditions.

Animals were fed *ad libitum* a commercial pelleted ration containing 18.18% crude protein, 13.43% crude fibre, 2656 Kcal/kg diet digestible energy and 2.29 ether extract that met all nutritional requirements of rabbit does according to NRC (1994).

Does were mated with mature bucks of the same breed. The buck/doe ratio was 1: 5. The doe was transformed to a cage of randomly chosen buck for 5 minutes. All does were mated twice whenever possible. Forced mating was performed if the doe refused to accept the buck. Ten days after mating, does were palpated to detect pregnancy. Doe that failed to conceive was remated with a randomly chosen buck in the same day of palpation. On the 27$^{th}$ day of pregnancy, the nest boxes were prepared for kindling and supplied with wood sawdust to provide a warm nest for the bunnies. At kindling, bunnies were examined and registered within 12 hours. Bunnies were weaned after four weeks of kindling. Light/dark rate during the experimental period was 12/12 hours as suggested by Lebas *et al*. (1984).

The studied traits included respiration rate (RR); rectal (RT) and skin (ST) temperature; number of services per conception (NSPC); gestation period (GP); litter size at birth (LSB) and at 21 days (LS21); milk yield (MY) and some blood profile, as well as, histological features for ovarian and uterus tissues of both groups. Rectal temperature was obtained in the morning between 0900 to 1100 hours using clinical thermometer, which was gently inserted in the rectum for 2-3 cm for one minute. The daily milk production (MY) was obtained from the difference in pups body weight measured before and affter suckling.

Blood samples were collected in the morning between 09.00 to 11.00 hours at the end of the fourth week of nursing period at both first and second parity. About 4-5 ml of blood were withdrawn from the marginal ear vein for determining hematological parameters. Erythrocytes counts (RBCs) were done using Thoma haemocytometer in a red blood diluting pipette, as well as, total leukocyte counts (WBCs) were executed using white blood diluting pipette (Schalm, 1965). Sahli hemoglobinometer was used for determining hemoglobin concentration (Hb). Winterobe hematocrit tubes were used for determination of the packed cell volume percentage through centrifugation the blood at

3000 rpm for 15 minutes (Ht %), (Winterobe, 1967).

At the end of the experiment, three does of each experimental group were randomly slaughtered. Specimens of ovary and uterus were fixed in a 10 % formalin saline; dehydrated; cleared; embedded in praffin wax and sectioned at 5 microns thickness using a rotary microtome, then Sections were mounted and stained by Hematoxylin and Eosin for histological investigation (Carleton *et al*., 1980).

Data were statistically analysed using GLM in SPSS programme (1993) according to the following model:

$$Y_{ijk} = \mu + T_i + P_j + TP_{ij} + e_{ijk}$$

Where, $Y_{ijk}$ = observation on the $ijk^{th}$ parturation; $\mu$ = general mean; $T_i$ = fixed effect of $i^{th}$ temperature, i = 1 & 2 (21.9 C$^o$ and 37.1 C$^o$); $P_j$ = fixed effect of $j^{th}$ parity, i = ($1^{st}$ and $2^{nd}$); $TP_{ij}$ = interaction effect of $i^{th}$ temperature and $j^{th}$ parity order and $e_{ijk}$ = error of the model, which included all the other effects not specified in the mixed model. Differences among experimental groups were separated by Duncan's multiple range test (Duncan, 1955).

## RESULTS AND DISCUSSION

The temperature-humidity index values were 20.8 (absence of heat stress) and 33.2 (very severe heat stress) in control (CG) and heat stressed (HSG) groups, respectively. Table 1 shows that heat stress significantly increased (P<0.01) the thermo-respiratory reponses (RR; RT and ST) as compared with those maintained under comfort conditions. Similarly, increasing environmental temperature from 18.8 to 30.7 $^o$C elevated RT in rabbits by about 1.0 $^o$C (Gad, 1996). Such increase in RT of heat stressed rabbits might be due to either poor ability of animals to prevent the rise in RT or to failure of physiological mechanisms of animals to balance the excessive heat load caused by exposure to high ambient temperature (Habeeb *et al*., 1998). Skin temperatures of NZW and CAL rabbits were higher in summer than those in winter that may be due to the warmth effect of the coat (Gad, 1996). RR in rabbits increased rapidly by raising air temperature level during summer conditions by 42-59 % higher than that in winter (Habeeb *et al*., 1998). On the other hand, Marai *et al*. (2001) found that RR and RT of doe rabbits didn't differ significantly during mild winter and hot summer conditions. Traits presented in Table 1 did not affected significantly by parity order or interaction between treatments and parity.

As showen in Table 2, NSPC increased, while LSB and LS21 decreased significantly (P <0.05 or 0.01) for HSG does compaired with CG does. Meanwhile, GP did not differ in response to treatment by heat stress. These results are in fairly agreement with those of Tuma *et al*. (2010), who observed no significant effect of season on GP, while service number of pregnancy was significantly affected by season and greater litter size was recorded in mild periods than that in hot periods (Bhatt *et al*., 2002 and Marai *et al*., 2001). The later investigation proved that length of gestation period was affected by the season of the year. The adverse effects of heat stress on conception could be attributed to the reduction in number and development of mature ovarian follicles (Yassein *et al*., 2008). Hot climate negatively affected the quality of oocytes and the process leading to the correct formation of meiotic chromosomes, as represented by the decreasing of telophase I and metaphase II (Hamam *et al*., 2001). In addition, Al-Katanani *et al.* (2002) reported that the proportion of oocytes and cleaved embryos that developed to blastocysts were lower in warm season than in cool season. Parity order did not affect GP and litter size (LS), while it had a highly significant effect on NSPC, which were higher in the second parity than that of the first one. This might be attributed to the load of pregnancy and parturition on does during the first parity, where these young does need to some time to restore their good body statues. Interaction had significant effects (P<0.05) on NSPC and GP, while LS did not differ in response to interaction, where NSPC and GP for does of HSG at second parity were of highest values.

Heat stress adversely affected MY (- 24 to - 29 %, P < 0.05 or 0.01) during the first three weeks of nursing period (Table 3). Similar findings had been reported by (Fernandez *et al.,* 1995 and Szendrö *et al*., 1998). Temperature of 2l $^o$C is known as the "comfort zone" for rabbits, therefore at either higher or lower temperature, the animal has to expend energy to maintain its body temperature (Lebas and Matheron, 1982 and Marai and Habeeb, 1994). Accordingly, it well be affect negativly on the availabilty of raw material of nutrientes needed for the secretion of milk. In addition to a reduction in metabolic activity in such conditions (Shafie *et al*., 1984). Also, concentration of the metabolic hormones and enzymes decreased significantly as a function of heat stress in an attempt by animals to diminish heat production to counteract the increased heat load (Johnson, 1980). As shown in Table 3 MY did not affected significantly by each of parity order or the interaction between temperature treatment and parity.

Table (4) shows that heat stress cuased a significant decrease (P<0.01) in RBCs; WBCs and Hb values (4.21 x $10^6$ /$mm^3$; 6.14 x $10^3$ /$mm^3$ and 6.61g/dl, resp.) as compared with those maintained under comfort temperature. On the contrary, Ht % didn't differ significantly by the temperature treatment. Fairly agreement observations were reported by Ondruska *et al*. (2011) who found significant decreases in RBCs counts and PCV % of does kept under heat-stressed conditions (36 °C). The decrease in RBC counts, Ht and Hb concentration might be due to the decrease of ACTH level in heat stress conditions (Seley, 1960) and the reduction in cellular oxygen that consumed for reducing metabolic heat production in order to compensate the elevated environmental heat load (Okab *et al*., 2008). In general, hematological changes seem to play an important role in adjusting the rabbit's physiology during elevated ambient temperature (Ondruska *et al*., 2011).

The NSPC; GP; LSB and LS21 differed significantly (P < 0.05 or 0.01) between the first and second parities, meanwhile most of the other studied traits in the present work didn't, (Table 2). In this respect, NSPC and GP at second parity were higher than those at first one (2.32 and 30.50 vs 1.64 and 30.32). Furtheremore, litter size was increased at birth and decreased at 21 dayes in the first parity as compared with those at second one (6.73 and 4.55 vs 6.09 and 4.68). Tuma *et al*. (2010) noticed no significant effect of parity order on GP, in spite of GP grew longer as doe grew older, while NSPC was affected by parity, whereas a significantly higher NSPC was recorded in the second kindling. On the contrary, the same author and Xiccato *et al*. (2004) found that parity order effect on litter size was not significant. In addition, Castellini *et al*. (2006) found a higher fertility rate in multiparous does as compared to primiparous ones.

The effect of the interaction between ambeint temperature and parity order on the studied parameters in the present work was mostly insignificant, where the differences among both groups were significant (P < 0.05 or 0.01) only for NSPC; LSB and LS21 (Table 2). Does of the second parity maintained under heat stress conditions had the highest value of NSPC, while those of first parity under comfort conditions showed the lowest one. LSB decreased to the lowest value for HSG does at the second parity, then that at first one, while does of the first parity maintained under comfort conditions were of the highest value of this trait. The lowest value of LS21 was recorded by heat stressed does at first or second parity (3.73 kits), while dose of second parity kept under comfort conditions were accompained by the highest one (5.64 kits). Significant interactions in NSPC and LS were observed also by Tuma *et al*. (2010), it seems that NSPC is a parameter of doe fertility which is influenced by both season and age.

Data presented in Table (5) show that correlation coefficients (r) among NSPC and each of LSB or LS21 were of moderate magnitude and negative (P<0.05). These negative correlations might be due to the low fecundity in does of poor fertility, which need to high number of services to be pregnant. The r values were positive (P<0.05 or 0.01) and of moderate magnitude among NSPC and each of RR; RT and ST and negative between NSPC and MY, but did not reach to the significant level except with MY2. These positive correlations with RR; RT and ST may be due to the stress of hot conditions would cause an increase in these parameters as shown in Table 1. In the meantime, the adverse effects of heat stress on conception could be attributed to the reduction in both number and development of mature ovarian follicles (Yassein *et al*., 2008) and the negatively effects on the quality of oocytes and the process leading to the correct formation of meiotic chromosomes, as represented by the decreasing of telophase I and metaphase II (Hamam *et al.*, 2001). Al-Katanani *et al.* (2002) also reported that the proportion of oocytes and cleaved embryos that developed to blastocysts was lower in the warm season than in the cool season. Furthermore, short exposure of pre-implantation rabbit embryos to elevated temperatures (41.5ºC) *in vitro* reduced embryo development (Makarevich *et al.*, 2006), consequently number of services needed for conception will increase. The r estimates among NSPC and each of RBCs; WBCs and Hb were negative and of moderate magnitude (P<0.05 or 0.01). Levels of blood hematological structures depend on the healthy conditions of does, consequently these structures will increase in does of a good body conditions that need to low number of services to be pregnant. GP correlated positively and significantly (P<0.05) only with RBCs, while the r between GP and the other studied traits were of low magnitude (Table 5).

The r among each of LSB or LS21 and each of MY1; MY2 and MY3 were positive and mostly significant. Each of RR; RT and ST correlated negatively and mostly significant with each of LSB; LS21 and MY during the four weeks of suckling period, these values of correlations ranged from low to moderate magnitude. Moderate to high magnitude of r among each of RR; RT and ST and each of RBCs; WBCs and Hb were observed (Table 5), these r values were negative and mostly significant. The negative correlation may be due to the increase in RR; RT and ST in response to heat stress conditions as shown in Table 1, as well as, reduction of feed intake; feed utilization; water metabolism; blood parameters; enzymatic reactions and hormonal secretions, in addition to protein; energy and mineral imbalances leading to decrease of LSB; LS21 and MY (Shafie *et al*., 1984; Habeeb *et al*., 1996 and Okab *et al*., 2008). The decrease in RBCs counts, Ht and Hb concentration might be due to a decrease of ACTH level in heat stress conditions (Seley, 1960) and the reduction in cellular oxygen that consumed for reducing metabolic heat production in order to compensate the elevated environmental heat load (Okab *et al*., 2008). In general, hematological changes seem to play an important role in adjusting the rabbit's physiology during elevated ambient temperature (Ondruska *et al*., 2011). Each of MY through the first three weeks of suckling period and LSB or LS21 were correlated positively and mostly significant with each of RBCs; WBCs and Hb, values of these correlations were of low or moderate magnitude. The positive correlation that observed between each of LS or MY and hematological structure of blood may be attributed to the helping role of these structure in preparing and formation of raw materials of nutrients that necessary for ovarian follicle and embryo development, as will as, milk formation (Lebas and Matheron, 1982 and Marai and Habeeb, 1994). Also, concentration of the metabolic hormones and enzymes decreased significantly as a result to heat stress, which will affect on animals attempting to diminish heat production to counteract the increased heat load (Johnson, 1980). The r values among Hb and each of RBCs and WBCs were positive and of high magnitude ($P<0.01$).

Does of CG showed normal ovarian tissues with multiple Graffian follicles that had normal granulosa cells and normal wall of theca interna and externa (Fig. 1). The uterus showed normal layer of endometrium with normal lining epithelia (Fig. 2). Ovaries of HSG does had few atretic follicles and few of Graffian follicles represented by dilated antrum and absent or degenerated ova (Fig 3). Some of these follicles showed occasionally obliterated granulosa cells and thickened wall by fibroblast. Uterus exerted sub-endometrial edema, since it lined by inactive epithelia and subendometrial leukocytic filtration (Fig. 4).

## CONCLUSIONS

High ambient temperature could be exerting acute negative effects on the studied reproductive and physiological traits of doe rabbits. Meanwhile, the difference between the 1$^{th}$ and 2$^{nd}$ parities in these traits or that of interaction between heat stress and parity was in low magnitude but reached to the significant level for the reproductive traits under consideration. Heat stress had also some deleterious effects on ovarian and uterus tissues of does. Consequently, rabbit breeders must use the available methods to alleviate heat stress on their animals during periods of hot conditions in Egypt.

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**Table 1. Respiration rate (RR, breaths/m.); rectal (RT) and skin (ST) temperatures (ºC) of the control (CG) and the heat stressed groups (HSG) at 1st and 2nd parities of NZW rabbit does (mean±SE).**

| Items | Traits | | |
|---|---|---|---|
| | RR | RT | ST |
| **Treatments** | ** | ** | ** |
| CG | 112.00 ± 0.49 | 38.5 ± 0.06 | 38.2 ± 0.08 |
| HSG | 126.82 ± 0.56 | 39.6 ± 0.06 | 38.5 ± 0.09 |
| **Parity** | ns | ns | ns |
| First | 119.5 ± 1.67 | 39.0 ± 0.14 | 38.3 ± 0.02 |
| Second | 119.4 ± 1.73 | 39.1 ± 0.14 | 38.3 ± 0.09 |
| **Interactions** | ns | ns | ns |
| CG x first | 112.3 ± 0.84 | 38.4 ± 0.11 | 38.2 ± 0.11 |
| CG x second | 111.7 ± 0.52 | 38.5 ± 0.06 | 38.1 ± 0.13 |
| HSG x first | 126.6 ± 0.81 | 39.6 ± 0.10 | 38.4 ± 0.15 |
| HSG x second | 127.0 ± 0.81 | 39.7 ± 0.06 | 38.5 ± 0.09 |

* = Significant (P<0.05), ** = highly significant (P<0.01) and ns = not significant.

**Table 2. Some reproductive traits of the control (CG) and the heat stressed groups (HSG) at the 1st and 2nd parities of NZW rabbit does (mean±SE)**

| Items | Reproductive traits | | | |
|---|---|---|---|---|
| | **NSC** | **GP** | **LSB** | **LS21** |
| **Treatments** | ** | ns | * | ** |
| CG | 1.32 ± 0.10 | 30.36 ± 0.17 | 6.91 ± 0.31 | 5.50 ± 0.37 |
| HSG | 2.64 ± 0.26 | 30.45 ± 0.21 | 5.91 ± 0.33 | 3.73 ± 0.31 |
| **Parity** | ** | ns | ns | ns |
| First | 1.64 ± 0.20 | 30.32 ± 0.21 | 6.73 ± 0.36 | 4.55 ± 045 |
| Second | 2.32 ± 0.26 | 30.50 ± 0.16 | 6.09 ± 0.30 | 4.68 ± 0.32 |
| **Interactions** | * | * | ns | ns |
| CG x first | 1.27 ± 0.14 | 30.55 ±0.28 | 7.18 ± 0.54 | 5.36 ± 0.72 |
| CG x second | 1.36 ± 0.15 | 30.18 ± 0.18 | 6.64 ± 0.34 | 5.64 ± 0.24 |
| HSG x first | 2.00 ± 0.35 | 30.09 ± 0.31 | 6.27 ± 0.47 | 3.73 ± 0.47 |
| HSG x second | 3.27 ± 0.27 | 30.82 ± 0.32 | 5.55 ± 046 | 3.73 ± 0.43 |

* = Significant ($P<0.05$), ** = highly significant ($P<0.01$) and ns = not significant.

**Table 3. Weekly milk yield (g) of the control (CG) and the heat stressed groups (HSG) at the 1st and 2nd parities of NZW rabbit does (mean±SE)**

| Items | Weekly milk yield | | | |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th |
| **Treatments** | ** | ** | * | ns |
| CG | 808.5 ± 57.9 | 1034.1 ± 58.6 | 1156.4 ± 76.6 | 737.1 ±77.4 |
| HSG | 572.5 ± 33.9<br>(-29%) | 731.1 ± 62.7<br>(-29%) | 879.6 ± 78.1<br>(-24%) | 559.8 ± 55.9<br>(-24%) |
| **Parity** | ns | ns | ns | ns |
| First | 699.1 ± 58.5 | 961.4 ± 69.5 | 1042.8± 85.1 | 633.9 ± 61.9 |
| Secon | 681.8 ± 84.9 | 803.9 ± 64.3 | 993.2 ± 80.5 | 663.0 ± 77.6 |
| **Interactions** | ns | ns | ns | ns |
| CG x first | 828.7 ± 88.7 | 1132.3 ± 64.8 | 1139.1 ± 107.5 | 677.7 ± 88.3 |
| CG x second | 788.2 ± 78.1 | 935.9 ± 91.1 | 1173.6 ± 114.1 | 796.4 ± 129.1 |
| HSG x first | 569.6 ± 55.9 | 790.5 ± 101.1 | 946.6 ± 130.6 | 590.0 ± 89.0 |
| HSG x second | 575.5 ± 41.2 | 671.8 ± 74.6 | 812.7 ± 87.7 | 529.6 ± 71.0 |

* = Significant ($P<0.05$), ** = highly significant ($P<0.01$) and ns = not significant.
( ) milk yield decreasing percentage doe to heat stress.

**Table 4. Some haematological traits of the control (CG) and the heat stressed groups (HSG) at the 1st and 2nd parities of NZW rabbit does (mean±SE).**

| Items | RBCs ($X\ 10^6$ /mm$^3$) | WBCs ($X\ 10^3$ /mm$^3$) | Hb (g/dl) | PCV (%) |
|---|---|---|---|---|
| **Treatments** | ** | ** | ** | ns |
| CG | 4.89 ± 0.11 | 6.75 ± 0.11 | 7.10 ± 0.04 | 35.23 ± 1.45 |
| HSG | 4.21 ± 0.08 | 6.14 ± 0.07 | 6.61 ± 0.02 | 33.18 ± 1.58 |
| **Parity** | ns | ns | ns | ns |
| First | 4.48 ± 0.11 | 6.44 ± 0.12 | 6.83 ± 0.06 | 33.82 ± 1.40 |
| Second | 4.62 ± 0.12 | 6.45 ± 0.11 | 6.87 ± 0.06 | 34.59 ± 1.65 |
| **Interactions** | ns | ns | ns | ns |
| CG x first | 4.86 ± 0.14 | 6.72 ± 0.18 | 7.07 ± 0.04 | 32.36 ± 1.53 |
| CG x second | 4.92 ± 0.17 | 6.78 ± 0.14 | 7.12 ± 0.06 | 34.00 ± 2.83 |
| HSG x first | 4.09 ± 0.07 | 6.17 ± 0.11 | 6.60 ± 0.03 | 35.27 ± 2.33 |
| HSG x second | 4.33 ± 0.13 | 6.12 ± 0.09 | 6.63 ±0.02 | 35.18 ± 1.83 |

* = Significant ($P<0.05$), ** = highly significant ($P<0.01$) and ns = not significant.

**Table 5. correlation coefficients among some reproductive and physiological traits of New Zealand White does**

| Traits | NSPC | GP | LSB | LS21 | RR | RT | ST | MY1 | MY2 | MY3 | MY4 | RBCs | WBCs | Hb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GP | 0.03 | | | | | | | | | | | | | |
| LSB | -0.37* | -0.14 | | | | | | | | | | | | |
| LS21 | -0.31* | 0.14 | 0.49** | | | | | | | | | | | |
| RR | 0.49** | 0.19 | -0.22 | -0.35* | | | | | | | | | | |
| RT | 0.55** | 0.05 | -0.30 | -0.42** | 0.81** | | | | | | | | | |
| ST | 0.38* | 0.03 | -0.34* | -0.31* | 0.49** | 0.58** | | | | | | | | |
| MY1 | -0.23 | 0.05 | 0.31* | 0.28 | -0.39** | -0.37* | -0.36* | | | | | | | |
| MY2 | -0.41** | 0.12 | 0.33* | 0.46** | -0.5** | -.043** | -0.45** | 0.69** | | | | | | |
| MY3 | -0.28 | -0.04 | 0.05 | 0.32* | -0.44** | -0.38* | -0.33* | 0.54** | 0.87** | | | | | |
| MY4 | -0.26 | 0.01 | -0.03 | 0.23 | -0.32* | -0.31* | -0.19 | 0.30* | 0.65** | 0.85** | | | | |
| RBCs | -0.32* | 0.34* | 0.07 | 0.33* | -0.5** | -0.59** | -0.26 | 0.35* | 0.31* | 0.27 | 0.28 | | | |
| WBCs | -0.48** | -0.04 | 0.40** | 0.27 | -0.56** | -0.58** | -0.47** | 0.44** | 0.44** | 0.32* | 0.15 | 0.24 | | |
| Hb | -0.53** | 0.05 | 0.33* | 0.40** | -0.79** | -0.87** | -0.52** | 0.44** | 0.44** | 0.32* | 0.24 | 0.67** | 0.63** | |
| Ht | -0.10 | 0.06 | 0.01 | -0.08 | 0.17 | 0.10 | 0.02 | -0.07 | -0.03 | 0.00 | 0.05 | -0.10 | 0.15 | 0.05 |

* = significant (P<0.05) and ** = significant (P<0.01).

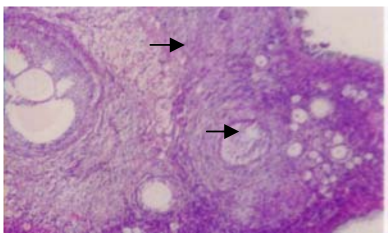

Fig. 1. Ovary of the control does showed normal ovarian structure that had normal granulosa cells and normal theca interna and externa, H&E.X300

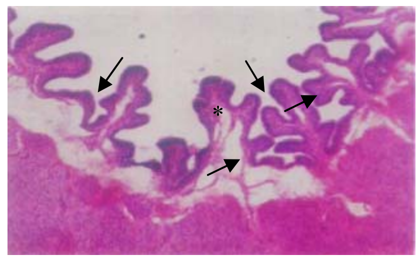

Fig. 2. Uterus of control doe showing normal structure and folding of endometrial mucosa in pregnant doe (arrows), H&E.X300.

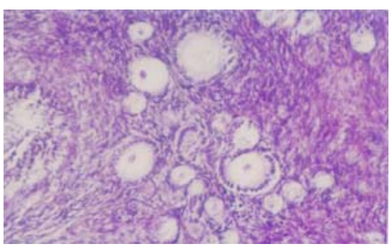

Fig. 3. Ovary of heat stressed doe showing atretic follicle, which represented by primordial cells with absent ova (arrows) and congestion of ovarin blood vessels, H&E.X300.

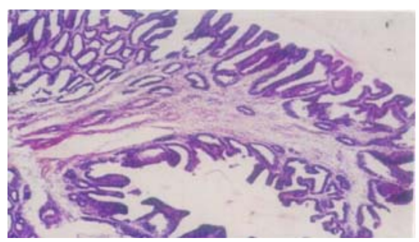

Fig. 4. Uterus of heat stressed doe showing endometrial mucosa, lined by inactive epithelia (arrows) and subendometrial leukocytic filtration (asterisk), H&E.X300.

# تأثير التعرض للاجهاد الحراري على بعض الصفات التناسلية والفسيولوجية لاناث الارانب

**على عبدالرازق سيد احمد عسكر وإسماعيل السيد إسماعيل**

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تم دراسة تأثير الحرارة العالية خلال البطن الاولى والثانية لاناث الارانب على بعض الصفات الفسيولوجية والتناسلية تم استخدام ٤٤ ولادة من ارانب النيوزيلندى (٢٢ من كل بطن) فى هذه الدراسة وحيث تم تقسيم الولادات فى كل بطن الى مجموعتين رئيستين بكل منها ١١ ولادة. المجموعة الاولى من الولادات كانت لاناث مرباة فى ظل حرارة معتدلة (٢١,٩ درجة مؤية ورطوبة نسبية ٤٦,١% ) والذى بما يعادل دليل الحرارة والرطوبة بمقدار ٢٠,٨ واستخدمت كمجموعة مقارنة بينما كانت ولادات المجموعة الثانية لاناث تم تعريضها لدرجات حرارة مرتفعة بمعدل ٨ ساعات يوميا (٣٧,١ درجة مؤية ورطوبة نسبية ٤٤,٨% ) والذى بما يعادل دليل الحرارة والرطوبة بمقدار ٣٣,٢ من الساعة ١٣:٠٠ الى ٢١:٠٠ وبعد ذلك يتم تخفيض درجة الحرارة الى مستوى مجموعة المقارنة من الساعة ٢١:٠٠ الى ١٣:٠٠. أظهرت النتائج المتحصل عليها ان الحرارة العالية قد سببت زيادة معنوية فى معدل التنفس وحرارة الجلد والمستقيم (١٢٦,٨ مرة فى الدقيقة ، ٣٩,٦، ٣٨,٥ درجة مؤية على التوالى)مقارنة بتلك الخاصة بالحيوانات فى ظل الحرارة المعتدلة (١١٢,٠ مرة فى الدقيقة، ٣٨,٥، ٣٨,٢ درجة مؤية على التوالى). أظهرت الاناث المجهدة حراريا زيادة معنوية فى عدد التلقيحات اللازمة للحمل ونقص معنوي في حجم البطن مقارنة بتلك الخاصة بالاناث الموضوعة فى حرارة معتدلة بينما لم تتأثرطول فترة الحمل معنويا بالمعاملة الحرارية. عدد التلقيحات اللا زمة للحمل كانت اعلى معنويا فى البطن الثانية عنها فى البطن الاولى. تاثر محصول اللبن بدرجة شديدة فى ظل الحرارة العالية حيث انخفض بمعدل ٢٤ الى ٢٩% مقارنة بمحصول اللبن للاناث المرباة فى حرارة معتدلة. سببت الحرارة العالية نقص معنوى فى القيم الخاصة بعدد كرات الدم الحمراء والبيضاء و تركيز الهيموجلوبين مقارنة بالقيم الخاصة بالارانب المرباة فى حرارة معتدلة. اظهر تاثير التداخل بين المعاملة الحرارية وترتيب البطن فى الغالب تأثير غير معنوى على معظم الصفات المدروسة حيث كانت الاختلافات بين مجموعات التداخل معنوية فقط فى عدد التلقيحات الازمة للحمل وطول فترة الحمل. عدد التلقيحات الازمة للحمل للاناث المجهدة حراريا فى البطن الثانية كانت الاعلى بينما سجلت الاناث فى البطن الاولى فى ظل الحرارة المعتدلة اقل عدد للتلقيحات اللازمة للحمل. ارتبطت معظم الصفات المدروسة بدرجة معنوية فى حدود متوسطة فى الغالب وخصوصا الصفات الخاصة بحرارة الجسم ومعدل التنفس التى ارتبطت سلبيا مع كل من حجم البطن والصفات الخلوية للدم وايجابيا مع عدد التلقيحات اللازمة للحمل بينما ارتبطت كل من حجم البطن ومحصول اللبن ايجابيا مع الصفات الخلوية للدم. اظهرت المعاملة الحرارية تاثير سيىء على الخصائص الهستولوجية لمبايض وارحام الاناث المجهدة حراريا. من هذه النتائج نستخلص ان المعاملة بالحرارة العالية كانت ذات تأثيرات سيئة على معظم الصفات الفسيولوجية والتناسلية التي تمت دراستها لانثى الارانب ولذلك يجب ان يستخدم مربى الارانب الوسائل المتاحة لتخفيف العبء الحرارى عن الارانب.