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PHYSIO-BIOCHEMICAL CHANGES AND HISTOLOGICAL STATUS OF THE HEAT -STRESSED RABBIT BUCKS AND ITS AMELIORATION USING VITAMIN E AND SELENIUM UNDER EGYPTIAN CONDITION

By

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Abstract: *Forty New-Zealand White (NZW) rabbit bucks were used. In the summer season, heat – stressed rabbit bucks were divided into four groups (10 each). The first group was kept as control group. The second, third and fourth groups (treated), were injected intramuscularly with vitamin E (100 IU/head), selenium (0.1 mg/kg body weight) and selenium plus vitamin E weekly at the same dose of the previous groups, respectively. Body thermoregulation, blood haematology and blood components of the summer heat- stressed rabbit bucks (control group) and treated with Vit. E or Se and Vit. E plus Se, were recorded. Histological status of the liver and kidney, were also observed.*

The results showed that, rectal temperature was significantly ($P<0.05$) lower, while ear lobe temperature and skin temperature were insignificantly lower of the summer heat-stressed NZW bucks injected with Vit. E or Se alone and Vit. E plus Se than the control group, whereas respiration rate was significantly ($P<0.05$) lower with the bucks injected by Vit. E plus Se. Haemoglobin concentration (Hb), percentage of packed- cell volume (PCV), red blood cells (RBC's) and white blood cells (WBC's) were significantly ($P<0.05$) higher of the summer heat–stressed NZW bucks injected with Vit. E alone or Vit. E plus Se than those injected with Se alone and the control group. Total protein and albumin concentrations in the blood plasma were significantly ($P < 0.05$) lower of the summer heat-stressed rabbit bucks (control group) and injected with Se alone than those injected with Vit. E alone or Vit. E plus Se. Globulin and urea- N concentrations were significantly ($P<0.05$) lower of the summer heat–stressed NZW bucks injected with Vit. E alone or Vit. E plus Se than those injected with Se alone and or control group. Cholesterol concentration was

significantly (P<0.05) lower of the summer heat–stressed NZW bucks injected with Vit. E or Se alone and Vit. E plus Se than the control group. However, creatinine and total lipids concentrations were significantly (P<0.05) higher of the summer heat-stressed rabbit bucks injected with Vit. E plus Se than those injected with Vit. E or Se alone and the control group. Testosterone concentration was significantly (P<0.05) higher, while cortisol concentration was significantly (P<0.05) lower of the summer heat–stressed NZW bucks injected with Vit. E or Se alone and Vit. E plus Se than the control group. Sodium concentration was significantly (P<0.05) higher, while potassium, calcium and total phosphorus concentrations were significantly (P<0.05) lower of the summer heat-stressed rabbit bucks (control group) than those injected with Vit. E or Se alone and Vit. E plus Se. Aspartate-aminotransferase (AST) and alanine- aminotransferase (ALT) activities were significantly (P<0.05) higher of the summer heat- stressed NZW bucks (control group) and injected with Se alone than those injected with Vit. E alone and Vit. E plus Se. Acid phosphatase (ACP) and alkaline phosphatase (ALP) activities were significantly (P<0.05) higher of the summer heat- stressed NZW bucks (control group) than those injected with Vit. E or Se alone and Vit. E plus Se, however, lactic dehydrogenase (LDH) activity was insignificantly higher. Histological status of the liver and kidney of the summer heat–stressed NZW bucks injected with Vit. E or Se alone and Vit. E plus Se were improved as compared to the control group.

INTRODUCTION

The thermal stress influence both animal welfare and the yield and quality of products. In fact, rabbits can be considered as one of the several emerging species quite suitable for meat production (Rostogi, 2001).

Blood components are the mirror which reflects the healthy condition of animals. So, the biochemical studies under different fluctuating climatic conditions are very important for clinicians in the field during interpretation of their findings. Minerals and trace elements has long been known to be important in animal nutrition as they may be dietary essential and vital to enzyme process of living cells or have some metabolic activity. They are also essential for bone formation, reproductive performance and hoemopoiesis. In addition, enzymes are the key molecules for cellular functions such as energy production, membrane transport and metabolism. On the other hand, the spermatozoon is the result of a complex process of cellular differentiation. During this process, morphofunctional modifications occur based on biochemical and cytochemical changes (Baccetti, 1972). This phenomenon involves the participation of several enzymes, including phosphatases.

Diet supplemented with 240 mg diet of vitamin E decreased saturated fatty acid of rabbit's muscles and liver (Tava *et al.,* 2002). Hullar *et al.* (1996) found that rabbit diet containing Se improved glutathione-peroxidase (GSH-Px) activity by 20-50%, changes in GSH –Px improved body's immunity against free radicals. Also, combination of vitamin E and Se have a synergistic effect on enhancement of cell-mediated immunity in rabbit (Liu, 1988).

The present study aimed to investigate the effects of selenium and vitamin E on body thermoregulation, blood haematology, blood components and histological status in the liver and kidney of the heat- stressed rabbit bucks, under Egyptian hot summer conditions.

MATERIALS AND METHODS

The present study was carried out in the Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Sharkiya Province, Egypt (30^{o} N). Forty mature NZW rabbit bucks (3.0-3.5 kg of body weight, 12 months of age), were used in the present work. The rabbit bucks were healthy and clinically free of external and internal parasites and were raised in flat deck batteries with universal specifications. The batteries were accommodated with feeders and automatic fresh water drinkers and were efficient for hygienic control. Feeding was carried out according to **NRC (1977)**, recommendations. Mean values of air temperatures, percentages of relative humidity, temperature-humidity index (THI) and length of daylight (hrs) in the Rabbitry during the experimental period are shown in Table 1.

The temperature–humidity index (THI) was estimated according to Livestock and Poultry Heat-Stress Indices, Agricultural Engineering Technology Guide, Clemson University, Clemson SC 29634, USA, using the following formulae: THI=db ^{o}F- (0.55–0.55 RH) (db ^{o}F- 58.00), where: db ^{o}F = dry bulb temperature in Fahrenheit and RH = relative humidity (RH% ÷ 100). The obtained values of THI were classified as follows: less than 82 = absence of heat-stress, 82 to < 84 = moderate heat –stress, 84 to <86 = severe heat- stress and over 86 = very severe heat – stress.

The rabbit bucks were divided into four groups (10 each) nearly equal in average 3.0–3.5 kg of the body weight. The first group was kept as control. The bucks in the second, third and fourth groups (treated) were injected intramuscularly with vitamin E (100 IU/ kg body weight /week as dl-α tochopherol acetate: Cairo Company for Medicine) dissolved in soybean oil, selenium (0.1mg selenium/kg body weight/week as sodium

selenite) and selenium plus vitamin E at the same dose of the previous groups, respectively.

Rectal temperature, ear lobe temperature, skin temperature and respiration rate were measured at 12.00 a.m. three times weekly during the experimental period. Rectal temperature was obtained gently by inserting the clinical thermometer for 2-3 cm in the rectum for two minutes. Skin temperature (between neck and loin, medial dorsal surface) was measured from one location on the body surface. The thermometer was fixed on the bare skin and on fur which was combed back into place by finger. Ear lobe (in the central area of auricle) temperature was measured by a clinical thermometer. The thermometer was placing into direct contact with the central area of the auricle. Respiration rate was determined by counting the frequency of flank movements per one minute. All possible precautions were taken in consideration to avoid disturbing the animals, including counting the respiration breaths just before measuring the body temperature.

Blood samples were collected from marginal ear vein under vacuum in heparinized tube once a week for 10 weeks. At each collection, 3-5 ml of blood was drained. Blood samples were divided into two portions. The first portion was immediately centrifuged at 600*g* for 15 minutes and plasma was then separated and stored at-20^{o}C for assaying of total protein, albumin, globulin, total lipids, creatinine, cholesterol, urea-N, AST, ALT, ALP, ACP, LDH, sodium, potassium, calcium, total phosphorus, testosterone and cortisol concentrations. The second portion was taken to determine haemoglobin (g/dl), packed- cell volume (%), red blood cells (x10^6/mm^3) and white blood cells (x10^3 mm^3).

Total proteins were determined colourimeterically according to Biuret method as described by Henry (1964) which based on copper in alkaline solution react with the peptide bonds in proteins producing a violet colour which proportional to the amount of proteins present. Albumin level was determined colourimetrically according to Doumas *et al.* (1971). Globulin level was calculated by subtracting the values of the total protein from albumin values. Total lipids concentration (mg/100ml) was estimated according to Schmit (1964). Cholesterol was determined using a very sensitive and rapid colourimetric technique which had been described by Bogin and Keller (1987). Creatinine and urea- N assayed colourimetrically according to the method described by Brood and Sirota (1948) and Caraway (1963), respectively.

Aspartate-aminotransferase (AST), alanine-aminotransferase (ALT) activities were determined using the method described by Reitman and

Frankle (1957). Alkaline phosphatase (ALP), acid phosphatase (ACP) and lactic dehydrogenase (LDH) activities were determined colourimeterically using commercial kits purchased from Bio- Merieux (Marey L'Eptoile, Charbonnieres, Les Bains, France) according to Graham and Pace (1967).

Total phosphorus, sodium, potassium and calcium concentrations in the blood plasma were determined colourimetrically according to the method described by Kuttner and Liechtenstein (1930), Trinder (1951), Sunderman Jr and Sunderman (1958) and Gindler (1972), respectively.

Testosterone and cortisol hormones were determined by Radioimmunoassay Technique (RIA) of Coat- Ab- Count Kits (Diagnostic Products Corporation–Los Angles, USA) according to Abraham (1977).

Haemoglobin concentration was determined in fresh blood samples using haemoglobinometer as the method described by Tietz (1982). Blood was withdrawn by packed-cell volume (PCV) capillary tube and centrifuged at 600 *g* for 15 minutes. PCV value (%) was read and recorded directly according to Winterobe (1965). Red blood cell's (RBC's) and white blood cell's (WBC's) were counted in fresh blood sample as the method described by Hawkey and Dennett (1989) using haemocytometer and counted at 400 X objective of a phase contrast microscope.

After slaughter, five randomly samples of the liver and kidney in each group were taken for histological studies. The samples were fixed in Bouins solution, dehydrated in ascending grades of ethyl-alcohol, cleard and embedded in paraffin – wax. Thereafter, the samples were sectioned at 5 microns thickness and stained with haematoxylin and stained with eosin then examined using 400 X objective of a phase contrast microscope.

Data were subjected to analysis of variance according to Snedecor and Cochran (1982). Percentage values were transformed to arc-sin values before being statistically analyzed. Duncan's new multiple range test was used for the multiple comparisons (Duncan, 1955).

RESULTS AND DISCUSSION

Temperature- humidity index (THI):

The temperature-humidity index (THI) estimated in Table 1 indicated exposure of the rabbit bucks to severe heat- stress during summer season.

Body thermoregulation:

Table 2 shows that, the effect of the hot summer season on the rectal temperature of the heat- stressed NZW rabbit bucks injected with Vit. E, or Se alone and Vit. E plus Se was significantly ($P<0.05$) lower and significantly ($P < 0.05$) lower in respiration rate with that injected by Vit. E plus Se, while skin temperature and ear lobe temperature was insignificantly lower than the control group. The highest ($P<0.05$) values of the rectal temperature and respiration rate of the summer heat-stressed NZW bucks were recorded in the control group and the lowest ($P<0.05$) value of the heat – stressed NZW bucks injected with Vit. E plus Se. The lowest values of the ear lobe temperature and skin temperature were recorded of the summer heat-stressed rabbit bucks injected with Vit. E plus Se and the highest value was recorded with the control group. Similar trends were reported by Zeidan *et al.* (2001) and Ghoname (2004). Bedmorek *et al.* (1996) and Hamdy and El-Malt (2000) who reported that selenium has beneficial effect on thyroid hormones metabolism and immunity and consequently improved the biological effect of the physiological traits in the heat-stressed bucks. Furthermore, Vit. E interacts with Se to prevent the oxidative breakdowen of cell membranes associated with the hydroproxides of polyunsaturated fatty acids. Gore and Qureshi (1997) and Hamdy and El-Malt (2000) also reported that Vit. E interacts with Se to protect tissue membranes from lipid peroxidation caused by free radical attack.

The change rate of the rectal temperature, skin temperature, ear lobe temperature and respiration rate of the summer heat-stressed NZW bucks injected with Vit. E or Se alone and Vit. E plus Se was insignificantly negative difference. Similar trends were recorded by Ghoname (2004).

Blood haematology:

Table 3 shows that, haemoglobin (Hb) concentration and percentage of packed-cell volume (PCV) were significantly ($P<0.05$) higher of the summer heat-stressed NZW rabbit bucks injected with Vit. E alone or Vit. E plus Se than those injected with Se alone and the control group. The highest ($P<0.05$) values of the haemoglobin concentration and percentage of PCV were recorded with the summer heat-stressed rabbit bucks injected with Vit. E plus Se and the lowest ($P<0.05$) value was recorded with the control group. These results are in agreement with those obtained by Hassanein *et al.* (1995) who found that Vit. E supplementation improved haemoglobin value by 70% and PCV percentage by 8.6%. Meshreky and Abbas (2000) found also that injected of NZW rabbit bucks with Vit. E alone or Vit. E plus Se increased significantly haemoglobin by 9.2 and 10.7%, respectively than the

control group. Ghoname (2004) found also that rabbit bucks injected with Vit. E plus Se had higher ($P<0.05$) haemoglobin value during the summer season. These results may be due to the activity of animals, since the males are more active in changing body position than females that may lead to increase in heat loss by radiation, conduction or convection.

Significantly ($P<0.01$) positive change rates were recorded in the haemoglobin concentration and percentage of PCV of the summer heat-stressed of NZW rabbit bucks injected with Vit. E alone or Vit. E plus Se, while rabbit bucks injected with Se alone was insignificantly positive difference.

Red blood cells (RBC's) and white blood cells (WBC's) was significantly ($P< 0.05$) higher of the summer heat-stressed NZW rabbit bucks injected with Vit. E alone or Vit. E plus Se than those injected with Se alone or the control group. The highest ($P<0.05$) values of the RBCs and WBC's were recorded with the summer heat-stressed rabbit bucks treated by Vit. E plus Se and the lowest ($P<0.05$) value was recorded with the control group.

Significantly ($P<0.05$ or 0.01) positive change rates in the RBC's and WBC's count were recorded with the summer heat-stressed NZW rabbit bucks injected with Vit. E alone and Vit. E plus Se, while WBC's count in the rabbit bucks injected with Se alone was insignificantly positive difference.

Blood components:

Table 4 shows that, total protein, albumin, creatinine and total lipids concentrations were significantly ($P<0.05$) higher of the summer heat-stressed NZW rabbit bucks injected with Vit. E plus Se than those injected with Vit. E or Se alone and control group. The highest ($P < 0.05$) values of each of total protein, albumin, creatinine and total lipids concentrations were recorded of the summer heat-stressed rabbit bucks injected with Vit. E plus Se and the lowest ($P<0.05$) values were recorded for the rabbit injected with Vit. E or Se alone and the control group. These results are in agreement with those obtained by Zeidan *et al.* (2000) and Meshreky *et al.* (2002) they found that NZW and Cal rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se improved significantly ($P<0.01$) total protein. Similarly, El-Husseiny *et al.* (1997) and Abd El-Kariem *et al.*(2002) showed that total protein was significantly ($P<0.05$) higher in the rabbit bucks injected with Vit. E.

Significantly (P<0.01) positive change rates were recorded for the total protein and albumin concentrations of the summer heat-stressed NZW rabbit bucks injected with Vit. E alone and Vit. E plus Se, while rabbit bucks injected with Se alone was insignificantly positive difference. Significantly (P < 0.05 or 0.01) positive change rates were recorded in the total lipids concentration of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se. Significantly (P<0.01) negative change rates were recorded in the creatinine concentration of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and significantly (P<0.01) positive with Vit. E plus Se.

Globulin concentration was significantly (P<0.05) lower of the summer heat-stressed NZW rabbit bucks injected with Vit. E alone or Vit. E plus Se than those injected with Se alone and the control group. The highest (P< 0.05) value of the globulin concentration was recorded of the summer heat-stressed rabbit bucks (control group) and injected with Se alone and the lowest (P<0.05) value with Vit. E plus Se. These results are in agreement with those obtained by Zeidan *et al.* (2000) and Meshreky *et al.* (2002). Similarly, Abd El-Kariem *et al.* (2002) found that globulin concentration was significantly (P < 0.05) higher in the male rabbits injected with Vit. E alone.

Significantly (P<0.01) negative change rates were recorded in the globulin concentration of the summer heat-stressed NZW rabbit bucks injected with Vit. E alone and Vit. E plus Se, while insignificantly negative difference with Se alone.

Urea- N concentration was significantly (P<0.05) higher of the summer heat-stressed NZW rabbit bucks injected with Se alone and the control group than those injected with Vit. E alone or Vit E plus Se. The highest (P<0.05) value of the urea – N concentration was recorded with the summer heat- stressed rabbit bucks in the control group, while the lowest (P<0.05) value with the bucks injected with Vit. E alone or Vit. E plus Se.

Significantly (P<0.05 or 0.01) negative change rates were recorded in the urea-N concentration of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se.

Cholesterol concentration was significantly (P < 0.05) lower of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se than the control group. The highest (P<0.05) value of the cholesterol concentration was recorded with the control group and the lowest (P<0.05) value with the bucks injected with Vit. E plus Se. These results may be attributed to the higher utilization of cholesterol for synthesis

of sex steroids. These results are in agreement with those obtained by Sommer (1996) and Meshreky *et al.* (2002) they found that rabbits injected by Vit. E plus Se, Vit. E or Se alone decreased plasma cholesterol level during the hot summer season. However, Shetaewi (1998) showed that serum cholesterol levels of the rabbit bucks increased with Vit. E injection.

Significantly ($P<0.01$) negative change rates were recorded in the cholesterol concentration of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se.

Testosterone concentration was significantly ($P<0.05$) higher of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se than the control group. However, cortisol hormone concentration was significantly ($P<0.05$) lower of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se than the control group. The highest ($P<0.05$) value of the testosterone hormone concentration was recorded with the summer heat-stressed rabbit bucks injected with Vit. E plus Se and the lowest ($P<0.05$) value was recorded with the control group. However, the lowest ($P<0.05$) value of the cortisol concentration was recorded with the summer heat-stressed rabbit bucks injected with Vit. E plus Se and the highest ($P<0.05$) value was recorded with the control group. These results are in agreement with those obtained by Zeidan *et al.* (2001) and Ghoname (2004). Behne *et al.* (1991) reported that selenium is necessary for the biosynthesis of testosterone and the production and normal development of the rats spermatozoa. Selenium may have an effect directly on the interstitial cells of testes or indirectly via its effect on the anterior pituitary hormone secretion.

Significantly ($P<0.01$) positive change rates were recorded in the testosterone hormone concentration of the summer heat –stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se. However, significantly ($P<0.01$) negative change rates were recorded in the cortisol hormone of the summer heat-stressed rabbit NZW bucks injected with Vit. E or Se alone and Vit. E plus Se.

Table 5 shows that, sodium concentration was significantly ($P<0.05$) higher of the summer heat-stressed NZW rabbit bucks (control group) than those injected with Vit. E or Se alone and Vit. E plus Se. However, potassium, calcium and total phosphorus concentrations were significantly ($P<0.05$) lower of the summer heat-stressed NZW rabbit bucks (control group) than that injected with Vit. E or Se alone and Vit. E plus Se. The highest ($P < 0.05$) value of sodium concentration was recorded with the summer heat-stressed rabbit bucks (control group) and the lowest ($P< 0.05$)

value with rabbit bucks injected by Vit. E plus Se. However, the highest ($P<0.05$) values of potassium, calcium and total phosphorus concentrations were recorded with the summer heat-stressed rabbit bucks injected with Vit. E alone and Vit. E plus Se and the lowest ($P < 0.05$) value with the control group.

Significantly ($P<0.01$) negative change rates were recorded in sodium concentration of the summer heat-stressed NZW rabbit bucks injected with Vit. E alone or Vit. E plus Se, while insignificantly negative differences with the rabbit bucks injected with Se alone. However, significantly ($P<0.01$) positive change rates were recorded in potassium, calcium and total phosphorus concentrations of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se.

Aspartate– aminotransferase (AST) and alanine- aminotransferase (ALT) concentrations were significantly ($P<0.05$) higher of the summer heat-stressed NZW rabbit bucks (control group) and injected with Se alone than those injected with Vit. E alone or Vit. E plus Se (Table 5). The highest ($P<0.05$) values of the AST and ALT concentrations were recorded of the summer heat-stressed rabbit bucks (control group) and the lowest ($P<0.05$) value with the rabbit injected with Vit. E plus Se. These results are in agreement with those obtained by Chicricato *et al.* (2000), Meshreky *et al.* (2002) and Ghoname (2004).

Significantly ($P<0.01$) negative change rates in the AST or ALT concentrations were recorded of the summer heat-stressed NZW rabbit bucks injected with Vit. E alone or Vit. E plus Se, while insignificantly negative difference with the bucks injected with Se alone.

Alkaline phosphatase (ALP) and acid phosphatase (ACP) concentrations were significantly ($P<0.05$) higher of the summer heat-stressed NZW rabbit bucks (control group) than those injected with Vit. E or Se alone and Vit. E plus Se. The highest ($P < 0.05$) values of the ALP and ACP concentrations were recorded of the summer heat-stressed rabbit bucks (control group) and the lowest ($P<0.05$) value with that injected with Vit. E plus Se.

Significantly ($P < 0.01$) negative change rates were recorded in the ALP and ACP concentrations of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se.

Lactic dehydrogenase (LDH) concentration was insignificantly higher of the summer heat-stressed NZW rabbit bucks (control group) than those injected with Vit. E or Se alone and Vit. E plus Se. The highest value

of the LDH concentration was recorded of the summer heat-stressed rabbit bucks (control group) and the lowest value of the rabbit bucks injected with Vit. E plus Se.

Insignificantly negative change rates were recorded in the LDH concentration of the summer heat-stressed NZW rabbit bucks injected with Vit. E or Se alone and Vit. E plus Se.

Histological status of the liver and kidney:

In the hot summer after the intramuscular injection of the Vit. E (Plate 1), Se (Plate 2) and Vit. E plus Se (Plate 3), there are slightly and mild improvement of the liver compared with that in the summer without any treatment (Plate 4). It was observed that the liver of the rabbit treated with Se only, showed, empty central vein, lymphocyte cells around the central vein and cell nucleus very obvious and appears active. So that, the liver of the rabbit after treatment by Vit. E and Se shows that the central vein was empty, hepatocytes appears good and arranged in rows, but the hepatocyte lies around the portal vein was slightly congested and the hepatic sinusoids were enlarged (Ghoname, 2004). So, the liver severely affected by the Vit. E, but slightly affected by Se. So, the Se decreases the effect of Vit. E when given together in compare with the normal liver in the summer (Plate 4).

In the hot summer after the intramuscular injection of the Vit. E (Plate 5), Se (Plate 6) and Vit. E plus Se (Plate 7) there is slightly and mild improvement of the kidney compared with that in the summer without any treatment (Plate 8). In the summer, the kidney treated by Vit. E, shows a good healthy renal tissue, renal tubules and renal cells is very clear and nucleus was obvious and some nucleus have two nuclei. So, the Vit. E improved the kidney activity, while rabbit bucks treated with Se only, showed slightly degeneration occur in the renal cells. So, the treatment by Se only decreases the renal activity (Ghoname, 2004). It was observed that the kidney after treated by Vit. E plus Se shows more improvement of the kidney compared to Se or Vit. E only (Plate 8).

In conclusion, under Egyptian hot summer conditions, treating of the heat-stressed rabbit bucks with vitamin E and selenium was promising in improving biophysical, biochemical and histological status of the liver and kidney. Therefore vitamin E and selenium could be used for amelioration of the summer heat – stressed rabbit bucks.

Table 1. Mean values of air temperature (°C), daylight length, relative humidity (%) and temperature-humidity index (THI) in the Rabbitry during the different seasons of the year, under Egyptian condition.

Seasons of the year	Air temperature (°C)		Relative humidity (%)		Temperature-humidity index (THI)		Length of daylight (hours)
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
Winter	8.86±0.21	19.15±0.35	48.62±0.35	64.33±1.15	45.12	64.78	11.55
Spring	13.60±0.18	24.16±0.18	37.41±0.43	52.64±1.21	64.40	70.93	14.13
Summer	20.84±0.32	34.30±0.46	38.83±0.48	53.66±0.95	65.64	84.63	15.24
Autumn	15.43±0.12	28.62±0.42	42.67±0.62	58.42±1.32	59.21	77.68	13.00

Table 2. Mean values of the body thermoregulation of the summer heat-stressed NZW rabbit bucks and its amelioration using Vit. E, Se or Vit. E plus Se.

Items	Control (Summer)	Treatments					
		Vitamin E	Change (%)	Selenium	Change (%)	Vitamin E + Selenium	Change (%)
Rectal temperature (^{o}C)	40.12±0.09^{a}	39.90±0.08^{b}	-0.55	39.91±0.08^{b}	-0.52	39.79±0.08^{b}	-0.82
Skin temperature (^{o}C)	39.88±0.17	39.32±0.11	-1.40	39.59±0.10	-0.73	39.30±0.13	-1.45
Ear lobe temperature (^{o}C)	36.56±0.13	36.25±0.22	-0.85	36.03±0.61	-1.45	35.80±0.28	-2.08
Respiration rate (r.p.m.)	101.58±0.51^{a}	100.11±0.24^{a}	-1.45	101.28±0.41^{a}	-0.30	99.80±0.47^{b}	-1.75

Means bearing different letters within the same classification, differ significantly ($P< 0.05$).

Table 3. Mean values of the blood haematology of the summer heat–stressed NZW rabbit bucks and its amelioration using Vit. E, Se or Vit. E plus Se.

Items	Control (Summer)	Treatments					
		Vitamin E	Change (%)	Selenium	Change (%)	Vitamine E + Selenium	Change (%)
Haemoglobin (g/dl)	11.65±0.18^{b}	12.63±0.27^{a}	8.41**	11.82 ± 0.21^{b}	1.46	12.74±0.23^{a}	9.36**
Packed –cell volume (%)	31.70±1.17^{b}	37.25±0.60^{a}	17.51**	32.15±0.54^{b}	1.42	37.50±0.62^{a}	18.30**
Red blood cells (x10^{6}/mm^{3})	4.52±0.28^{b}	6.13±0.41^{a}	35.62**	4.75±0.36^{b}	5.09*	6.24±0.32^{a}	38.05**
White blood cells (x10^{3}/mm^{3})	6.22±0.25^{b}	7.12±0.37^{a}	14.47**	6.30±0.31^{b}	1.29	7.26±0.28^{a}	16.72**

Means bearing different letters within the same classification, differ significantly (P< 0.05).

** (P < 0.01) * (P <0.05)

Table 4. Mean values of some blood plasma components of the summer heat – stressed NZW rabbit bucks and its amelioration using Vit. E, Se or Vit. E. plus Se.

Items	Control (Summer)	Treatments					
		Vitamin E	Change (%)	Selenium	Change (%)	Vitamin E + Selenium	Change (%)
Total protein (gm/100ml)	6.04±0.17 ^{c}	6.74±0.30^{b}	11.59**	6.08±0.34^{c}	0.66$^{N.S}$	7.24±0.39^{a}	19.87**
Albumin (gm/100ml)	3.12 ± 0.13^{c}	4.21 ±0.12^{b}	34.94**	3.17±0.14^{c}	1.60$^{N.S.}$	5.18±0.16^{a}	66.03**
Globulin (gm/100ml)	2.92±0.11^{a}	2.53±0.11^{b}	-13.36**	2.91±0.12^{a}	-0.34$^{N.S.}$	2.06±0.11^{c}	-29.45**
Creatinine (mg/100ml)	1.21±0.11^{b}	1.07±0.08^{c}	-11.57**	1.03±0.06^{c}	-14.88**	1.47±0.10^{a}	21.49**
Urea – N (mg/100ml)	15.24±1.83^{a}	11.82±1.16^{b}	-22.44**	14.27±1.43^{a}	-6.36*	10.16±1.22^{b}	-33.33**
Total lipids (mg/100ml)	303.71±6.13^{b}	348.26±6.37^{b}	14.67**	315.24±6.14^{c}	3.80*	362.15±7.13^{a}	19.24**
Cholesterol (mg/100ml)	64.35±3.88^{a}	50.81±4.99^{b}	-21.04**	46.72±5.22^{b}	-27.40**	39.18±5.07^{c}	-39.11**
Testosterone (ng/ml)	2.46±0.10^{d}	5.28±0.10^{b}	114.63**	3.12±0.12^{c}	26.83**	6.14±0.12^{a}	149.59**
Cortisol (Ug/ml)	14.12±0.91^{a}	13.18±0.42^{b}	-6.66**	13.26±0.52^{b}	-6.09**	11.86±0.28^{c}	-16.01**

Means bearing different letters within the same classification, differ significantly (P< 0.05).

** (P < 0.01) * (P <0.05) NS: Not significant

Table 5. Mean values of some blood plasma minerals and enzymes concentrations of the summer heat – stressed NZW rabbit bucks and its amelioration using Vit. E, Se or Vit. E plus Se.

Items	Control (Summer)	Treatments					
		Vitamin E	Change (%)	Selenium	Change (%)	Vitamin E + Selenium	Change (%)
Sodium (mg/100ml)	146.13±3.50^{a}	120.15±3.81^{c}	-17.78**	138.46±3.76^{b}	-5.25$^{N.S}$	118.24±4.20^{c}	-19.09**
Potassium (mg/100ml)	4.05±0.14^{c}	5.64±0.24^{a}	39.26**	4.57±0.18^{b}	12.84**	5.82±01.17^{a}	43.70**
Calcium (mg/100ml)	8.14±0.24^{c}	10.25±0.32^{a}	25.92**	9.67±0.29^{b}	18.80**	10.42±0.38^{a}	28.01**
Total phosphorus (mg/100ml)	4.02±0.29^{c}	7.62±0.53^{a}	78.04**	6.35±0.38^{b}	48.36**	7.84±0.60^{a}	83.18**
Aspartate-aminotransferase(U/L)	23.57±1.86^{a}	20.10±1.04^{b}	-14.72**	22.86±0.86^{a}	-3.01$^{N.S.}$	19.64±0.92^{b}	-16.67**
Alanine-aminotransferase (U/L)	14.28±1.02^{a}	12.81±1.10^{b}	-10.29**	13.85±1.02^{a}	-3.01$^{N.S.}$	12.14±0.98^{b}	-14.99**
Alkaline phosphatase (U/L)	20.94±1.24^{a}	14.16±2.02^{b}	-32.38**	14.65±2.33^{b}	-30.04**	12.82±2.30^{b}	-38.78**
Acid phosphatase (U/L)	18.91±0.86^{a}	11.87±1.62^{c}	-37.23**	14.06±1.87^{b}	-25.65**	11.25±1.87^{c}	-40.51**
Lactic dehydrogenase (U/L)	262.39±6.18	249.30±6.78	-4.99$^{N.S}$	250.93±7.58	-4.37$^{N.S}$	246.23±8.75	-6.16$^{N.S.}$

Means bearing different letters within the same classification, differ significantly (P< 0.05).

** (P < 0.01) NS: Not significant

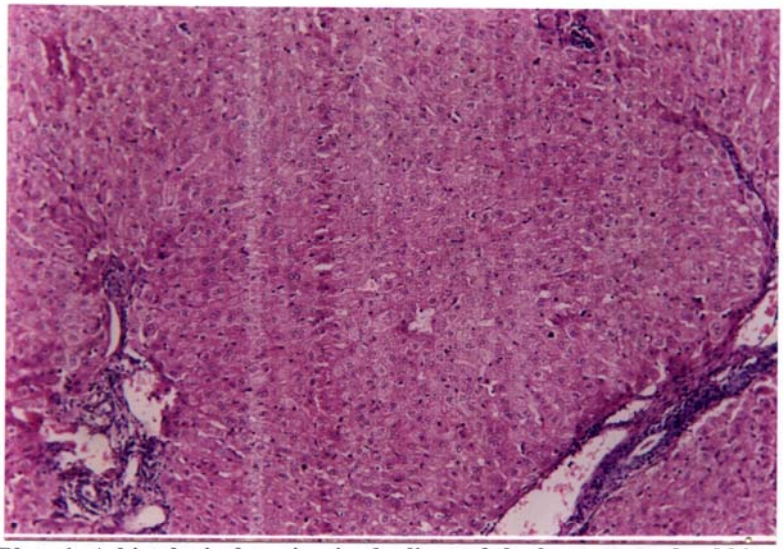

Plate 1. A histological section in the liver of the heat-stressed rabbit bucks injected with Vitamin E showing slightly fibrosis and round cell infiltration of the portal tract (Stained by H&E at 400 p).

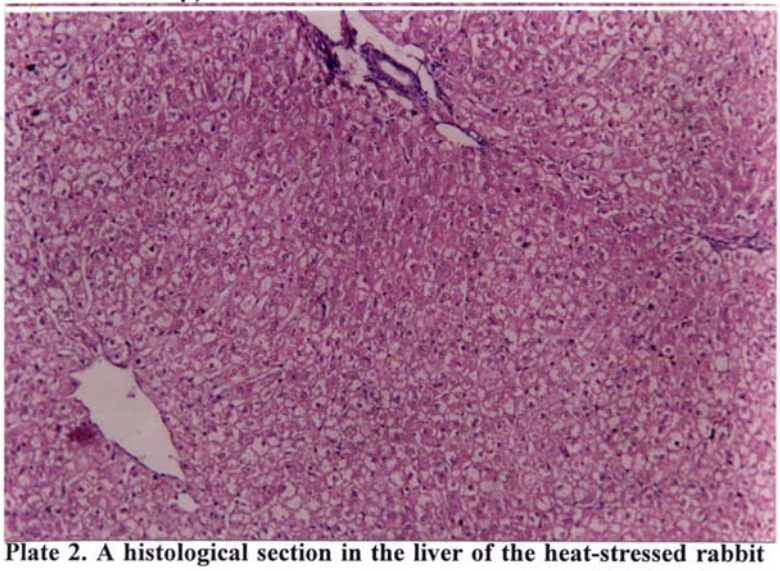

Plate 2. A histological section in the liver of the heat-stressed rabbit bucks injected with Selenium showing active of the hepatocytes with aggregated around the portal tract (Stained by H & E at 400 p).

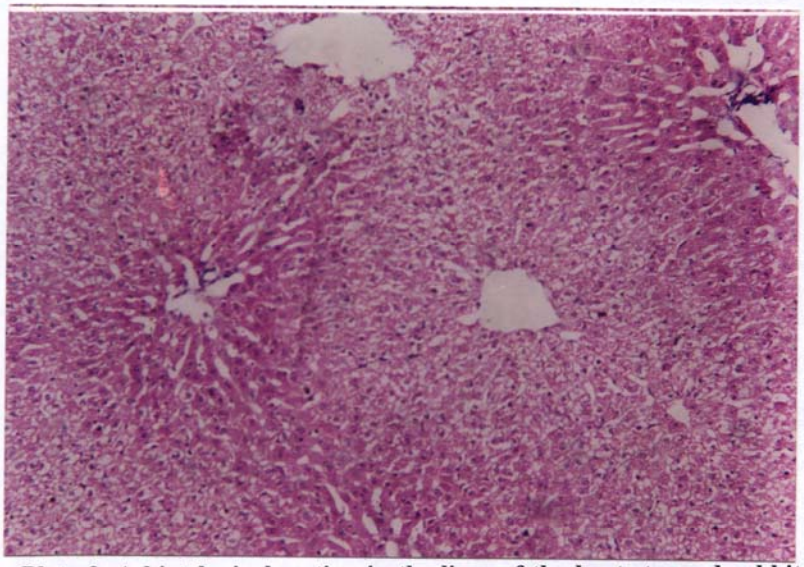

Plate 3. A histological section in the liver of the heat-stressed rabbit bucks injected with Vitamin E plus Selenium showing highly active of the hepatocytes (Stained by H & E at 400 p).

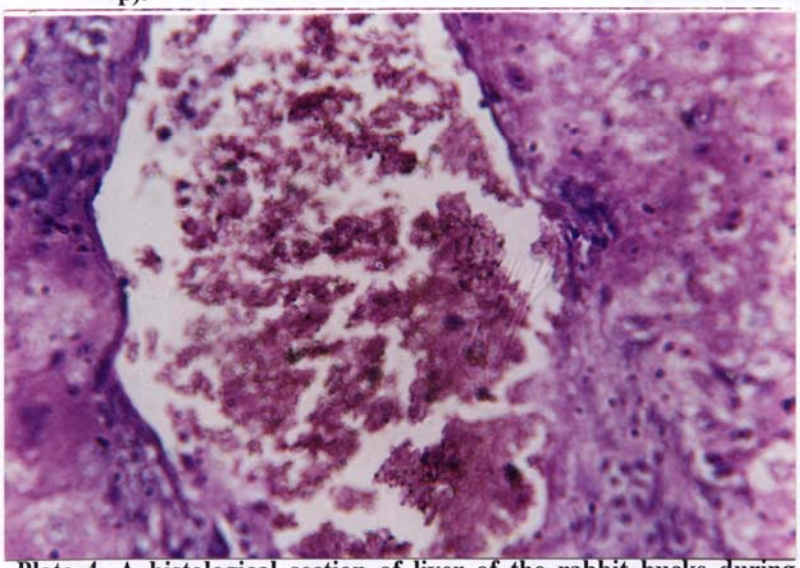

Plate 4. A histological section of liver of the rabbit bucks during summer revealed a high amount of red-blood cells in the central vein, fibrosis in the portal tract and large amount of neutrophil (Stained by H &E at 400 p).

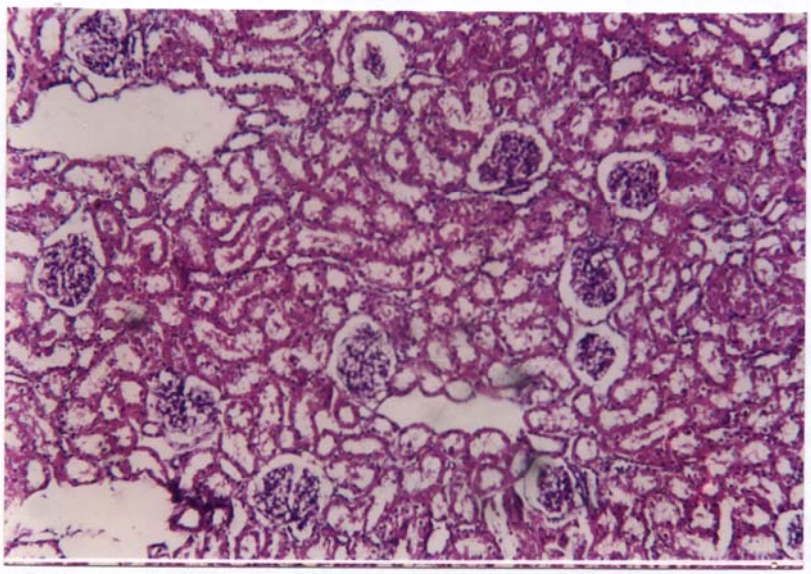

Plate 5. A histological section in the kidney of the heat-stressed rabbit bucks injected with Vitamin E showing the appearance of normal renal tubules (Stained by H & E at 400 p)

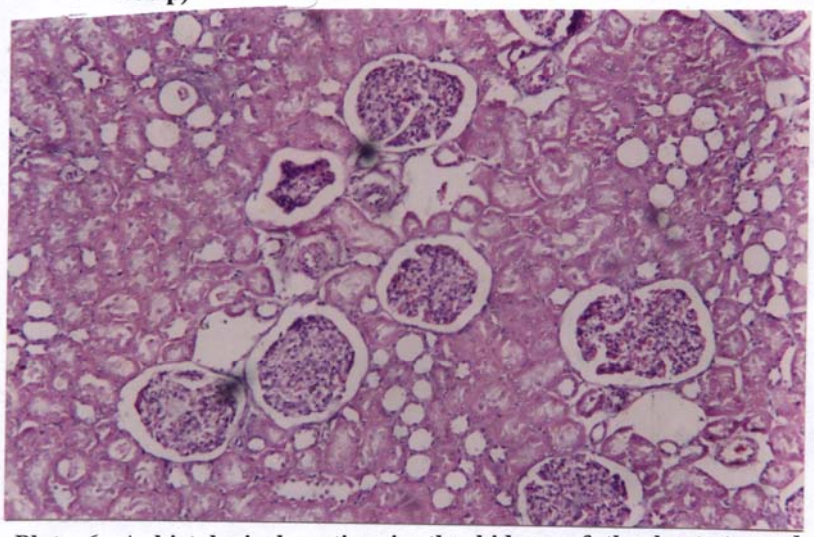

Plate 6. A histological section in the kidney of the heat-stressed rabbit bucks injected with Selenium showing normally renal corpusles (Stained by H & E at 400 p).

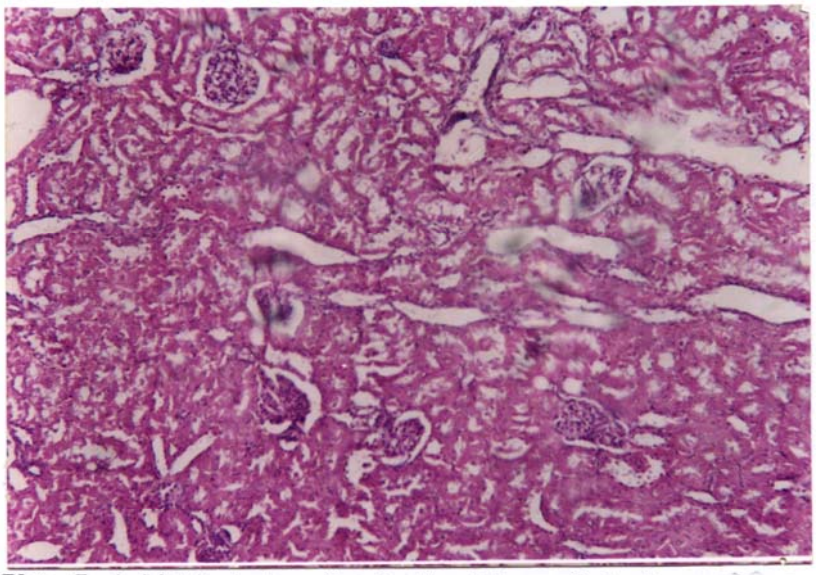

Plate 7. A histological section in the kidney of the heat-stressed rabbit bucks injected with Vitamin E plus Se showing normally and healthy renal corpusles and renal tubules (Stained by H&E at 400 p).

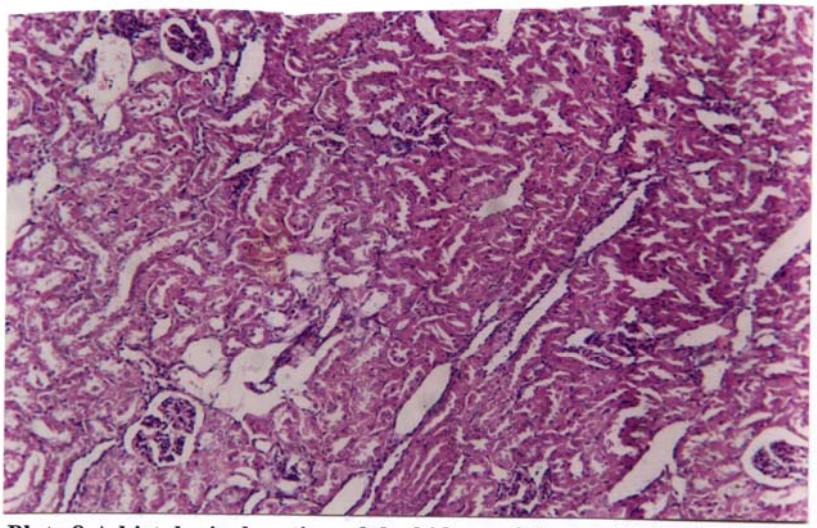

Plate 8 A histological section of the kidney of the rabbit bucks during summer revealed aggregation of hepatocytes distributed around the renal corpusles (Stained by H & E at 400 p).

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الملخص العربى

التغيرات الفسيوبيوكيمائية والحالة التشريحية لذكور الأرانب المعرضة للعبئ الحرارى وتحسينها بإستخدام فيتامين E والسيلينيوم تحت الظروف المصرية

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استخدم فى هذه الدراسة عدد ٤٠ ذكر أرنب نيوزيلاندى أبيض (NZW) فى موسم الصيف. قسمت ذكور الأرانب المعرضة للعبئ الحرارى إلى أربع مجاميع (١٠ ذكور فى كل مجموعة). المجموعة الأولى استخدمت كمجموعة مقارنة. المجموعة الثانية، الثالثة والرابعة استخدمت كمجاميع معاملة حيث تم حقنهم عضليا بفيتامين E (١٠٠ وحدة دولية/ أرنب/أسبوعيا)، سيلينيوم (٠,١ ملجم/كجم من وزن الجسم الحى/ أسبوعيا) وسيلينوم مع فيتامين E أسبوعيا بنفس الجرعات السابقة على الترتيب. تم قياس التنظيم الحرارى للجسم، صورة الدم وبعض مكونات الدم لذكور الأرانب المعرضة للعبئ الحرارى فى فصل الصيف (مجموعة المقارنة) وكذلك للأرانب المعاملة بفيتامين E، السيلينوم أو فيتامين E مع السيلينوم. كذلك تم دراسة الحالة التشريحية لكل من الكبد والكليتين لذكور الأرانب.

أوضحت النتائج انخفاض درجة حرارة المستقيم معنويا (على مستوى ٠,٠٥) فى ذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف بعد الحقن بفيتامين E أو Se بمفردة أو فيتامين E مع Se عن مجموعة المقارنة، بينما انخفض معدل التنفس معنويا (على مستوى ٠,٠٥) عند الحقن بفيتامين E مع Se. فى حين انخفضت درجة حرارة صوان الأذن ودرجة حرارة الجلد بدرجة غير معنوية فى ذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف بعد الحقن بفيتامين E أو Se بمفردة أو فيتامين E مع Se عن مجموعة المقارنة. زيادة تركيز هيموجلوبين الدم وحجم الخلايا الكلية، كرات الدم الحمراء والبيضاء معنوياً (على مستوى ٠,٥) لذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف بعد الحقن بفيتامين E أو فيتامين E مع Se. عن تلك المحقونة بالـ Se بمفرده أو مجموعة المقارنة. انخفاض تركيز البروتين الكلى والألبيومين معنويا (على مستوى ٠,٠٥) فى ذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف بدون معاملة (مجموعة المقارنة) أو التى حقنت بـ Se بمفردة عن تلك التى حقنت بفيتامين E بمفردة أو فيتامين E مع Se. إنخفاض تركيز الجلوبيولين واليوريا – N معنوياً (على مستوى ٠,٠٥) لذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف بعد الحقن بفيتامين E بمفرده أو فيتامين E مع Se مقارنة بالمحقونة بـSe بمفرده أو مجموعة المقارنة. كذلك إنخفض تركيز الكوليسترول معنوياً (على مستوى ٠,٠٥) فى ذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف بعد الحقن بفيتامين E أو Se أو فيتامين E مع Se عن مجموعة المقارنة. ارتفاع تركيز الكرياتينين والليبيدات الكلية معنويا (على مستوى ٠,٠٥) فى ذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف بعد الحقن بفيتامين E مع Se عن تلك التى حقنت بفيتامين E أو Se بمفردة أو مجموعة المقارنة.

زيادة تركيز هرمون التستسترون معنوياً (على مستوى ٠,٠٥) بينما إنخفض تركيز هرمون الكورتيزول معنوياً (على مستوى ٠,٠٥) فى ذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف بعد الحقن بفيتامين E أو Se بمفرده أو فيتامين E مع Se مقارنة

بمجموعة المقارنة. ارتفاع تركيز الصوديوم معنويا (على مستوى ٠,٠٥) فى حين انخفض تركيز كل من البوتاسيوم والكالسيوم والفوسفور الكلى معنويا على (مستوى ٠,٠٥) فى ذكور الأرانب المعرضة للعبئ الحرارى فى فصل الصيف بدون معاملة (مجموعة المقارنة) عن تلك التى حقنت فيتامين E أو Se بمفردة أو فيتامين E مع Se. زيادة نشاط أنزيم ALT، AST معنوياً (على مستوى ٠,٠٥) فى ذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف (مجموعة المقارنة) أو بعد الحقن بـ Se بمفردة مقارنة بالمحقونة بفيتامين E أو فيتامين E مع Se. زيادة نشاط أنزيم الفوسفاتيز الحامضى (ACP) والقلوى (ALP) معنوياً (على مستوى ٠,٠٥) بينما إنخفض نشاط أنزيم LDH بدرجة غير معنوية فى ذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف مقارنة بالمعاملة بفيتامين E أو Se بمفرده أو فيتامين E مع Se.

لوحظ تحسن الحالة التشريحية لكل من الكبد والكليتين فى ذكور الأرانب NZW المعرضة للعبئ الحرارى فى فصل الصيف بعد الحقن بفيتامين E أو Se بمفرده أو فيتامين E مع Se مقارنة بمجموعة المقارنة.