Egyptian Journal of Rabbit Science, 24 (1): 47 – 66(2014)

IMPACT OF PRENATAL STRESS ON THERMOREGULATORY AND PHYSIOLOGICAL RESPONSES IN DOE RABBITS AND REFLECTED IT ON THEIR OFFSPRING

Fadila M. Easa; A. S. O. EI-Badry; Amal M. Hekal and F. B. A. Badri*

Department of Rabbit Breeding Research, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Dokki, Giza, Egypt.

**Poultry Production Department, Faculty of Agriculture, Ain Shams University, Cairo, Egypt.*

It is well understood that, exposure of rabbits to heat stress evokes a series of remarkable changes in their biological functions, which ends with impairment of production and reproduction. The objective of the present work is to quantify the effects of acclimatization to the high environmental temperature by modulating their physiological responses for thermoregulation in female rabbits and reflected it on their offspring. Forty five New Zealand White rabbit does were assigned to three groups, according to different times of heat exposure .The first group was exposed to natural ambient temperature (25±3°C) and was considered as control (C), the second (T1) and the third groups (T2) were exposed to a high ambient temperature (36±3^{o}C) for one hour for 3 consecutive days at the 14th and the 27th day of pregnancy, respectively.

The rabbit does of T2 have high rectal temperature and respiratory rate compared with control and T1 groups at late pregnancy while, rectal temperature was decreased in rabbit does during lactation period and their offspring in T2 compared with control and T1 groups. Heat stress exposure at late stage of pregnancy caused a significant decrease on gestation period and an increase in litter weight and litter size at 21 and 28 days of age as well as viability % from birth to 28 days compared to the other treatments. Higher in prolactin and lower triiodothyronine secretions were observed in the T2 compared to the other groups at late pregnancy and 14 days of lactation period. AST and ALT values were significantly lower in T2 compared with the control and T1 groups during lactation period. Furthermore, doe exposed to heat acclimation *at late pregnancy were the least affected, in most of the traits studied which reflected positively on decreasing of body temperature.*

Conclusively, *it can be concluded that heat acclimation for does rabbit at late pregnancy lead to improve the acquisition of thermotolerance for offspring but, this the improving was less for offspring resulting from does rabbit acclimatized at the beginning of pregnancy and that may be due to increase prolactin in does rabbits at late pregnancy that role play important in modulate some thermoregulatory processes during heat exposure and that reflected on their offspring.*

Key wards: Rabbits, thermoregulation, heat exposure, offspring, thyroid hormone.

The domestic rabbit is a homoeothermic mammal. The thermo neutral zone of growing rabbits is 15-18 ^{o}C. In tropical and sub-tropical countries, climatic heat as a major constraint on animal productivity, production and reproduction were impaired as a result of the drastic change in biological function caused by heat stress (Daader *et al*., 1989). Furthermore, the effects of high temperature on pregnancy or embryonic survival vary with the species, temperature, period of exposure, gestation length and stage of pregnancy (Hafez, 1987).The main thermoregulatory mechanism, in rabbits, is by heat exchange through the ears that have a large arteriovenous anastomotic system. In the nose, the nasal glands moisten inspired air, which also has a role in thermoregulation (Cervera and Fernandez, 1998).

Acclimatization is a process by which animals adapt to environmental conditions and engage behavioral, hormonal and metabolic changes. Alterations in the hormonal profile are mainly characterized by a decline and increase in anabolic and catabolic hormones, respectively. The endocrine system plays an integral part in the animal's response to stress (Ayyat *et al.*, 2004).

Thyroid hormones play a fundamental role in obligatory and adaptive thermogenesis (Lowell, and Spiegelman, 2000). Experimental evidence supports an essential role for thyroid hormones in thermogensis of mammals Silva, (2003) and they are considered as key hormones in controlling metabolic heat production in homeothermic animals (Ribeiro *et al*., 2001).

Also, prolactin is sensitive to the prevailing environmental temperature and this rise in prolactin values is likely to be implicated in the acclimation responses to thermal load. It has been reported that higher circulating prolactin during heat stress may modulate some mechanisms of heat dissipation and heat production oriented to support homeothermy (Alamer, 2011).

In the course of prenatal and early postnatal ontogeny, environmental factors may influence the development of the respective physiological control systems for the entire life period, especially by changes in neural organization and expression of related effector genes especially, heat shock proteins 70 (Wang, *et al*., 2007 and Lindquist, and Craig, 1988).

Exposure of embryos to experimentally elevated temperature during organogenesis has long been known to be embryotoxic (Upfold, *et al*., 1989). Hyperthermia at critical stages during embryonic development cause several developmental abnormalities (Edwards *et al*., 2003). Later embryonic stages (*e.g,* blastula), which have many more cells, have been shown to be capable of induction of thermotolerance (Heikkila *et al*., 1985). Thus thermotolerance increases the resistance of surviving cell by several orders of magnitude, particularly if the heat fractions are given daily (Miller and Ziskin, 1989).

Therefore, the objective of this study was to evaluate the effects of prenatal heat exposure treatment on physiologically and metabolically responses in female rabbits and its reflects on their offspring.

MATERIALS AND METHODS

Experimental animals

This study was carried out at the Rabbits Farm of Sakha Station, Animal Production Research Institute, Agriculture Research Center, Egypt, during the period from May to June, 2013. A total number of forty five non pregnant, non lactating, New Zealand White rabbit does of 12 months age with an average initial weight of 2.7±0.31 kg were used,. Does were naturally inseminated using four NZW bucks rabbit fed the same diet. Pregnancy diagnosis was done by palpation at 10 days post-mating and does fail to conceive post 1st mating was reinseminated. At pregnancy the does were assigned to three groups (15 rabbit/group) according to heat exposure treatment as follow: 1) The first group was exposed to natural ambient temperature (25±3°C) and was considered as control (C), the second group was exposed to a high ambient temperature (36±3^{o}C) for 1 hour for 3 consecutive days by using electric heaters equipped with thermostat and thermometer at the 14th day of pregnancy (T1), the third was exposed to a high ambient temperature

(36±2 ^{o}C) for 1 hour for 3 consecutive days by using electric heaters equipped with thermostat and thermometer at the 27th day of pregnancy (T2).

Animal housing and management:

The Rabbitry building was naturally ventilated through mesh windows and provided with automatically controlled sided exhaustion fans.

The does were kept individually in flat-deck cages of galvanized wire net, equipped with automatic drinkers, feeding hoppers and movable next boxes. Urine and faeces dropped from cages on the floor were cleaned daily. The ambient temperature and relative humidity ranged from 25 to 33ºC and 65-75%, respectively. All groups were maintained under similar management and hygienic conditions and 16L: 8D photoperiod throughout the experimental period. The rabbits in all groups were offered food and water *ad libitum*. The chemical analysis of the commercial pellet diet was: crude protein 18.0%, crude fiber 12.0% and ether extract 2.8%. Digestible energy (kcal DE/kg diet) was calculated as 2600. During the suckling period, milk yield was determined by the differences in LBW before and after suckling. Doe rabbits were individually weighed at the beginning of the experiment and weekly during the experimental period. Litter size and weight were recorded for each group at birth and weekly up to weaning at 28 days. Feed intake during pregnancy and lactation were also recorded.

Thermoregulatory parameters:

Rectal temperature was measured individually at midday by a digital thermometer. Respiration rate was measured by visually counting breaths per minute using a stop watch and were done when the animal was sitting quietly and breathing regularly at 8.00 a.m. These measurements were recorded at late pregnancy and during lactation period for does and their offspring during suckling period at 14 and 28 days of age.

Blood parameters:

Blood samples were taken from does at late pregnancy, (14 and 28 days) of lactation period from ear vein of does into clean sterile tubes. Blood samples were let to coagulate and centrifuged at 3500 rpm for 15 minutes and serum was separated and stored at –20 ^{o}C untill assay. Concentrations of total protein, albumin, globulin, glucose, total cholesterol, total lipids and activity of aspartate (AST) and alanine (ALT) aminotransferases, were estimated by the colorimetric method using commercial kits (Diamond Diagnostic, Egypt). Prolactin, and T3 were determined in blood serum using spectrophotometer (Spectronic 21 DUSA).

Statistical analysis

All results were analyzed using the general linear models procedure of SAS (2001). The model was $Yij = \mu + Gi + eij$

Where, Yij = An observation, μ = Overall means, Gi =Effects heat treatment and eij= Residual error term.

Duncan's multiple range tests was performed (Duncan, 1955) to detect significant differences among means.

RESULTS AND DISCUSSION

Live body weight:

All experimental groups of doe rabbits have approximately similar values of live body weight at the beginning of the experiment, while, significant differences in live body weight of female rabbits at the end of experiment (Table1). However, female rabbits reared under heat acclimation at 27 days of age (T2) had significantly heavier body weight than the other groups at kindling and at weaning. Also, female rabbits reared under heat acclimation at 14 days of age (T1) had significantly heavier body weight than the control group. Previous studies showed that heat acclimation improved weight gain in rabbits (Marai *et al*., 1991) in rats (Mirit *et al*., 2012) which is in agreement with our results. Treatment with heat acclimation elevated activities of the enzymatic antioxidant system and that the inhibition of antioxidant enzymes is a possible cause of the heat-stress-induced oxidative stress in rats, and enhanced thermotolerance may be associated, at least in part, with the elevated activity of the enzymatic antioxidant system and reflected it body weight gain.

Feed consumption:

The obtained data for the values of total feed intake of does as affected by temperature are shown in Table 1. Rabbits reared under high temperature in control and heat exposure at 14 days of progeny (T1) groups consumed significantly slight lower feed than those reared under heat exposure in T2 with insignificant differences between all the groups. These results are in agreement with (Marai *et al*., 2007). Such phenomenon is due to that environmental temperature stimulates the peripheral thermal receptors to transmit suppressive nerve impulses to the appetite centre in the hypothalamus causing the decrease in feed consumption, *i.e.* dry matter intake and consequently fewer substrates become available for enzymatic activities, hormone synthesis and heat production (Kamal, 1975). The decline

Table 1. Effect of thermal manipulation on live body weight (LBW) of doe rabbits at different ages, during summer season.

Traits	C	T1	T2	SE
LBW at mating (kg)	2821	2864	2876	99.72
LBW at kindling (kg)	2728.26[b]	2791.20[ab]	2903.13[a]	52.55
LBW at weaning (kg)	2738.13[b]	2801.26[ab]	2913.26[a]	49.88
Feed consumption (kg)	9006.00	9075.33	9232.00	744.72

[a, b…] Means with different superscripts within row are significantly different ($P \leq 0.05$).
C: does kept at thermoneutral temperature about 25^{o} C (Control group); T1 and T2 (Does were subjected at 14 and 27 days of the gestation period to $36^{o}C$ / one hour for three consecutive days, respectively).

in feed intake of rabbits under high temperature was also reported by (Ayyat *et al*., 2004).

Reproductive efficiency traits:

Results listed in Table (2) showed the effect of ambient temperature on the reproductive traits (gestation period, litter weight, litter size and mortality rate). Ambient temperature affected significantly gestation period, litter weight and litter size at all ages, however, mortality rate % was affected from birth to 28 days of age. High temperature significantly increased gestation period in T1 and control group as compared to those reared under acclimation temperature in T2.

The significant increase in gestation period in the hot period is similar to that reported by Marai *et al*. (2000). McNitt and Moody (1991) and Marai *et a*l.(1994) attributed the increase in gestation period to the decrease in each of feed intake and T3 hormone level and consequently the decrease of protein biosynthesis, that result in foetus requiring more time to reach full term, under hot conditions. However, gestation period length was less in T3 may be a result of utilization nutrients during pregnancy and prolactin might have a role in the process of growth and maturation of the gut mucosa during ontogeny (Bujanover *et al*., 2002).

On the other hand, litter weight and litter size at 7 and 14 days of age were significantly increased in control group and T1 as compared to T2. However, the differences in litter weight and litter size were not significant at 21 and 28 days of age. Mortality rate % from birth to 28 days recorded the highest values under high temperature in control group and T1 with insignificant difference between the two groups as compared to T2. The

Table 2. Effect of thermal exposure on reproductive traits of does rabbit, during summer season.

Traits	Age (day)	C	T1	T2	SE
Gestation period (day)		30.80[b]	31.20[a]	30.20[c]	0.10
Litter size	1	7.00 [a]	6.60[ab]	5.80[b]	0.30
	7	6.20[a]	6.60[a]	4.60[b]	0.48
	14	5.40[ab]	5.80[a]	4.60[b]	0.39
	21	4.60	4.50	4.50	0.32
	28	4.40	4.46a	4.50	0.31
Litter weight (g)	7	792.00[ab]	854.60a	774.00[b]	22.30
	14	1528.00[a]	1543.00a	1371.00[b]	49.59
	21	1877.00	1801.00	2092.00	136.91
	28	2205.00	2242.00	2502.00	102.83
Mortality rate %	1-28	36.38[a]	28.38[ab]	22.00[b]	5.75

[2 a, b….] Means with different superscripts within row are significantly different ($P \leq 0.05$).
C: does kept at thermoneutral temperature about 25^{o} C (Control group); T1 and T2 (Does were subjected at 14 and 27 days of the gestation period to 36^{o}C / one hour for three consecutive days, respectively).

decrease of litter weight and litter size in the groups reared under high temperature in control group and T1 may be due to the decrease of doe milk yield as a result to low feed intake (Bassuny, 1999) while, the improvements of T2 might have been also attributed to the exogenous prolactin caused an increased of thermal shock activity for the HSP70 proteins and increased 1.6 fold the bile secretion from the liver (Beata *et al*., 2004). Also, beneficial effects of mother's milk by suggesting that mother's milk contain Hsp70 protein and factors to promote Hsp70 induction. Therefore, induction of Hsp70 expression plays an important role in maintaining intestinal homeostasis in rats (Jennifer *et al*., 2011).

Milk yield:

Results in Table (3) showed that does in T2 recorded significantly ($P<0.05$) highest average daily milk yield at different suckling intervals, followed by those in T1 and control group. The decrease of doe milk yield in control and T1 may be due to low feed intake (Bassuny, 1999). It is interest to note that daily milk yield in all treatment groups increased gradually up to 21 days and decreased at 28 days of suckling period thereafter (Table 3). Similar trends of changes in milk yield of rabbits were observed by Omara *et al.* (2004).

Table 3. Effect of thermal treatment on milk yield (MY) of does rabbit at different suckling intervals, during summer season.

Traits	C	T1	T2	SE
MY7 (g)	80.0	82.00	94.00	4.78
MY14 (g)	130.00	142.00	143.00	18.99
MY21 (g)	150.00^{b}	155.00^{b}	175.00^{a}	28.68
MY28 (g)	92.00^{b}	98.00^{ab}	112.00^{a}	5.68

[1] Data expressed as LSM ± S.E.

[2 a, b….] Means with different superscripts within raw are significantly different (P≤0.05).

C: does kept at thermoneutral temperature about 25^{o} C (Control group); T1 and T2 (Does were subjected at 14 and 27 days of the gestation period to 36^{o}C / one hour for three consecutive days, respectively).

Thermoregulatory parameters

The effects were significant on the thermoregulatory parameters (respiration rate (RR) and temperatures of rectum (Tr)) at late pregnancy and during lactation period from does and at 14 and 28 days of suckling period from their offspring (Table 4).

During summer the initial values of (Tr) ranged from 39 to 40.96 °C. For all groups, there was gradual increase in (Tr) during the experimental period. However, the elevation in Tr and RR was more pronounced for the group of rabbits in T2 compared to T1 and control groups at late pregnancy. While, the group (T1) and control groups had higher Tr and RR values compared to respective values obtained for the group of rabbits in T2 during lactation period. This suggests that lactating mothers may need to be more active during daytime because of their elevated food and water requirements that cannot be satisfied by feeding at night alone. There may also be a disruption of sleep, because of disturbance by their offspring (Young *et al*., 1998; Waterhouse *et al*., 2001). Potential drivers of the elevated body temperature during lactation include the heat associated with digestion of the elevated levels of food intake, and the heat generated as a byproduct of milk synthesis and the resting metabolic rate. But, reducing in Tr for the group of rabbits in T2 may be due to the lower metabolic rate of heat-acclimated rabbits exposed to heat probably played an important role in preventing the increasing rectal temperatures (Oliveira *et al*., 1985). Also, Shido *et al*., (1991) concluded that the reduction of metabolic heat production associated with locomotor activity in heat-acclimated rats which reflected on reduction of body temperatures.

Table 4. Effect of thermal treatment on thermoregulatory parameters of New Zealand White rabbits, during summer season.

Traits	Age (day)	C	T1	T2	SE
Does					
RT (C º)	At late pregnancy	39.02[b]	39.06[b]	40.86[a]	0.87
RR		84.40[b]	84.40[b]	114.40[a]	12.62
RT (C º)	During lactation period	40.96[a]	40.04[ab]	39.00[b]	1.19
RR		113.40[a]	104.20[ab]	85.00[b]	15.03
Offspring					
RT (C º)	At 14 days of suckling period	40.94[a]	40.80[a]	38.36[b]	0.93
RT (C º)	At 28 days of suckling period	41.02	41.10	40.02	0.87

[a, b….] Means with different superscripts within raw are significantly different ($P \leq 0.05$).
RT: Rectal temperature RR: Respiration rate.
C: does kept at thermoneutral temperature about 25º C (Control group); T1 and T2 (Does were subjected at 14 and 27 days of the gestation period to 36ºC / one hour for three consecutive days, respectively).

On the other hand, the higher value of (RR) obtained with (T2) could be attributed to thermally increase in pulmonary ventilation that augmented evaporative heat loss. In rabbits exposed to high ambient temperature, increase in metabolic heat production led to an increase in respiratory evaporative water loss by panting (Gonzalez, *et al*., 1971).

Data presented in Table 4, showed significant differences in rectal temperature (°C) in the experimental three groups (C, T1 and T2) for offspring during suckling period. The averages rectal temperature of T2 was significantly lower compared to the C and T1 groups at 14 days of age. However, rectal temperature was nearly similar for all treatment groups at 28 days of age; the differences in rectal temperature were not significant. The most important results for using heat exposure especially at late pregnancy were the decrease of metabolic rate by reducing of triiodothyronine hormone which reflected positively on decreasing of body temperature.

Blood parameters

1- Hormones Blood parameters

Data presented in Table 5, show significant differences in prolactin levels (PRL) between the experimental three groups (C, T1 and T2) at late pregnancy and 14 days of lactation period. During summer, there was

Table 5. Effect of thermal acclimation on hormones parameters of does rabbit, during summer season.

traits	Age (day)	C	T1	T2	SE
Prolactin (ng/ml)	At late pregnancy	2.23[c]	2.47[b]	3.40[a]	0.04
	At 14 lactation period	5.06[c]	5.34[b]	6.54[a]	0.05
	At 28 lactation period	3.25	3.37	3.33	0.04
T3 (nmol/l)	at late pregnancy	2.40[a]	2.47[a]	1.61[b]	0.41
	At 14 lactation period	2.61[a]	2.67[a]	1.58[b]	0.45
	At 28 lactation period	2.16	1.91	1.85	0.14
T4 (nmol/l)	at late pregnancy	97.81[a]	82.97[b]	86.98[b]	2.54
	At 14 lactation period	99.20[a]	89.11[b]	85.99[b]	3.17
	At 28 lactation period	92.30	90.30	86.21	6.57

[a, b….] Means with different superscripts within raw are significantly different ($P \leq 0.05$).
C: does kept at thermoneutral temperature about 25^o C (Control group); T1 and T2 (Does were subjected at 14 and 27 days of the gestation period to 36^{o}C / one hour for three consecutive days, respectively).

gradual increase in (PRL) during the experimental period. However, the elevation was more pronounced for the group of rabbits (T2). The (T2) group had higher level (PRL) compared with the control and T1 groups at late pregnancy and at 14 days of lactation period.

Circulating prolactin levels are increased during thermal stress in a variety of mammals including rabbits (Roy and Prakash, 2007). Increased prolactin initially seems contradictory (especially in lactating rabbits T2 compared with the other groups), given prolactin’s well-known role in maintaining galactopoiesis in some species and lactogenesis in ruminants, but prolactin may play an important role in acclimation through improved insensible heat loss and sweat gland function (Beede and Collier, 1986). Whether increased prolactin levels affect the ability of animals to metabolically adapt during a heat load is currently unknown but is of interest, given its importance as a homeorhetic hormone. Furthermore, prolactin has been shown to stimulate the expression of -60 in rats (Stucco *et al*., 2001) and heat shock proteins are known to be involved in cytoprotection during heat stress and protect against hyperthermia. Prolactin may also affect the maintenance of sustained fluid flow to the vascular system by facilitating fluid absorption from the gastrointestinal tract.

All groups had lower ($P < 0.05$) (PRL) values at late lactation period. However, (PRL) value was nearly similar for all treatment groups; the differences in (PRL) value were not significant. The release of prolactin is less in late lactation (Cowie, 1969). McNeilly and Friesen (1978) found that the amount of prolactin appearing in plasma in response to suckling decreased as lactation advanced, the supply still appears to be adequate to maintain milk secretion.

Results in Table 5 showed decrease in thyroid hormones (triiodothyronine and thyroxine) values for the T2 group compared to the control and T1 group during pregnancy and at 14 days of lactation period. The results indicate that the changes in thyroid status produced by administration of (T1) and (T2) during summer season related thermal load influenced thermoregulation in rabbits. This could be a response to decrease in level of thyroid hormones related to (T2) treatments and exposure to hot environment during summer which led to a decrease in metabolic rate and heat dissipation to the environment during pregnancy. While, showed an increase in triiodothyronine and thyroxine values in the other groups during lactation period may be due to thyroid hormones are considered necessary for cellular metabolism of the mammary gland and energy utilization which could be considered as important factors in milk biosynthesis (El-Masry and Habeeb, 1989). However, triiodothyronine and thyroxine values were nearly similar for all groups at 28 days of lactation period; the differences in triiodothyronine and thyroxine values were not significant.

2- Other Blood parameters

Results in Tables (6, 7 and 8) showed reduction in blood serum total protein, globulin, glucose, total lipid and cholesterol at late pregnancy and 14 days of lactation period, in T2 compared with C and T1 under high ambient temperature may be due to the high demand of the foetus at late stages of pregnancy (Marai *et al*., 1994). Particularly, the decrease in glucose in blood is due to fetal consumption and conversion of glucose to lactose of milk (Marai *et al*., 1994). The decrease in cholesterol level may be due to the decrease in protein synthesis (lipid is transported as lipoprotein). However, (AST and ALT) values were nearly similar for all treatment groups at late pregnancy; the differences in (AST and ALT)

Table 6. Effect of thermal acclimation on total protein, albumin and globulin concentrations of does rabbit, during summer season.

traits	Age (day)	C	T1	T2	SE
Total protein (g/dl)	At late pregnancy	7.01[a]	6.84[ab]	6.55[b]	0.12
	At 14 lactation period	7.18[a]	5.76[b]	6.05[ab]	0.50
	At 28 lactation period	7.03	6.64	6.61	0.31
Albumin (g/dl)	At late pregnancy	3.41[a]	3.33[ab]	3.12[b]	0.08
	At 14 lactation period	3.52[a]	3.16[b]	3.14[b]	0.11
	At 28 lactation period	3.23[b]	3.40[ab]	3.53[a]	0.06
Globulin (g/dl)	At late pregnancy	3.60	3.50	3.43	0.13
	At 14 lactation period	3.66[a]	3.60[a]	2.91[b]	0.44
	At 28 lactation period	3.38	3.34	3.49	0.32
A/G ratio	at late pregnancy	0.97	0.96	0.91	0.05
	At 14 lactation period	0.97	0.77	0.60	0.33
	At 28 lactation period	0.97	0.57	1.03	0.21

[a, b….] Means with different superscripts within raw are significantly different ($P \leq 0.05$).

C: does kept at thermoneutral temperature about 25^{o} C (Control group); T1 and T2 (Does were subjected at 14 and 27 days of the gestation period to 36^{o}C / one hour for three consecutive days, respectively).

Table 7. Effect of thermal acclimation on total lipids, cholesterol and glucose concentrations of does rabbit, during summer season.

Traits	Age (day)	C	T1	T2	SE	Sig.
Total lipids (mg/dl)	At late pregnancy	217.08[a]	223.58[b]	188.30[b]	22.24	?"
	At 14 lactation period	217.74[a]	221.59[b]	188.15[b]	22.32	
	At 28 lactation period	215.75[a]	220.91[a]	237.82[a]	14.9	
Total cholesterol (mg/dl)	At late pregnancy	37.16[a]	38.65[b]	38.13[b]	0.39	
	At 14 lactation period	39.95[a]	38.36[b]	33.70[b]	2.81	
	At 28 lactation period	36.76	38.32	37.50	0.53	
Glucose (g/dl)	At late pregnancy	54.93[a]	50.99[b]	49.85[b]	1.01	
	At 14 lactation period	55.00[a]	51.28[b]	49.94[b]	0.94	
	At 28 lactation period	55.19	54.34	53.96	3.23	

[a, b….] Means with different superscripts within raw are significantly different ($P \leq 0.05$).
C: does kept at thermoneutral temperature about 25^{o} C (Control group); T1 and T2 (Does were subjected at 14 and 27 days of the gestation period to 36^{o}C / one hour for three consecutive days, respectively).

Table 8. Effect of thermal acclimation on liver function of does rabbit during summer season

Traits	Age (day)	C	T1	T2	SE
Activity of AST (IU/ml)	At late pregnancy	15.68	15.64	16.60	4.38
	At 14 lactation period	16.14 [a]	14.26[a]	10.81[b]	0.89
	At 28 lactation period	15.96[a]	10.42[b]	14.08[b]	0.88
Activity of ALT (IU/ml)	at late pregnancy	40.61	40.89	41.59	3.08
	At 14 lactation period	38.30[a]	38.02[a]	28.80[b]	2.51
	At 28 lactation period	38.22[a]	37.86[a]	28.98[b]	2.53

[a, b….] Means with different superscripts within raw are significantly different (P≤0.05).
C: does kept at thermoneutral temperature about 25^{o} C (Control group); T1 and T2 (Does were subjected at 14 and 27 days of the gestation period to 36^{o}C / one hour for three consecutive days, respectively).

values were not significant. The blood enzymes are influenced by the external environment including feeding practices, type of shelter and many other aspects of hard management, since they are intimately related to metabolism (Marai, *et al*., 2007).

Tables (6, 7 and 8) showed the metabolic profile of blood. No significant effect was observed for total protein, globulin, albumin, glucose, total lipid and cholesterol among all groups at 28 days of lactation period. Also, the rabbits of T1 and control group had significantly higher AST and ALT values than those of the T2 group at 14 and 28 days of lactation period.

Reduction in blood metabolites under high environmental temperatures in control group may be due to the decrease in feed intake and subsequent reduction of metabolism or to dilution of blood and body fluids as a result of the increase in water intake. Marai *et al*., (2007) found that albumin was significantly lower when the animals were exposed to heat stress conditions. Also, Marai *et al*., (2002) showed that blood glucose was decreased significantly in NZW rabbits exposed to heat stress conditions by 20.7%. The decrease in plasma glucose could also be due to the marked dilution of blood and body fluids as a whole or to the increase in glucose utilization to produce more energy for greater muscular expenditure required for high respiratory activity (Marai *et al*., 2002). Other studies showed that glucose concentration increases under heat stress conditions due to the decrease in glucose utilization, depression of both catabolic and anabolic enzyme secretions and subsequent reduction of metabolic rate (Webster, 1976). In addition, the increase of AST and ALT levels with exposure to hot temperature may be due to increase in stimulation of gluconeogenesis by corticoids hormones (Thompson, 1973). On the other hand, the decrease of AST and ALT levels in T2 may be due to administration of PRL shows signs protective effects on hepatocytes in this group (Beata *et al*., 2004). Also, Shido *et al*., (1991) concluded that the reduction of metabolic heat production associated with locomotor activity in heat-acclimated rats which reflected positively on improving of liver function.

Generally, these results indicate that early environmental stimulation of body functions improves their maturation and reactivity to environmental variations ("training effect") during the prenatal period. It can be concluded that heat acclimation for doe rabbits at late pregnancy was more effective than heat acclimation at early pregnancy and results in improving the acquisition of thermotolerance, for offspring. Whereas, this effect is less on offspring resulting from doe rabbits acclimatized at the beginning of pregnancy and that may be due to increase prolactin in does rabbits at late pregnancy that play important role in modulate some thermoregulatory processes during heat exposure and reflected it on their offspring.

Conclusively, it can be concluded that heat acclimation for does rabbit at late pregnancy lead to improve the acquisition of thermotolerance for offspring but, this the improving was less for offspring resulting from does rabbit acclimatized at the beginning of pregnancy and that may be due to increase prolactin in does rabbits at late pregnancy that role play important in modulate some thermoregulatory processes during heat exposure and that reflected on their offspring.

REFERENCES

Alamer, M. (2011). The role of prolactin in thermoregulation and water balance during heat stress in domestic ruminants. *Asian J. of Animal and Veter. Adva.,* **6** (12): 1153-1169.

Ayyat M.S., God H.A.M., EL-Aasar T.A., El-Monem U.M. (2004). Alleviation of heat-stressed growing rabbits by using some feed additives under Egyptian condition. *Egyptian J. Nutrition and Feeds,* **7**: 83-96.

Bassuny, S.M., (1999). Performance of doe rabbits and their weanlings as affected by heat stress and their alleviation by nutritional means under Egyptian conditions. *Egyptian Journal of Rabbit Science,* **9**(1): 73-86.

Beata, S. M; M. Drozdz; F. Ryszka; B. Dolinska and P. Scigala (2004). The influence of prolactin on the chosen biochemical parameters of the rabbit liver in ischemia. *Acta Poloniae Pharmaceutica -Drug Res.*, **61**:477-482.

Beede, D. K. and R. J. Collier. (1986). Potential nutritional strategies for intensively managed cattle during thermal stress. *J. Animal Sci*., **62**: 543-554.

Bujanover Y, Wollman Y, Reif S, Golander A. Bujanover Y, Wollman Y, Reif S, Golander A. J Pediatr Endocrinol Metab. (2002). A possible role of prolactin on growth and maturation of the gut during development in the rat. Jun;**15**(6):789-94.

Cervera, C. and J. Fernandez Carmona, (1998). *Climatic Environment.* In: The Nutrition of The Rabbit. Blas, C. De. And J. Wiseman. CAB Interational. pp: 273-295, Chapter 15.

Cowie, A. T. (1969). Variations in the yield and composition of the milk during lactation in the rabbit and the galactopoietic effect of prolactin. *Journal of Endocrinology*, **44**, 437-450.

Daader, A.H., I.F.M. Maria, A.A. Habeeb and H.M. Yousef, (1989). Improvement of growth performance of friesian calves under Egyptian subtropical conditions. 1-Internal cooling technique using diuretics and drinking cool water. *Proceeding of 3rd Egyptian–British Conference on Animal, Fish and Poultry Production*, Alexandria, Egypt, **2**: 595-605.

Duncan, D. B. (1955). Multiple range and multiple F tests. *Biometrics*,**11**:1– 42

Edwards, M.J.; R.D. Sauders and K. Shiota. (2003). Effects of heat on embryos and foetuses. *Intl. J. Hyperthermia*., **19**: 295-324.

El-Masry K.A. and Habeeb A. A. (1989). Thyroid function in lactating Friesian cows and water buffaloes under winter and summer Egyptian conditions. *Proceedings of 3rd Egyptian-British Conference on Animal Fish and Poultry Production Alexandria*, Egypt, **2**: 613-620.

Gonzalez, R. R., J. Matthew Kluger and J. D. Hardy, (1971). Partitional calorimetry of the New Zealand White rabbits at temperatures 5-35°C. *Journal of Applied Physiology*, **31** (5): 728-734.

Hafez, E.S.E. (1987). *Reproduction in Farm Animals*. 5th Edition, LEA & Febiger, Philadelphia.

Heikkila, J.J.; J.G.O. Miller; G.A. Schultz; M. Kloc and L.W. Browder. (1985). Heat shock gene expression during early animal development in Atkinson, B.G. and D.B. Walden (Eds). Changes in eukaryotic gene expression in response to environmental stress. New York: Academic Press, pp: 135-158.

Jennifer L. Liedel, Yuee Guo, YueyuE YU, Sheng-Ru Shiou, Sangzi CHEN, Elaine O. Petrof, Shien H, Mark W. Musch, and Erika C. C.. (2011). Mother's Milk-Induced Hsp70 Expression Preserves Intestinal Epithelial Barrier Function in an Immature Rat Pup Model. Pediatr Res. May 2011; **69**(5 Pt 1): 395–400.

Kamal T.H. (1975). Heat stress concept and new tracer methods for heat tolerance in domestic animals. *Proceedings of 1st Scientific Conference on Peaceful Uses of Atomic Energy for Scientific and Economic Development*. Atomic Energy Commission, Baghdad, Iraq.

Lindquist, S. and E.A. Craig. (1988). The heat shock protein. Annu. Rev. Genet., **22**: 631-677.

Lowell, B.B. and B.M. Spiegelman, (2000). Towards a molecular understanding of adaptive thermogenesis. Nature, 404 (6778): 652-660.

Marai I.F.M., Abdel-Samee A.M., El Gafaary M.N. (1991). Criteria of res pons e and adaptation to high temperature for reproductive and growth traits in rabbits. Options Méditerranéennes : Série A. Séminaires Méditerranéens; No. **17** pages 127- 134

Marai I.F.M., Ayyat M.S. and Abd El-Monem U.M. (2000). Young doe rabbit performance traits as affected by dietary zinc, copper, calcium or magnesium supplements under winter and summer conditions of Egypt. *Proceedings of 7th World Rabbit Congress*, Valencia, Spain. Pp 313-320.

Marai I.F.M., El-Sayiad Gh. A. and Ayyat M.S.. 1994. Some blood and milk constituents as affected by breed and pregnant stage in rabbits. *Options Mediterraneennes*, **8** (Supplement): 475-487.

Marai, I.F.M.; A.A.M Haeeb and A.E.Gad, (2007). Biological functions in young pregnant rabbit does as affected by heat stress and lighting regime under subtropical conditions of Egypt. *Tropical and Subtropical Agroecosystems*, **7:**165 – 176.

Marai, I.F.M., Habeeb, A.A.M. and Gad, A.E. (2002). Rabbits, productive, reproductive and physiological performance traits as affected by heat stress: a review. *Livestock Production Science*, **78**: 71-90.

Mcneilly, A. S. and Friesen, H. G. (1978). Prolactin during pregnancy and lactation in the rabbit. *Endocrinology*, **102,** 1548-1554.

Miller, M.W. and M.C. Ziskin. (1989). Biological consequence of hyperthermia. *Ultrasound in Med. Biol*., **15**:707-722.

Mirit Eynan , Offir Ertracht , Hanan Gancz , Yechezkel Kashi , Yehuda Arieli (2012). Prolonged latency to CNS-O_2 toxicity induced by heat acclimation in rats is associated with increased antioxidative defenses and metabolic energy preservation. *Journal of Applied Physiology* , Vol. **113** :595-601.

NcNitt J.I. and Moody, Jr. G.L. (1991). Gestation length of four medium breeds of rabbits in Lousiana. *Journal of Applied Research*, **14**: 80-82.

Oliveira SG, Tarasantchi J, and Griggio M.(1985). Effects of temperature acclimation on rabbit metabolic rate and rectal temperature. *Braz J. Med. Biol. Res*., **18** (3):367-72.

Omara, M.E.; A.M.A. Mohi El-Din and M.A.M. Abu El-Hamd (2004). Effect of diets containing different types of silage on productive and reproductive performance of doe rabbits and growth performance of their bunnies. *J. Agric. Sci. Mansoura Univ*., **29**(10): 6301-6312.

Ribeiro, M.O., S.D. Carvalho, J.J. Schultz, G. Chiellini, T.S. Scanlan, A.C. Bianco and G.A. Brent, (2001). Thyroid hormone-sympathetic interaction and adaptive thermogenesis are thyroid hormone receptor isoform–specific. *Journal of Clinical Investigations*, **108** (1): 97-105.

Roy, K.S. and B.S. Prakash. (2007). Seasonal variation and circadian rhythmicity of the prolactin profile during the summer months in repeat-breeding Murrah buffalo heiers. *Reprod. Fertil. Dev*., **19:** 596-605.

SAS, (2001). *Statistical Analysis System*, User's Guide Version 8.2 Cary NC. USA.

Shido, O.; S. Sakurada and T. Nagasaka (1991). Effect of heat acclimation on diurnal changes in body temperature and locomotor activity in rats. *J . Physiology.*, Feb 1991; **433**: 59–71.

Silva, J.E., (2003). The thermogenic effect of thyroid hormone and its clinical implications. *Annals of Internal Medicine*, **139** (3): 205-213.

Stucco, C.; E. Callegari and Gibori. (2001). Opposite effect of prolactin and prostaglandin F2a on the expression of luteal genes as revealed by rat cDNA expression array. *Endocrinology*, **142**: 4158-4161.

Thompson G.E. (1973). Review of the progress of dairy science. Climatic physiology of cattle. *Journal of Dairy Research*, **40:** 441-473.

Upfold, J.B.; M.S.R. Smith and M.J. Edwards. (1989). Quantitative study of the effect of maternal hyperthermia on cell death and proliferation in the guinea pig brain on day 21 of pregnancy. *Teratology*, **39**: 173-179.

Wang C, Bomberg E, Billington C, Levine A and Kotz CM. (2007). Brainderived neurotrophic factor in the hypothalamic paraventricular nucleus reduces energy intake. *American Journal of Physiology— Regulatory, Integrative and Comparative Physiology*, **293**: R1003-R1012.

Waterhouse, J., Folkard, S., Van Dongen, H., Minors, D., Owens, D.,Kerkhof, G., Weinert, D., Nevill, A., Macdonald, I.,Sytnik, N., . (2001). Temperature profiles, and the effect of sleep on them, in relation to morningness-eveningness in healthy female subjects. *Chronobiol. Int.* 18, 227-247.

Webster .J.Y., (1976). *The influence of the climatic environment on metabolism in cattle. In: H. Swan and W.H. Broster, Editors, Principles of Cattle Production, Butterworths, London.*

Young, A. J., Castellani, J. W., O'Brien, C., Shippee, R. L., Tikuisis, P., Meyer, L. G., Blanchard, L. A., Kain, J. E., Cadarette, B. S. and Sawka, M. N. (1998). Exertional fatigue, sleep loss, and negative energy balance increase susceptibility to hypothermia. *J. Appl. Physiol.*, **85**: 1210-1217.

تأثير الإجهاد قبل الولادة على الاستجابات الحرارية والفسيولوجية في اناث الأرانب وانعكاس ذلك على خلفاتهم

فضيلة محمد عيسى ، عبد العزيز سيد عثمان ، أمل مغاورى هيكل ، فيصل بيومى عبد السلام

قسم بحوث تربية الأرانب والرومى والطيور المائية، معهد بحوث الإنتاج الحيوانى، مركز البحوث الزراعية، الدقى، جيزه، مصر.

* قسم إنتاج الدواجن، كلية الزراعة ، جامعة عين شمس، مصر.

من المعروف جيدا أن تعرض الأرانب للإجهاد الحراري يثير سلسلة من التغييرات الملحوظة في الوظائف البيولوجية الخاصة بهم والتي تنتهي بانخفاض الإنتاج والتكاثر.لذا الهدف من هذة الدراسة هو تقيم آثار التأقلم الحرارى عن طريق تحويراستجابتها الفسيولوجية للتنظيم الحراري في اناث الأرانب وانعكاس ذلك على خلفاتهم.

خصص خمسة واربعين ارنب نيوزيلندا أبيض وعند ثبوت الحمل تم تقسيمهم إلى ثلاث مجموعات متساوية، وفقا لوقت التعريض المجموعة الأولى عرضت إلى درجة حرارة الغرفة الطبيعية (٣±٢٥ درجة مئوية) وكانت تعتبر مجموعة الكنترول ،وتعرضت المجموعة الثانية والثالثة،(T1 and T2) إلى درجة حرارة عالية (٣±٣٦ درجة مئوية) فى أوقات مختلفة من التأقلم الحرارى لمدة ساعة لمدة ٣ أيام متتاليةعند عمر ١٤ و ٢٧ من الحمل على التوالي.

وكانت اهم النتائج المتحصل عليها كلاتى:

١- اناث الارانبT2 لديهم ارتفاع فى درجة حرارة الجسم وكذلك معدل التنفس في نهايه فترة الحمل (في الفترة المتاخرة من الحمل) مقارنة مع مجموعة الكنترول و T1، بينما انخفضت درجة حرارة الجسم في اناث الارانب خلال فترة الرضاعة وكذلك ذريتهم فى T2 مقارنة مع مجموعة الكنترول و T1.

٢- ادى االتعرض للأجهاد الحرارى فى المرحلة المتاخرة من الحمل الى انخفاض معنوى فى فترة الحمل في المجموعة T2 عن غيرها. كان اجمالى عدد الخلفة عند الولادة أكثر في T2 وكذلك مجموعات الوزن عند الولادة والفطام كانت أعلى في المجموعات T2عن غيرها عند اعمار ٢١ - ٢٨ من العمر ، كانت نسبة الوفيات من الولادة وحتى الفطام أقل في T2 عن غيرها.

٣- مستوى هرمون البرولاكتين أعلى وكذلك انخفاض مستوى هرمون الغدة الدرقية في المجموعة T2 عن غيرها في أواخر الحمل وعند ١٤ يوما من فترة الرضاعة. بينما كان مستوى هرمون البرولاكتين اقل فى جميع المعاملات في أواخر فترة الرضاعة.

٤- الأرانب المجموعة T2 كانت أقل معنويا فى مستوى AST و ALT عن المجاميع الاخرى خلال فترة الرضاعة

٥- عموما فان اناث الارنب المتاقلمة في وقت متأخر من الحمل كانت الاقل تاثرا فى معظم الصفات المدروسة والتى انعكست ايجابيا على خفض درجة حرارة الجسم.

التوصية: يمكن أن نستخلص إلى أن التعرض الحرارى لاناث الارنب في وقت متأخر من الحمل يعمل على تحسين اكتساب التحمل الحرارى للنسل الناتج من هذة الامهات، ولكن هذا التأثير يكون أقل على النسل الناتج من امهات متأقلمة في بداية الحمل والتي قد تكون بسبب زيادة البرولاكتين في اناث الأرانب في وقت متأخر من الحمل والذى يلعب دورا مهم في تعديل بعض عمليات التنظيم للحرارى أثناء التعرض للحرارة وانعكاس ذلك على **خلفاتهم**.