J. Agric. Sci. Mansoura Univ., 25 (6): 3221 - 3233, 2000.

DIURNAL AND SEASONAL VARIATIONS IN THERMOREGULATION AND PHYSIOLOGICAL REACTIONS OF PREGNANT AND NON-PREGNANT RABBITS

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ABSTRACT

This work was carried out in the Rabbitry of the poultry farm, Animal Production Department, Cairo University, Giza, Egypt, during the period from September 97 till August 98. Forty New Zealand White (NZW) does were used in this study. Does were individually housed and fed commercial pelleted rabbits ration. Twenty does were used in cold season and other twenty were used in hot season. Does were divided in both seasons into two equal groups according to reproductive status (non-pregnant and pregnant does). The effects of climatic fluctuations in air temperature on the thermoregulations reactions (rectal temperature (RT), skin temperature (ST), fur temperature (FT), ear lobe temperature (ET), respiration rate (RR) and pulse rate (PR)) of the does were tested at day time hours, 07:00, 12:00, 17:00 and 22:00 twice monthly throughout the season (6 months). Climatic conditions (ambient temperature (AT) and relative humidity (RH)) were recorded twice weekly throughout the experiment. Values of AT and RH averaged 13-20°C and 55-80% in cold season and 26-30°C and 62-82% in hot season, respectively. Blood measurements (hematocrit (Ht), hemoglobin (Hb), total protein (TP), albumin and glucose were determined twice monthly during the season. Reproductive performance of does (conception rate, gestation length, litter size and weight at birth, litter size and weight at weaning, pre-weaning mortality and milk yield) was recorded.

Thermoregulation measurements (ST, FT, ET and RR) were significantly higher in hot than cold season. FT, and ET were significantly higher in pregnant than in non-pregnant does. The determination of pulse rate had no trend due to seasonal variation in pregnant and in non-pregnant does. Ht%, Hb, TP and Albumin reduced significantly as AT increased during hot season for non-pregnant and pregnant does, while the level of level of glucose in serum increased with elevation of air temperature. Reproductive performance of does, generally, was better in cold season than in hot season, except conception rate was higher in hot season than in cold season. However most differences in reproductive performance due to seasonal variation were not significant.

Keywords: Rabbits, hot climate, thermoregulation, physiological reactions, pregnancy.

INTRODUCTION

Rabbits are sensitive to environmental temperature. New Zealand White rabbits (NZW) are one of the most wide spread exotic breed used in the rabbit intensive production in Egypt. The thermoneutral zone for NZW rabbits ranges between 15°C and 21°C (Gonzalez *et al*., 1971 and Marai *et al*., 1991). Once temperature and humidity reach certain critical limits, the rabbit is unable to dissipate metabolic heat through the normal thermo-regulatory processes and is forced to lower its metabolic rate by reducing feed intake (Finzi, 1994). Shafie *et al*. (1970) reported that increasing the environmental temperature from 10°C to 35°C increased both body temperature and pulse rate of NZW rabbits from 39.4°C to 40.5°C and from 122 to 156 pulses per minute. Also, the respiration rate increased enormously, from 69 to 190 breaths per minute by raising air temperature from 18.3°C to 35.3°C. Above 35°C rabbits can no longer regulate their internal temperature and heat prostration sets in (Lebas *et al*., 1986). Shafie *et al*. (1970); Gad (1996); Habeeb *et al*. (1998) and Daader *et al*. (1999) found that body temperature, respiration and pulse rates values were significantly higher, during hot climatic conditions. In rabbits, the sweat glands are not functional and perspiration (the vaporization of water through the skin) is not great due to the thick fur. Therefore the important heat dissipation through water vaporization pathway is respiration, the nasal mucous and the ear lobe that plays an effective role in that respect (Marai and Habeeb, 1994).

Blood constituents have been used as indicators to monitor health (Zamet *et al*., 1979), reproduction (Parker and Blowey, 1976 and Daader and Seleem 1999) and physiological status of the animal (Daghash and Abd El-Nabi, 1995). Exposure to high environmental temperature increases the heat load on the animal during the first few days of exposure; rabbits become, easily uncomfortable. Moreover, does at high environmental temperatures for long periods induce poor reproductive performance. The pattern of physiological elimination of the effects of heat stress, by moving to cooler environment is not elucidated. Cyclic variation in the physiological reaction of rabbits is induced by diurnal variation of climatic temperature (Finzi *et al*., 1994). The physiological reactions of pregnant rabbits to hot climatic conditions are not clearly demonstrated.

The objective of this work was to determine the effect of seasonal variation and diurnal fluctuation in climatic conditions on thermoregulation and physiological reactions of exotic female rabbits in Egypt. The result of this study is to be considered for improvement of managerial methods to alleviate the harmful effect of the hot season on the reproduction and welfare of rabbits.

MATERIALS AND METHODS

This study was carried out in the Rabbitry of the Poultry Farm, Animal Production Department, Cairo University, Giza, Egypt during a complete year from September 1997 to August 1998.

Animals and general management

A total number of 40 female New Zealand White (NZW) rabbits with nearly equal average body weight (3.5 Kg), aged 6-7 month were used in this experiment. The does were housed individually in batteries provided with continuous feeders and automatic waterers. Does were fed commercial pelleted rabbits ration contained 17% crude protein, 12% fiber, 2.4% fat and 2700 kcal/kg DM. Feed and water were available *ad libitum.*

Experimental design

Total of 20 does were used in each of cold period (September to February, autumn and winter) and hot period (March to August, spring and summer). In each period the does were individually housed in cages and divided into two equal groups. The first one (10 does) was raised without mating (non-pregnant). The second group (10 does) was inseminated naturally with good fertility bucks. To assure pregnancy, does were palpated after 10 days from mating.

Experimental procedure

1. Climatic assessment

The indoors-diurnal climatic conditions were recorded twice weekly at 07:00, 12:00, 17:00 and 22:00h during cold and hot season in the rabbitry.

2. Thermal measurements of does

Rectal temperature (RT), skin temperature (ST), fur temperature (FT) and ear lobe temperature (ET) were recorded twice monthly during each season for 5 females of each group. RT was obtained by inserting a clinical thermometer 2-3 cm in the rectum for one minute, while ST and FT were measure by a digital thermometer (Digitemp D2000/D2010).

3. Respiration and pulse rate

Respiration rate (RR) was determined by counting the frequency of flank movements per one minute. Pulse rate (PR) was recorded. All possible precautions were taken in consideration to avoid irritating the animals, particularly the pregnant, during rectal temperature or respiration rate estimation.

4. Hematological tests

Blood samples were taken morning at 07:00h from 5 females of each group twice monthly during each season from the marginal ear vein. Hematocrit (Ht) and hemoglobin (Hb) were determined immediately after collecting the blood. Blood was centrifuged for 15 minutes at a speed of 3000 rpm to collect serum for determination of total protein (TP), albumin and glucose in serum by using relevant kits. The biochemical analyses were carried out in the laboratory of Animal Production Research Institute, Dokki, Giza.

5. Reproductive performance of does

Conception rate, gestation length, litter size and weight at birth, litter size and weight at weaning and pre-weaning mortality were recorded per doe during the season. Milk yield was estimated at 28 days by weighing the pups before and after suckling. The pups were separated from their mothers for 24 hours before suckling.

Statistical Analysis

Data were analyzed as 3 factor factorial analysis of variance using MSTAT (1986) software program according to the following model

$Y_{ij} = \mu + X_i + X_j + X_{ij} + X_k + E_{ijkl}$ where

Y= Observation

X_i= Effect of season, i, 1-2 (1=cold season, 2=hot season)

X_j= Effect of reproductive status, j,1-2 (1=non-pregnant, 2=pregnant)

X_{ij}= The interaction between season and reproductive status

X_k= Effect of daytime, k, 1-4 (1=7h, 2=12h, 3=17h, 4=22h)

E_{ijkl}= Experimental error

The effect of day time was only included for body temperatures, pulse rate and respiration rate. Differences among means were tested using Duncan Multiple Range Test (Duncan, 1955). The reproductive performance data were analyzed by using T-test.

RESULTS AND DISCUSSION

Table (1) shows the diurnal climatic conditions during the experimental periods in cold and hot seasons. The maximum ambient temperature in cold and hot periods was recorded at 17:00h, while the maximum relative humidity was recorded at 07:00h in both seasons. The diurnal variations in air temperature and relative humidity were 2.4°C and 5.8% respectively in cold season and 2.6°C and 11.6% in hot season.

During cold season the average minimum and maximum values of ambient temperature (AT) and relative humidity (RH) were 13°C -20°C and 55%-80%, respectively, while, in hot season the AT and RH were 26°C -30°C and 62%-82%, respectively. The relative humidity was always within the proper level, thus it had no particular significant effect on the physiological reactions.

Thermal reactions

The RT of non-pregnant does was not affected by diurnal variations in climatic conditions in the cold season (Table 2). On the other hand, in hot season RT of non-pregnant does varied within a very narrow range (0.2°C) from noon (12:00h) till night (22:00h) (Table 2). This result reflects the high efficiency of NZW body heat regulation. Shafie *et al.* (1970) found similar result, that diurnal variation in body temperature of rabbits was 0.2°C - 0.3°C. The RT of pregnant does was affected significantly by air temperature in cold season from 07:00h to 12:00h and in hot season at 12:00h. Results denote that the change in RT of pregnant does through the day was 0.48°C and 0.28°C in cold and hot season, respectively (Table 2), which proved that pregnant does are more sensitive than non-pregnant does.

The ST was significantly higher in hot than in cold season in both non-pregnant and pregnant rabbits (Table 2). The difference due to seasonal variation in overall mean of ST was 4°C. Diurnal variation of skin temperature was almost limited (1.2°C) in cold and hot seasons (Table 2). Similar trend was observed in ST of non-pregnant and pregnant in cold and hot season, it significantly increased from morning (07:00h) up to 17:00h then it decreased at night (22:00h). Shafie *et al.* (1970) reported that ST was nearly stable all over the year due to the efficient insulation by fur coat. It was noticed that the coat was taller in winter than in summer. This enables rabbits to conserve heat during winter, while at summer hair density was less, which enables rabbits to dissipate more heat.

The overall mean of fur temperature in the hot season was higher than overall mean in the cold season by 10°C. The FT of non-pregnant rabbits rose significantly in cold and hot seasons from 07:00h to 17:00h then decreased at 22:00h (Table 2). In pregnant does, FT during cold season rose significantly from 07:00h till noon 12:00h then significant decrease was observed till night (22:00h). On the other hand, in that hot season ST of the pregnant does continued to increase from 07:00h till after noon (17:00h) then decreased at 22:00h (Table 2).

The ear lobe temperature (ET) of does was significantly higher in hot season than in cold season, the difference in overall mean of ET due to seasonal variation was 10°C. Diurnal variation in cold season was 3.2°C in non-pregnant does and 4.8°C in pregnant ones, while in hot season it was 2.6°C in non-pregnant and 1.6°C in pregnant does. This result declared that ear lobe of rabbits plays an important role in heat regulation. Lebas *et al.* (1986) reported that if the air temperature was above 25-30°C, the animals stretch-out their body and step up their ear temperature so that they can loose as much heat as possible by radiation and convection. The ear function in rabbits is like a car radiator. Shafie *et al.* (1970) reported that at summer, the animal stretches the ear and releases it far from the body, exposing both surfaces to the surrounding air to increase the radiating and evaporating surface to the maximum, while at winter the ear pina are folded to cut away its internal surface from contact with air, at the same time, it drags the ear to bring it closer to the body. The physiological pathway of the ear lobe temperature is through the control of blood circulation from body core to special blood vessels bed in the ear lobes. The lobes of ears are supplied with a very big meshwork of blood capillaries and arterio venous, shunts which could be dilated or contracted by vasomotor mechanism (Johnson *et al.,* 1957).

In the present study, it was observed that the increase in air temperature at, 12:00h, from 16.8 to 28°C was associated with an elevation in RT of non-pregnant from 39.38°C to only 39.40°C, while ET was elevated enormously from 23.8°C to 34.2°C. Also, ET of pregnant does significantly increased (7.6°C) by increasing 11.6°C in air temperature (Table 1 and Table 2). This result explains the importance of heat dissipation pathway through the ear in rabbits. It appears that during high environmental temperature heats exchange between ear lobes and the environment is augmented in accordance with the physical laws of heat exchange. In hot season blood flows into the blood vessels of the ear lobes at its full capacity to increase heat loss by convection and radiation, as well as vaporization of water diffused through the thin skin and feeble fur of the ear.

Table 1: Average of diurnal climatic conditions in the rabbitry during the cold and hot seasons.

Season	Day time (h)				SE
	7	12	17	22	
Ambient temperature (°C)					
Cold	14.6^{d}	16.8^{c}	17.0^{c}	16.6^{c}	0.6
Hot	26.6^{b}	28.0^{ab}	29.2^{a}	27.8^{ab}	
Relative humidity (%)					
Cold	76.4^{a}	70.6^{abc}	71.0^{abc}	74.6^{ab}	2.1
Hot	77.4^{a}	71.4^{abc}	65.8^{c}	69.2^{b}	

^{a,b,c,d} **Means within trait having different superscripts differ significantly (P ≤ 0.05)**

Table 2: Circadian rhythm in body temperatures (°C) of NZW female rabbits under cold and hot climatic conditions.

Season	Non-pregnant does				Pregnant does				SE
	Day time (h)								
	7	12	17	22	7	12	17	22	
Rectal temperature									
Cold	39.40^{ab}	39.38^{ab}	39.40^{ab}	39.40^{ab}	38.94^{c}	39.14^{bc}	39.42^{ab}	39.16^{abc}	0.13
Hot	39.44^{ab}	39.40^{ab}	39.38^{ab}	39.60^{a}	39.28^{abc}	39.46^{ab}	39.20^{abc}	39.18^{abc}	
Skin temperature									
Cold	31.60^{cd}	32.40^{bcd}	32.80^{bc}	32.40^{bcd}	31.20^{d}	32.60^{bc}	33.40^{b}	32.20^{bcd}	0.43
Hot	35.20^{a}	35.80^{a}	36.40^{a}	35.40^{a}	35.00^{a}	36.40^{a}	36.20^{a}	36.00^{a}	
Fur surface temperature									
Cold	18.20^{f}	20.80^{cde}	22.00^{c}	21.60^{cd}	18.80^{ef}	23.00^{c}	22.60^{c}	19.60^{def}	0.72
Hot	29.60^{ab}	31.40^{ab}	31.80^{a}	31.00^{ab}	29.20^{b}	31.20^{ab}	31.40^{ab}	30.80^{ab}	
Ear surface temperature									
Cold	22.00^{d}	23.80^{bcd}	25.20^{bcd}	24.60^{bcd}	21.80^{d}	25.6^{bc}	26.60^{b}	23.00^{cd}	1.13
Hot	32.40^{a}	34.20^{a}	35.00^{a}	34.20^{a}	32.40^{a}	33.20^{a}	33.80^{a}	34.00^{a}	

^{a,b,c,d,e,f} **Means within trait having different superscripts differ significantly (P≤0.05).**

Skin, fur and ear lobe temperatures are liable to be affected to a certain magnitude by both air temperature and rectal temperature. The heat flows from the internal core to the surrounding air through the body surface according to the physical laws of heat flow in proportion to the temperature gradients between the different sites (Kamar *et al.,* 1975). In this study, when the overall mean of air temperature rose by about 11.6°C from 16.3°C in cold season to 27.9°C in hot season, the increase in overall mean of RT, ST, FT and ET were 0.1°C, 3.5°C, 10.0°C and 9.6°C, respectively. This result reveals that fur and ear temperature play an effective role in thermoregulation of rabbits. Table 3 shows at 07:00h in cold and hot season that the highest values between RT and AT followed by the gradient between ST and FT then RT and ST, while the lowest gradient was between FT and AT.

Pulse rate had no trend due to seasonal variation or diurnal variation in non-pregnant and pregnant does (Table 4). The increase of 12°C in the air temperature from cold to hot season at 07:00h (Table 1) led to increase in pulse rate from 195 to 200 pulse/minute in non-pregnant does and from 196 to 212 pulse/minute in pregnant ones (Table 4) that is with greater magnitude in case of pregnancy. Similar result was found by Johnson *et al.* (1957) in NZW rabbits.

Table 3. Temperature Gradients (°C) at 07:00h.

Season		RT-ST	ST-FT	FT-AT	RT-AT
Cold	Non-pregnant	7.80	13.40	3.60	24.80
	Pregnant	7.74	12.40	4.20	24.34
Hot	Non-pregnant	4.24	5.60	3.00	12.84
	Pregnant	4.28	5.80	2.60	12.68

Table 4: Pulse rate (ppm) and respiration rate (rpm) of non-pregnant and pregnant NZW rabbits under diurnal and seasonal climatic conditions.

Season	Non-pregnant				Pregnant				SE
	Day time (h)								
	7	12	17	22	7	12	17	22	
Pulse rate									
Cold	195[ab]	203[ab]	201[ab]	202[ab]	196[ab]	195[ab]	201[ab]	170[c]	6.8
Hot	200[ab]	193[ab]	190[b]	200[ab]	212[ab]	214[a]	196[ab]	206[ab]	
Respiration rate									
Cold	130[c]	127[c]	126[c]	129[c]	126[c]	131[c]	146[bc]	138[c]	9.5
Hot	192[a]	181[a]	175[ab]	174[ab]	184[a]	185[a]	184[a]	170[ab]	

[a,b,c] **Means within trait having different superscripts differ significantly (P≤ 0.05).**

Respiration rate of pregnant does was higher than that of non-pregnant does (Table 4). The overall mean of RR was 157.9 in pregnant versus 154 in non-pregnant. Table (1) and (4) show that the increase in AT at morning (07:00h) as a result of seasonal variation resulted in increase in RR by about 62 and 58 rpm in non-pregnant and pregnant does, respectively. Marai (1994) reported that respiration rate increased rapidly from 69 to 190 breaths/minute by raising air temperature from 18.3°C to 33.3°C. During hot season it could be observed that RR was high from 07:00h to 12:00h then it decreased till 22:00h. This result shows good mechanism for reaction of does to heat stress. The only controlled means of latent heat dissipation is by altering the breathing rate, since sweat glands in rabbits are not functional and perspiration (water vaporization) through the skin is never great because of the dense fur. The heat dissipation through the respiration represented about 30% of total heat dissipation (Lebas *et al*., 1986). Results showed that when air temperature was approximately doubled, cold to hot season, respiration rate increased by 41.1% and 33.6% in non-pregnant and pregnant does, respectively. Similar results were obtained by Marai *et al.* (1994); they reported that RR in NZW increased by 35.1% due to increase in ambient temperature from winter (19.2°C) to summer (33.8°C). Similar trend was found by Shafie *et al.* (1970); Shafie *et al.* (1982); Marai *et al.* (1994) and Naqvi *et al.* (1995).

Blood elements

Results revealed that overall hematocrit value (Ht) decreased from 36.8% to 35.1% when the air temperature increased by about 11.6°C. Similar results were found by Habeeb *et al.* (1994) and Marai *et al.* (1994), they stated that high environmental temperature was associated with lower haematocrit value. The reduction could be attributed to increased plasma volume to enable proper water supply for water vaporization as the major way for heat dissipation in hot conditions. Table (5) shows that Ht value of non-pregnant does was higher than that of pregnant does in both cold and hot seasons. The reduction in Ht value due to the increase in air temperature was 10.2% and 19.3% in the serum of non-pregnant and pregnant does, respectively. The higher reduction in Ht of pregnant does during the hot season may be due to the increase in water content of plasma (dilution) to replenish for more water vaporization in response to greater metabolic activity, thus more heat load.

Table 5: Effect of seasonal variation and reproductive status on some blood constituents in NZW female rabbits.

Season	Non-pregnant	Pregnant	SE
Hematocrit (%)			
Cold	39.20 [a]	38.40 [a]	1.80
Hot	35.20 [ab]	31.00 [b]	
Hemoglobin (g/dl)			
Cold	12.01 [a]	10.81 [ab]	0.79
Hot	8.95 [b]	8.54 [b]	
Total protein (g/dl)			
Cold	8.02	8.85	0.63
Hot	7.59	7.22	
Albumin (g/dl)			
Cold	4.10	5.34	0.53
Hot	5.59	4.46	
Globulin (g/dl)			
Cold	3.92 [ab]	3.51 [ab]	0.72
Hot	2.00 [b]	2.77 [b]	
Albumin/Globulin			
Cold	1.05	1.52	0.70
Hot	2.80	1.61	
Glucose (mg/dl)			
Cold	85.07 [b]	101.55 [a]	8.49
Hot	118.13 [a]	119.95 [a]	

[a,b,c] Means within trait having different superscripts differ significantly ($P \leq 0.05$).

Hemoglobin concentration (Hb) was lower in hot than in cold season and in pregnant than in non-pregnant does (Table 5). Similar results were obtained by Marie *et al.* (1994). This reduction of Hb in hot season may lead to reduction in oxygen intake and consequently reduction in metabolic heat production. The decrease in Hb, also, may be due to depression of haematopoiesis or/and the dilution of blood (hemodilution) during hot environmental conditions.

Total protein (TP) decreased by exposure to high environmental temperature and to the stress of pregnancy (Table 5). Also, significant decrease was observed in the level of globulin in serum of non-pregnant and pregnant does. The depression in TP and globulin may be attributed to decrease in feed intake consequently feed utilization and reduction in protein biosynthesis (Habeeb *et al.,* 1993). Hemodilution may be another reason of the decrease in concentration of these components. The slight decrease of protein level in serum of pregnant does in hot season may be resulted from the increase in total body water, thus dilution of plasma and the demand of the fetus to amino acids which are taken from maternal circulation. Changes in TP and albumin were not significant between seasons and reproductive status. In cold environmental temperature, albumin in pregnant was higher than that in non-pregnant does. The increase in albumin may be in accordance with achieving pup requirements. Albumin/globulin ratio increased as AT increased, however the increase was higher in non-pregnant than pregnant does.

Glucose level in serum showed significant variation through the reproductive status in cold season. The highest levels of glucose in serum were obtained in pregnant does. The increase in glucose level may be due to the increase of gluconeognesis during pregnancy. Lindsay and Pethich (1983) reported that 60% to 70% of the glucose produced is removed by pregnant uterus and its contents. Significant increase was found in glucose level of non-pregnant does serum in hot than in cold season, while, this increase in glucose was insignificant in pregnant does.

Reproductive performance

Reproductive performance of does, generally, was better in cold than in hot season, except conception rate was higher in hot than in cold season (Table 6). El-Fouly *et al.* (1984) reported that ovulation rate and fertilization were not influenced by continuous exposure of female rabbits to high air temperature (35°C). Gestation period was not affected by environmental temperature (Table 6). This result was consistent with the finding of Ghaly (1988). Litter size at weaning, litter weight at birth, litter weight at weaning and milk yield were higher in cold than in hot season. Pre-weaning mortality% was higher in hot than in cold season. However the differences in reproductive performance due to seasonal variation were significant only in litter weight at weaning and milk yield, this result may be due to higher variation between individuals.

Table 6: Effect of season on reproductive performance of NZW female rabbits.

Traits	Hot season	Cold season	SE
Gestation length (day)	31.44	31.16	0.15
Conception rate	52.6	48.0	3.6
Litter size at birth	6.32	6.20	0.44
Litter size at weaning	4.76	5.60	0.67
Litter weight at birth (g)	359.2	401.4	38.7
Litter weight at weaning (g)	1474^{b}	1836^{a}	174
Pre-weaning mortality %	27.3	12.3	6.4
Milk yield (g)	288.8^{b}	396.5^{a}	3.2

^{a,b} **Means within trait having different superscripts differ significantly ($P \leq 0.05$)**

Raising the average environmental air temperature from 20°C to 30°C was associated with lower litter weight at birth and weaning, litter size at weaning and higher mortality. The depression in litter size and weight at weaning may be due to inhibition of lactogenesis, hence, decrease in milk supply to the growing young which leads to decrease in growth and high mortality. This result confirmed the finding of Hassanein (1980) who reported that the highest value (31.8%) of mortality rate was recorded in sustained high ambient temperature (35°C). On the other hand, Ghaly (1988) found that increasing air temperature to 30°C lowered milk yield about 40% from that under air temperature of 20°C. Abdalla *et al.* (1990) attributed the reduction in milk yield of ewes during hot season to the decrease in energy metabolism and calorigenic hormones. They concluded that lactation is a more powerful stress as compared to pregnancy either under thermoneutral or hyperthermic conditions. Abd El-Moty *et al.* (1991) reported that the higher mortality rate of young due to heat stress of does was mostly during the first week of life. Probably, the intrauterine environment of pregnant does developing heat induced hyperthermia throughout the gestation period inhibits in some manner the post-natal viability of the offspring and the post-partum development of the mammary glands of the mothers and subsequently milk production.

It can be concluded that exposure of female rabbits to hot climatic conditions (which represent long period in Egypt, from May to October), as well as, the stress of pregnancy did not affect thermoregulation drastically as shown in table 7. While the hot climatic conditions have a harmful effect on reproductive performance of NZW rabbits (Table 6).

Table 7: Changes in the physiological reactions of non-pregnant and pregnant does under summer morning air temperature (26.6°C) from that at winter morning (14.6°C).

	Non-Pregnant	Pregnant
Thermal traits		
RT	+ 0.04	+ 0.34
ST	+ 3.60	+ 3.80
FT	+ 11.40	+ 10.40
ET	+ 10.40	+ 10.60
RR	+ 62	+ 58
PR	+ 5	+ 16
Blood traits		
Ht	- 4.00	- 7.40
Hb	- 3.16	- 2.27
TP	- 0.43	- 1.62
Alb	+ 1.49	- 0.88
Glob	- 1.92	- 0.74
Alb/Glob	+ 1.75	+ 0.09
Glucose	+ 53.06	+ 18.40

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التغيـر اليـومى و الموسـمى فـى التـوازن الحـرارى و الإسـتجابة الفسـيولوجية للأرانب الحوامل و غير الحوامل

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أجرى هذا البحث فى وجدة الأرانب بمزرعة الدواجن بكلية الزراعة – جامعة القاهرة خلال الفترة من سبتمبر 1997 و حتى أغسطس 1998. و أستخدم فى هذه الدراسة عدد أربعون أرنب أنثى من نوع النيوزيلاندى الأبيض. و قد قسمت فردياً فى بطاريات و تغذت على عليقة تجارية مصبعات.

أجريت الدراسة على 20 أنثى خلال الموسم البارد و 20 أنثى أخرى خلال الموسم الحار. قسمت الإناث خلال الموسم إلى عشرة حوامل و عشرة غير حوامل. تم دراسة تأثير التغير فى درجة حرارة البيئة على التوازن الحرارى (درجة حرارة المستقيم و الجلد و الفراء و الأذن). كما تم قياس معدل التنفس و النبض على فترات (الساعة السابعة صباحاً – الثانية عشر ظهراً – الخامسة عصراً – العاشرة مساءاً) و أخذت القياسات السابقة مرتين فى الشهر خلال الموسم. و تم تسجيل كل من درجة الحرارة المحيطة و الرطوبة النسبية مرتين أسبوعياً خلال الموسم.

تراوحت درجة الحرارة و الرطوبة النسبية ما بين 13 – 20 م° , 55 – 80 % على التتابع فى الموسم البارد. بينما كانت تلك القياسات فى الموسم الحار 26 – 30 م°, 62 – 82 % على التتابع. كما تم تقدير كل من المكونات الخلوية% - الهيموجلوبين – البروتين الكلى – الألبيومين –الجلوبيولين - الجلوكوز فى الدم مرتين شهريا خلال الموسم لكل من الإناث الحوامل و غير الحوامل. تم تسجيل المظاهر التناسلية للإناث فى الموسمين و هى: نسبة الخصب – مدة الحمل – عدد و وزن الخلفة عند الميلاد و الفطام – نسبة النفوق فى الخلفة من الميلاد و حتى الفطام – إنتاج اللبن. و كانت أهم النتائج كالتالى:

كانت درجة حرارة الجلد و الفراء و الأذن و معدل التنفس أعلى معنوياً فى الموسم الحار عن الموسم البارد و كانت درجة حرارة الفراء و الأذن أعلى معنوياً فى الإناث الحوامل عنه فى غير الحوامل. و لم يسلك معدل النبض اتجاه محدد فى كل من الأرانب الحوامل و غير الحوامل أثناء الجو الحار أو البارد.

كانت نسبة المكونات الخلوية و الهيموجلوبين و الألبيومين منخفضة معنوياً مع ارتفاع درجة الحرارة خلال الموسم الحار فى كل من إناث الأرانب الحوامل و غير الحوامل بينما أرتفع مستوى الجلوكوز فى البلازما مع ارتفاع درجة الحرارة.

كانت المظاهر التناسلية للإناث بوجه عام أحسن فى الموسم البارد عنه فى الموسم الحار ماعدا نسبة الخصب. و كان تأثير الموسم غير معنوى فى معظم المظاهر التناسلية للإناث.