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Heat Adaptability Of Growing New Zealand White rabbits Under Egyptian Conditions

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ABSTRACT

The present study was conducted in the private Farm at Shyrkia, Governorate, Egypt during winter and summer seasons 2013. The work aimed to study the heat adaptability of growing male New Zealand White (NZW) rabbits.

Twenty growing male (NZW) were divided into two equal and similar groups. The 1st group were subjected to mild winter climate (Temperature humidity index THI= 16.1) and the 2nd group were exposed to hot humid summer (THI= 31.1). Results revealed that daily gain, daily feed intake and feed efficiency of growing NZW rabbits were affected negatively by exposure to hot climate. Respiration rate and rectal temperature increased (p □ 0.01) due to exposure to heat stress.

Red blood cell (RBC) counts, packed cell volume (PCV), hemoglobin, platelets, mean cell volume (MCV), mean cell hemoglobin (MCH) and mean cell hemoglobin concentration (MCHC) were significantly decreased during hot summer. Similarly, total leucocytes, nuetrophils and lymphocytes decreased significantly. while monocytes and basophils decreased unsignificantly, esoinphils did not affected significantly by exposure to hot climate. Total; proteins (TP) glucose (Glu), albumin, globulins, A/G ratio, total lipids and cholesterol were decreased significantly, and triglycerides did not affected significantly by exposure to hot climate.

Liver function including alkaline phosphatase (ALP), acid phosphatase (ACP), alanine aminotransferase (ALT), aspartate aminotransferase (AST) and billrobin were decreased significantly due to heat stress exposure. Kidney functions which include creatinine and uric acid were decreased significantly due to exposure to hot climate. Activities of some blood minerals were decreased significantly as affected by heat stress i.e.; sodium, calcium, potassium and phosphorus.

Activity of some blood hormonaes; cortisol, triiodothyroxine (T_3) and thyroxine (T_4) were significantly decreased during summer season. Results suggest that exposure of growing New-Zealand white rabbits to hot environmental conditions adversely affects physiological functions as reflected by the hematological, biochemical parameters, hormonal and various immunological function. These disturbances of internal physiological status of mammals led to impairment of all activities of these mammals.

INTRODUCTION

Heat stress (HS) is defined as a stress inflicted by a wide range of environmental conditions that induce a state of physiological damage within an animal's body, and means that animals are not able to regulate their heat homeostasis passively. It mainly occurs when animals are exposed to high ambient temperatures, high humidity, high wind speed, and high direct and indirect solar radiation *(1)*.

Heat stress resulted in drastic changes in biological functions of the animal's body and consequently, lower productivity so metabolism of carbohydrates, protein, fat, minerals and vitamins are disturbed under heat stress conditions due to depression in appetite and feed consumption. Hormonal profile, especially anabolic hormones such as insulin, growth hormone, cortisol, Triiodothyroxine and thyroxine are also disturbed *(2,3)*.

On the other view, exposing farm animals to high ambient temperature led to disturbance of the animal's normal physiological balances and consequently results in negative nitrogen, minerals, energy and thermal balances and lowered production *(4,5)*.

There is a great necessity for increasing animal population to solve animal protein deficiency problem in developing countries like Egypt. Increasing protein production may came from short cycle animals kept by the small scale farmers such as rabbits. Rabbits are suitable to be raised for meat production in Egypt due to its high fecundity and prolificacy, short generation interval and high feed conversion efficiency. Animals in Egypt may suffer from heat stress during the long hot humid climate in summer (May to November). A temperature of 13-20 °C is known "comfort zone" for rabbits *(6)*.

Rabbits, as a homoeothermic animal, can regulate the heat input and output of their bodies using physical, morphological, biochemical, and behavioural processes to maintain a constant body temperature *(7)*.

Blood examination gives the opportunity to investingate the presence of several metabolites and other constituents and helps detect conditions of stress, which can be nutritional, environmental or physical *(8,9)*.

Okab *et al.,* **(10)** concluded that rabbits during summer season suffer from heat stress causing deterioration in some physiological functions including feed intake, hematological constituents and biochemical parameters of blood plasma. These changes can be reflected in the performance of New-Zealand White rabbits under hot environmental conditions of Egypt.

The objective of this study was to investigate the bad effects of Egyptian hot humid climate on some physiological, hematological and biochemical responses of male New Zealand white rabbits.

MATERIALS AND METHODS

The present study was conducted in the private farm at Sharkia Governorate during the winter season (January and February) and during hot summer season (July and August) 2013.

The work aimed to study as effects of heat stress on growth performances, physiological traits and immunological function in male New Zealand White (NZW) rabbits.

Materials

Twenty growing males weaned at 7-8 weeks were used in the present study. The study included two periods; mild (from 1st January until the end of February) and hot (from the 1st of July until the end of August). The rabbits were divided into to equal and similar groups (10 each). The 1st group was used as a control and subjected to mild climate during winter, . While, 2nd group was exposed to hot climate during summer season.

Animals were fed the same diet during mild and hot periods. Drinking water was available *ad libitum* and the ingredients and chemical analysis of the commercial pelleted diet were as shown in Table 1&2. Chemical composition was done according to the Association of Official Analytical Chemists, *(11)*. The Rabbitry building was naturally ventilated through wired windows and provided with automatic controlled sided exhaustion fans.

Table 1. Ingredients of the commercial pelleted diet used during the experimental periods.

Ingredients	%
Wheat bran	27
Barley grain	30
Clover hay	18
Cotton seed meal (decort)	5
Soy bean meal	15
Molasses	3
Limestone	1.3
Sodium chloride	0.3
Dl- Methionine	0.10
Premix	0.3
Total	100

One kilogram of premix contain: vit. A 12000 000 IU, vit. D3 2200 00 IU, vit. E 1000 mg, vit. K3 2000 mg, vit. B1 1000 mg, vit. B2 4000 mg, vit. B6 100 mg, vit. B12 10 mg, pantothenic acid 3.33 g, biotin 33 mg, folic acid 0.83 g, choline chloride 200 g, Zn 11.79 g, Mn 5 g, Fe 12.5 g, Cu 0.5 g, I 33.3 mg, Se 16.6 mg and Mg 66.7 g.

Table 2. Chemical composition of diet of experimental growing New Zealand White rabbits

Item	DM	% On DM basis					
		OM	CP	EE	CF	NFE	ASH
Diet	91.26	91.05	18.23	2.54	12.17	57.16	9.25

Methods

Temperature humidity index (THI) was calculated using the equation of *(12)* as follows:

THI = db°C – [(0.31-0.31 RH) (db°C - 14.4)], where db°C = dry bulb temperature in Celsius and RH= relative humidity percentage/100. The THI values obtained were then classified as follow *(12)* : <27.8= absence of heat stress, 27.8 to < 28.9= moderate heat stress, 28.9 to <30.0 = severe heat stress and 30.0 and more = very severe heat stress.

Table 3. Air temperature, relative humidity, temperature-humidity index and length of natural daylight values during the experimental period (X ± S.E.)

Months and periods	Temperature (°C)	Relative humidity (%)	Temperature humidity index (THI)	Natural daylight length(h:m)
January 2013	14.6±0.9	53.5 ± 2.6	14.57	10:31
February 2013	16.2±0.6	50.0 ± 2.0	17.57	11:14
Overall mean	16.4±0.7	51.7 ± 1.2	16.10(Absence of heat stress)	11:12
July 2013	32.6±0.5	58.2±0.8	30.23	14:07
August 2013	34.6±0.4	55.6±1.5	31.78	13: 40
Overall mean	33.7±0.6	57.0±0.8	31.13 very severe heat stress	13:51

Productive performance

Feed consumption was recorded daily. Feed conversion was calculated as the amount of ration consumed for production of unit of body gain.

Live body weight was recorded weekly. Daily intake and water consumed calculated during the experimental period.

Daily body gain, relative and growth rate, were calculated for each rabbit according to the following equation.

Daily body gain = final body weight – initial body weight /period (days).

Relative growth rate= [final body weight – initial body weight/ (initial+ final)/2] ×100

Rectal temperature was measured by inserting thermocouple type k (2-3 cm) in the rectum for one minute. Respiration rates were determined by counting the frequency of flank movements/min. *(13)*.

Blood samples were collected at the end of the experiment in vacationer tubes and were centrifuged for 20 minutes at 3000 g to obtain plasma which was kept in a refrigerator (-20^{0}C) until blood analysis.

Blood samples with K3-EDTA anticoagulant were used for the determination of hematological parameters, i.e white blood cells (WBC), neutrophils, lymphocytes, monocytes, eosinophils, basophils, red blood cells (RBC), blood hemoglobin (Hg), hematocrit (Ht), platelets (PLT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC).

These parameters were assessed by Cell-DYN 3500 Hematology Analyzer (Abbott Diagnostic Division, Santa Clara CA). Recommended settings and calibration for rabbit hematology were applied according to the manufacturer's operation manual.

Concentrations of total protein, albumin, total lipids, triglycerides and cholesterol as well as activity of asprtate (AST) and alanine (ALT) transaminases were determinate in blood calorimetrically using commercial kits and spectrophotometer. However, concentration of globulin was computed by subtracting albumin from total protein concentration. Concentrations of thyroid hormones (T3 and T4) and cortisol were determinate according to *(14)* method. Concentrations total protein (g/dl) was measured according to *(15)*. However, concentration of globulin was computed by subtracting albumin from total protein concentration. Albumin (g/dl), total lipids (mg/dl), cholesterol (mg/dl) and high density lipoprotein (mg/dl) were estimated by *(16)*. Asprtate transaminases (AST), alanine transaminases (ALT), alkaline phosphatase (ALP) and acid phosphatase (ACT) (IU/dl) were determined according to *(17)*. Creatinine, uric acid and billrubin were determined enzymatically using commercially available kits. Sodium, potassium, calcium and phosphors were estimated by Atomic Absorption Apparatus.

The data were statistically analyzed using computer system according the following model;

$$Y_{ik} = \mu + P_i + e_{ik.,}$$

where μ= the overall mean; P_i = the fixed effect of climatic periods (1=mild and 2= hot; $_{i=1,2}$), and e_{ik} = random error.

Analysis of variance using the General Linear Model (GLM) was used to calculate the means of the studied traits using *(18)*.

RESULTS AND DISCUSSION

Effect of heat stress on

Growth performance and thermoregulation

Results in Table 4 show the effect of high environmental temperature of growing New Zealand White rabbits. Final body weight decreased significantly from 2794 to 2450 gm due to exposure to high ambient temperature in comparing with control group. Daily body gain decreased significantly by 20%, relative growth rate decreased by 16.4%, dry matter intake decreased by 14%, water intake increased significantly by 37%, feed efficiency decreased significantly by 26.0%, feed conversion increased significantly by 32% and rectal temperature increased significantly by 3%.

Marai and Habeeb *(19)* reported that high environmental temperatures stimulate peripheral thermal receptors to transmit suppressive nerve impulses to the appetite centre in the hypothalamus causing a decrease in rabbit feed intake. In addition, *(7)* found that the decreases in DMI in summer were 46.9% on Day 60, 65% on Day 90, and 44.4% on Day 120 of age compared with winter values.

The reduction in daily gain was due to a drastic decrease in rabbit total feed intake and in the feed conversion ratio, which might have led to less protein biosynthesis and less fat deposition *(10,20-22)*.

New Zealand White rabbits maintained under mild and hot climate have respiration rate of 63.3 and 123 RPM due to exposure to heat stress. Respiration rate increased significantly by 94 % after the exposure to hot climate. Rectal temperature (RT) and respiration rate (RR) are the most sensitive indices of heat tolerance among the physiological reactions studied *(23)*. The rectal temperature is considered as a good measure of core one and has been used by many investigators as an indicator for the response of animals to air temperature fluctuations *(24)*.

Habeeb *et al.*, *(25,26)* indicated that the increase in rectal temperature of the heat stressed rabbits may be due to either poor ability of the animals to prevent the rise in rectal temperature or to failure of the physiological mechanisms of animals to balance the excessive heat load caused by exposure to high ambient temperature.

Askar and Ismail, *(27)* evaluated the effect of heat stress throughout the first and second parities of NZW doe rabbits on some reproductive and physiological traits. Results obtained showed that high temperature caused a significant increase ($P<0.05$ or 0.01) in respiration rate; rectal temperature values (126.8 breaths/min., 39.6 °C, resp.) as compared with those maintained under comfort conditions (112.0 breaths/min, 38.5°C respiration).

Table 4. Effect of heat stress on growth performance of NZW male rabbits maintained under mild and hot conditions (X ± S.E.).

Items	Mild Climate (17±4) ^{0}C	Hot Climate (35±5) ^{0}C	Change (%)
Final body weight (g)	2794±51.6	2450±64.1	87.7**
Daily body gain (g)	31.6±0.86	25.2±1.34	80.0**
Relative growth Rate (%)	106±2.28	88.9±3.79	83.6**
Dry matter intake (g /day)	136±5.65	117±4.66	86.0**
Water intake (g /day)	478±7.54	659±9.16	137**
Feed efficiency (body gain /feed intake)	0.23±0.005	0.17±0.007	74.0**
Feed conversion (feed intake /body gain)	4.32±0.10	5.72±0.25	132**
Rectal temperature (^{0}C)	38.6±0.12	40.1±0.12	103**
Respiration Rate (RPM)	63.3±4.1	123±3.1	194**

**Significant at 0.01

Blood hematology

Results in Table 5 show the effect of high environmental temperature on blood hematology of growing New Zealand White Rabbits.

Red blood cells (RBCs) decreased significantly by 17%, hemoglobin decreased by 18 %, blood platelets decreased by 25%, Packed cell volume or hematocrit (PCV) decreased by 14.4 %, Mean cell volume (MCV) decreased by 9.3%, Mean cell hemoglobin (MCH) was decreased by 8.4%, Mean cell hemoglobin concentration (MCHC) decreased by 7.4% these results happened after the exposure to hot climate. These results are in agreement with the findings of ***(10,21,28,29)*** who reported that heat stress in mammals decreased in RBC counts, PCV, and Hb concentration. In addition, the depression of PCV during the hot season was also reported to be related to a reduction in cellular oxygen, a requirement for reducing metabolic heat production in order to compensate for the elevated environmental heat load.

Daader *et al.*, *(30)* showed that RBC counts, PCV and hemoglobin concentration decreases during heat stress due to depression of haematopoiesis and to haemodilution.

Table 5. Effect of heat stress on some blood hematology of growing NZW rabbits maintained under mild and hot climates (X ± S.E.)

Items	Mild Climate (17±4) ^{0}C	Hot Climate (35±5) ^{0}C	Change (%)
Red Blood Cells Count, RBC's (x10^6/μl)	6.16±0.08	5.11±0.09	83**
Hemoglobin Concentration(g/dl)	12.7±0.18	10.4±0.25	82**
Platelet Counts(x10^3/μL)	574±27.7	431±44.3	75 **
PCV or Hematocrit (%)	44.7±0.87	38.2±0.43	85.6**
Mean Cell Volume, (M.C.V.) (%)	78.5±2.12	71.2±1.34	90.7**
Mean Cell Hemoglobin, (M.C.H).(pg)	21.5±0.56	19.7±0.26	91.6**
Mean Cell Hb Conc.,(M.C.H.C)(g/dl)	28.5±0.76	26.4±0.62	92.6**

**Significant at 0.01

Immunological functions

Data in Table 6 show the effect of high environmental temperature on White blood cells of growing New Zealand White rabbits.

Total leukocyte decreased significantly by (25.5%), Neutrophils decreased by (39.4 %), lymphocytes decreased by (15.0%), Monocytes decreased insignificantly by (19.9 %), Eosinophils decreased insignificantly by (51.9 %), Basophiles decreased insignificantly from 0.08 to 0.00 x10^{3}due to exposure to high ambient temperature in comparing with control group.

Ondruska *et al., (29)* investigated the effect of heat stress (i.e., elevated ambient temperature (Ta; 36°C ± 3°C) on some hematological and biochemical parameters in different categories of gender and age of NZW rabbits. Animals were divided into two main groups (control and treatment). Results revealed that WBC counts were significantly decreased ($P < 0.05$) in the treatment group.

Kriesten *et al., (31)* observed that in the 28-day fetus, the WBCs (leukocyte) count was markedly lower (0.4 ± 0.1%) than in the doe. although in another report, observed by Bartolotti *et al., (32)* WBC counts in the day-29 fetus were significantly elevated (19.0 ± 8.1 X 103/ul).

Table 6. Immunological function of growing NZW rabbit's responses to exposure to hot climate under Egyptian Conditions (X ± S.E.)

Items	Mild Climate (17±4) ^{0}C	Hot Climate (35±5) ^{0}C	Change (%)
Total Leucocytic Count, (WBC's x10^3/μL)	12.9±0.44	9.54±0.35	74.5**
Neutrophils (x10^3/μL)	5.02±0.24	3.04±0.18	60.6**
Neutrophils Band (Staff) x10^3/μL	0.50±0.02	0.31±0.02	62.0**
Neutrophils Segmented x10^3/μL	4.53±0.25	2.72±0.16	60.0**
Lymphocytes (x10^3/μL)	6.71±0.26	5.70±0.24	85.0**
Monocytes (x10^3/μL)	0.50±0.39	0.40±0.03	80.1 NS
Eosinophils (x10^3/μL)	0.54±0.11	0.26±0.02	48.1 NS
Basophils (x10^3/μL)	0.08±0.01	0.00±0.00	0.00 NS

NS Not significant **Significant at 0.01

Some blood biochemical changes, adrenal and thyroid gland functions

Data in Table 7 show the effect of high environmental temperature on some blood metabolites changes of growing New Zealand White rabbits. Glucose decreased significantly by 22%, total protein decreased by 16.0%, albumin decreased by 19.3%, globulin decreased by 12.6%, A/G ratio decreased by 20.7 %, total lipids decreased by 33.1%, Cholesterol decreased by 21.8%, triglycerides decreased insignificantly by 27.5 % after the exposure to hot climate.

These results were similar to obtained by *(25,33-35)* and disagreed with *(36)*.

Ibrahim (37) showed that the plasma total proteins, albumin and globulin contents is affected by the environmental temperature, total proteins, albumin and globulin decreased between winter and summer. Serum total proteins, albumin and globulin concentrations were slightly higher, without significant difference between summer and winter. Similarly with the previous results, *(20)* showed that Serum total protein, albumin and globulin decreased significantly in summer than in winter.

Cortisol decreased significantly by 28.1%, Triiodothyronine T_3 decreased by 26.2%, Thyroxine T_4 decreased significantly by 22.3% after the exposure to hot climate. The present results were similar to those reported by *(38)*.

Table 7.Effect of heat stress on some blood biochemical changes, Adrenal and thyroid gland functions of growing NZW rabbits(X ± S.E.)

Items	Mild Climate (17±4) ^{0}C	Hot Climate (35±5) ^{0}C	Change (%)
Glucose (mg/dl)	88.0±3.13	68.6±2.41	78.0**
Total protein (g/dl)	7.78±0.11	6.55±0.05	84.0**
Albumin (A) (g/dl)	3.47±0.12	2.80±0.14	80.7**
Globulin (G) (g/dl)	4.35±0.12	3.80±0.13	87.4**
A/G ratio (g/dl)	0.87±0.07	0.69±40.0	79.3**
Total lipids (mg/dl)	435±9.42	291±26.0	66.9**
Cholesterol (mg/dl)	123±4.06	95.9±2.60	78.2**
Triglycerides (mg/dl)	109±4.44	79.0±4.18	72.5**
Cortisol (µg/dl)	2.28±0.09	1.64±0.17	71.9**
Triiodothyronine(T3) (ng/dl)	141±8.75	104±0.91	73.8**
Thyroxine(T4) (µg/dl)	5.83±0.13	4.53±0.03	77.7**

**Significant at 0.01

Liver functions and kidney functions

Data in Table 8 administrate that the effect of high environmental temperature on liver functions and kidney functions of growing New Zealand White rabbits.

Alkaline phosphates decreased significantly by 18.4%, Creatinine decreased by 22.4%, Acid phosphatase decreased by 33.3%, Alanine aminotransferase decreased by 21.3%, Aspartate aminotransferase decreased by 26.9%, Uric acid decreased by 34.1%, Billrobin decreased by 23.8 %, Sodium decreased by 19.3%, Potassium decreased by 21.2 %, Calcium decreased by 32.6 %, Phosphorus decreased by 19.7% these effects due to exposure to high ambient temperature in comparing with control group. These results were similar to those reported by *(39)*.

El-Maghawry *et al., (40)* observed that The AST and ALT are dependent on the amino acid groups of alanine and glutamine taken up by the liver and reflect the changes in the liver metabolism associated with glucose synthesis. Aspartate aminotransferase activity was not significantly affected by the season. But, Alanine aminotransferase (ALT) activity was significantly (P<0.01) decreased during the summer season. The overall mean values of ALT during spring were 84.3 ± 2.94 IU/L compared with 65.7 ± 2.63 IU/L during summer *(10)*.

Serum creatinine concentration increased significantly in rabbits reared under summer than in those reared under winter season conditions *(35)*. Soliman et al., *(41)* showed that the increase in creatinine may indicate changes in kidney function Thus, the negligible increase in creatinine shows insignificant changes in kidney functions during both seasons.

Table 8. Effect of heat stress on Liver and Kidney functions of growing NZW rabbits (X ± S.E.)

Items	Mild Climate $(17\pm4)\ ^0C$	Hot Climate $(35\pm5)\ ^0C$	Change (%)
Alkaline phosphatase(ALP) u/l	91.4±2.60	74.6±1.07	81.6**
Acid phosphatase (ACP) u/l	0.33±0.01	0.22±0.01	66.7**
Alanine aminotransferase (ALT) u/l	77.0±3.51	60.6±1.67	78.7**
Aspartate aminotransferase (AST) u/l	85.0±4.31	62.1±1.81	73.1**
Total Billrobin (mg /dl)	0.42±0.23	0.32±0.25	76.2**
Creatinine (mg /dl)	1.47±0.27	1.14±0.57	77.6**
Uric acid (mg /dl)	0.41±0.31	0.27±0.38	65.9**
Sodium (mmol/l)	171±7.70	138±1.27	80.7**
Potassium (mmol/l)	6.28±0.17	4.95±0.12	78.8**
Calcium (mg/dl)	18.4±0.55	12.4±0.30	67.4**
Phosphorus (mg/dl)	10.9±0.38	8.75±0.32	80.3**

**Significant at 0.01

Generally, exposing the mammals to hot humid climate or to heat stress conditions resulted in a significant impaired of growth performances. The decrease in growth traits may be attributed to the following physiological, immunological and biochemical responses:

The significant decrease in feed consumption and efficiency and the significant increase in water consumption and consequently negative energy, protein, minerals and vitamins balances (Table, 4). 2- The disturbances in normal thermoregulation as observed by increasing each of rectal temperature and respiration rate significantly (Table, 4). 3- The disturbances in normal hematological function as observed in a significant decrease in each of RBC,s; HP; Platelets; PCV; MCV; M.C.H; M.C.H.C. (Table, 5). 4- The impairment of immunological functions as indicated by decreasing of total WBC,s; Neutrophils (band and segmented); Lymphocytes; Monocytes; Eosinophils and Basophils (Tables, 6).

The significant decrease in blood total protein, albumin and globulin (Table, 7), also may be due to the disturbances of normal immunological functions of the heat stressed rabbits. 5- Decreasing blood metabolites such as glucose, total protein, albumin, globulin, total lipids, cholesterol and triglycerides (Table, 7). 6- The significant decrease in adrenal and thyroid glands activities as observed by decreasing blood cortisol ,T3 and T4 hormone concentration (Table ,7). 7- Decreasing liver functions as showed by the significant decrease of ALP; ACP; ALT, AST enzymes and bilrobin (Table,8). 8- Kidney functions, as well as, impaired significantly as found by the significant decrease in each of blood creatinien, uric acid, sodium, potassium, calcium and phosphorus (Table, 8).

It can be concluded that, heat stress conditions impaired , growth performance due to the disturbances in normal physiological, immunological and biochemical functions of animal body and the modification of the hot environmental conditions may reduce animal heat production and increase its heat loss and help in keeping the animal within or near to the range of thermoneutral state. Alleviation of heat load on animals can be achieved by providing suitable feeding, housing, management and employing techniques (physical, physiological, nutritional and managerial) to modify environmental conditions. As well as, using genetic improvement techniques such as artificial insemination, gene engineering and embryo transfer may be used to alleviate heat stress conditions.

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الملخص العربي

تأقلم الأرانب النيوزلندي البيضاء النامية للمناخ الحار تحت ظروف مصر

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أجريت هذه الدراسة بمزرعة خاصة علي مرحلتين الأولي في الشتاء خلال شهري يناير وفبراير والثانية صيفا خلال شهري يوليو و أغسطس وقد أجريت التجربة علي الأرنب النيوزلندي الأبيض.

الهدف من البحث هو دراسة وتشخيص الآثار الضارة للعبء الحراري علي الخصائص الإنتاجية والفسيولوجية والمناعية والبيوكميائية

أستخدم في هذه الدراسة عشرون أرنب نامي قسمت الي مجموعتين متشابهتين ومتساويتين عرضت المجموعة الأولي الي المناخ المعتدل تحت ظروف الشتاء واعتبرت مجموعة مقارنة بينما وضعت المجموعة الثانية تحت ظروف العبء الحراري صيفا.

تم قياس دليل الحرارة والرطوبة خلال شهر يناير و حتى نهاية شهر فبراير وكان دليل الحرارة والرطوبة داخل الغرفة هو(١٦,١) مما يعني أن الحيوانات كانت لا تتعرض لتأثير إجهاد حراري واستخدم في هذه التجربة عشرة أرانب ذكور نامية بمتوسط وزن ٨٢٦ جم وعند عمر ٦-٧ أسابيع .

أما في التجربة الثانية تحت ظروف الجو الحار ما يقرب من ستون يوما ابتداءً من شهر يوليو حتى نهاية شهر أغسطس وكان متوسط دليل الحرارة والرطوبة خلال هذه الفترة داخل الغرفة هو(٣١,١٣) مما يعنى أن الحيوانات كانت معرضة لتأثير الإجهاد الحراري واستخدم في هذه المرحلة عشرة أرانب نامية ذكور بمتوسط وزن ٩٣٥جم وعند عمر ٦-٧ أسابيع .

ويمكن تلخيص أهم النتائج فيما يلي:

أدي تعريض الأرانب النامية إلي المناخ الحار صيفا إلي حدوث انخفاض معنوي في كل من وزن الجسم الحي (١٢،٣ %) ومعدل الزيادة اليومية (١٦،٤%) و وكمية الغذاء المستهلك (١٤%) و نسبة كرات الدم الحمراء (١٧%) وتركيز الهيموجلوبين (١٨%) والصفائح الدموية (٢٥%)، كما قلت نسبة كلا من PCV (١٥%) و MCV (٩،٣%) وMCH (٨،٤%) و MCHC (٧،٤%) كما تأثرت كرات الدم البيضاء حيث قلت نسبة كريات الدم البيضاء (٢٥،٥%) خلال فترة الجو الحار حيث قلت الخلايا المتعادلة (٣٩,٤%)و الخلايا اللمفية (١٥%) والخلايا الأحادية (١٩,٩%) .

وتأثرت أيضا تركيزات بعض التغيرات البيوكميائية في الدم حيث انخفضت نسبة الجلوكوز (٢٢%) في الدم بشكل ملحوظ كذلك أنخفض تركيز البروتين (١٦%) والألبومين (١٩،٣%) والجلوبيولين (١٢،٦%) .

وتأثرت أيضا الليبدات الكلية (٣٣،١%) والكولستيرول (٢١،٨%) والدهون الثلاثية (٢٧،٥%) حيث أنخفض تركيز هم في الدم بشكل كبير .

كما تأثرت وظائف الغدة الدرقية والكظرية حيث انخفضت نسبة تركيز الكورتيزول (٢٨،١%) وكذلك هرمون T_3 (٢٦،٢%) وهرمونT_4 (٢٢،٣%). كذلك تأثرت وظائف الكبد حيث قل تركيز أنزيم الفوسفاتيز القاعدي (١٨،٤%) والفوسفاتيز الحمضي (٣٣،٣%) و قل أيضا تركيز **Alanine aminotransferase**(٢١،٣%) و **Aspartate aminotransferase** (٢٦،٩%) كما تأثرت وظائف الكلية حيث انخفضت نسبة الكرياتينين (٢٢،٤%) و حمض اليوريك (٣٤،١%) والبيليروبين الكلي (٢٣،٨%) كما انخفضت أيضا بعض المعادن مثل الصوديوم (١٩،٣%) والبوتاسيوم (٢١،٢%) والكالسيوم (٣٢،٦%) والفسفور (١٩،٧%).

التعرض للعبء الحراري أدي إلي زيادة معنوية في كلا من درجة حرارة المستقيم (٣%) وزيادة معدل التنفس (٩٤%) وزيادة كمية الماء المستهلك (٣٧%) ومعامل التحويل الغذائي (٣٢%) . نستنتج مما سبق أن التعرض للمناخ الحار يتسبب في انخفاض الصفات الإنتاجية معنويا نتيجة الخلل الناشئ عن اختلال الاتزان الحراري والمائي وكذلك الضرر الناجم في وظائف الغدة الدرقية والكظرية ووظائف الكبد ووظائف الكلي واختلال عملية التمثيل الغذائي في الجسم وكذلك ضعف جهاز المناعة.

ولذلك لابد من إتباع الأساليب المختلفة لتخفيف الآثار الضارة للعبء الحراري من اجل تحسين الخصائص الإنتاجية والفسيولوجية والمناعية.