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INFLUENCE OF ENVIRONMENTAL TEMPERATURES ON SOME PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS OF NEW-ZEALAND RABBIT MALES

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ABSTRACT

The physiological performance and biochemical parameters of sixteen adult New-Zealand White rabbit males of 6 months old and 2.5 ± 0.14 kg live body weight was investigated during spring and summer seasons in natural conditions. The maximum and minimum ambient temperatures were 27.1 ºC and 18.9 ºC in spring versus 32.2 ºC and 26.5 ºC in summer, while the average relative humidity was 86.1 % in spring versus 89.5 % in summer. Results showed a decrease in body weight (BW) during summer, which was accompanied with decreases in food intake and increase in water intake. Hematological values, including hemoglobin (Hb), packed cell volume (PCV) and red blood cell (RBC) counts were decreased, while white blood cell (WBC) counts were increased during summer compared with spring. Plasma total protein (TP), globulins (G), total lipids (TL) and cholesterol were increased during the summer season. Activity of some plasma enzymes indicated that there were significant decreases in alanine-aminotransaminase (ALT) and alkaline phosphatase (ALP), and increases in lactate dehydrogenase (LDH) during summer compared with spring. Results suggest that exposure of New-Zealand rabbits to hot environmental conditions adversely affects physiological functions as reflected by the hematological and biochemical parameters.

Key words: rabbits, environmental temperature, physiology and biochemistry

INTRODUCTION

At present, the most important topic in rabbit research is to improve the production taking into account the farmer requirements, animal welfare and habitat. It is well known that rabbits are very sensitive to extreme environmental conditions, particularly temperature. The rabbits exposed to ambient temperature of 25 ºC for 12 hours daily had lower weight gains than rabbits kept at 15 ºC. Environmental temperatures above 28 ºC cause heat-induced physiological stress. Thermoregulation in rabbits is rather poor as they have few functional sweet glands (Naqvi et al., 1995). The critical air temperature for the quiet-fasting rabbit is 27 to 28 ºC, which could be modified by humidity, hair coat, age, fatness, wind and other factors, i.e. at air temperatures below 27 ºC a chemical regulation of rabbit body temperature comes into action. This involves increased biological oxidation, resulting in increased heat production. When the air temperature rises beyond the upper limit of thermo-neutrality range (32 ºC), physical regulation of body temperature is insured by the adjustment of blood flow to skin and by the perspiration mechanisms. Vasomotor and cardio-respiratory mechanisms are also involved, in addition to other physiological mechanisms. In general, chronic exposure to extremes of heat leads to decomposition

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of normal physiological and biological mechanisms with a consequent damage of many organs (El-Sobhy, 2000). Feed intake is reduced through high temperature conditions; the growth is reduced consequently due to the decreased digestible energy intake (Ayyat et al., 1996). Climatic heat stress had deleterious effect on exotic temperate breeds, such as New-Zealand white rabbits more than indigenous tropical breeds, such as Egyptian Baladi rabbits (Tag El-Din et al., 1992) as the long term heat stress causes marked decreases in the hematological parameters.

The present study investigates the effects of environmental temperature (spring and summer seasons) on some major physiological and biochemical parameters of the New-Zealand rabbits males under Egyptian climate conditions.

MATERIAL AND METHODS

This experiment was carried out at the Environmental Studies Department, Institute of Graduate Studies and Research, Alexandria University. Sixteen New-Zealand adult male white rabbits aging 6 months and weighing 2.5 ± 0.14 kg in average were used to study the effect of natural climatic conditions of spring and summer seasons on physiological performance and biochemical parameters. The animals were divided into two equal groups, where the first group was used during spring and the second was used during summer. The bucks were kept for two weeks, as preliminary period, in natural spring and summer conditions, and then maintained under these conditions for two months during each season. During the experimental period the rabbits were individually housed in universal galvanized wire batteries with feed and water offered *ad libitum* and were daily observed. A commercially balanced pelleted ration for breeding rabbits containing 18% crude protein, 14% crude fiber, 2% fat and 2600 kcal DE/ kg feed was used. Live body weight, feed and water intake, ambient air temperature and relative humidity were recorded daily.

Blood samples were collected from each animal from the ear vein into heparinized tubes and were placed immediately on ice. Plasma was obtained by blood centrifugation at 3,000 rpm for 20 min. and stored at -20 ºC until analysis. The whole blood was subjected to hematological analysis shortly after collection. Hemoglobin (Hb), packed cell volume (PCV), red blood cell (RBC) counts and white blood cell (WBC) counts were determined using conventional methods. Plasma was used for the determination of total protein (TP), albumin, total lipids (TL), cholesterol, aspartate aminotransaminase (AST), alanine aminotransaminase (ALT), alkaline phosphatase (ALP), urea and creatinine using commercial kits. Lactate dehydrogenase (LDH) was determined according to Setrove and Makarova (1989).

Statistical analysis was performed using the General Linear Model (GLM) produced by Statistical Analysis Systems Institute (SAS, 2000). Significant differences among means were evaluated using Duncan's Multiple Range Test of SAS (2000).

RESULTS AND DISCUSSION

The maximum and minimum ambient temperatures in both seasons were 27.1 ºC and 18.9 ºC in spring, versus 32.2 ºC and 26.5 ºC in summer, while the average relative humidity was 86.1 % in spring and 89.5 % in summer (Fig. 1).

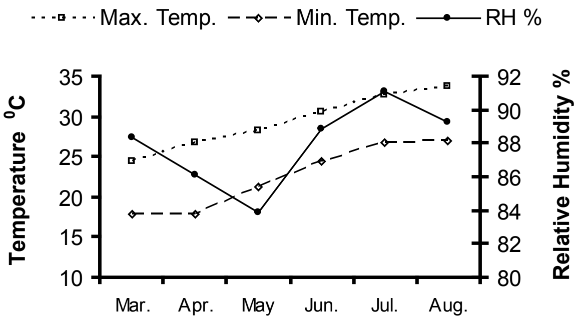

Fig. 1: Monthly variations in ambient temperature and relative humidity during spring (March - May) and summer (Jun - August) seasons

Results presented on Fig. 2 show that body weight was affected by the season, where marked decreases were observed during summer compared with that of spring. Such effect was accompanied with a parallel effect on feed intake (Fig. 2). The decline in live body weight observed in summer season is in agreement with those reported by Al-Homidan and Ahmed (2000); Ayyat et al., (2002) and Marai et al. (1994). They concluded that poor growth performance of rabbits under heat stress may have been a result of the decrease in feed intake. High environmental temperature stimulates the thermal receptors to transmit suppressive nerve impulses to the appetite center in the hypothalamus causing the decrease in feed consumption (Marai et al., 1994). This may lead to less protein biosyntheses and/or less fat deposition, leading to lower body gain. The increase in water consumption during hot season was reported by Al-Homidan and Ahmed (2000).

Heat stress induced the reduction in RBC counts, Hb and PCV, where the overall means of these parameters tended to decline during the summer season. The average PCV values were significantly ($P<0.05$) affected by the season and these values were lower in summer than in spring (Fig. 3). Ashour (2001) and Gad et al. (1995) found that hematological parameters were highest in winter, retained during autumn and spring and were lowest in summer. They reported that these parameters decreased with the increase of ambient temperature from winter to summer, which was observed in our study. This drop is responsive trial to reduce oxygen intake, thus reducing metabolic heat production under this hot condition (Ashour et al., 1995 and Ashour, 2001). The decreases in oxygen intake are important for animals to keep heat balance (Solouma, 1999). It was reported that heat stress decreases the level of ACTH, which, in turn, decreases the values of RBC counts, Hb and PCV (Seley 1960).

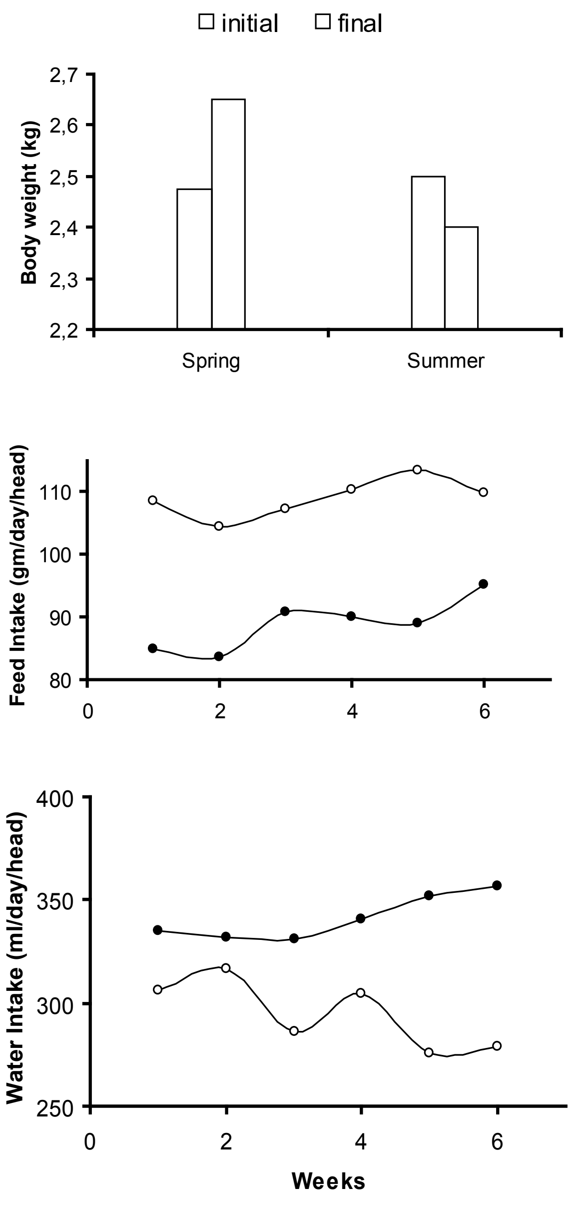

Fig. 2: Changes in body weight and feed and water intake in New-Zealand male rabbits during spring (○) and summer (●) seasons

Calculated characteristics of erythrocytes were markedly affected by the season. In particular, MCV was significantly (P<0.01) increased, MCHC was significantly (P<0.01) decreased during summer compared with spring, while MCH was not affected by the season (Fig. 3). MCHC plays an important role in detecting the influence of heat stress, which decreases by the elevation of ambient temperature. A decrease in overall mean of MCHC in summer (Fig. 3) is in agreement with those obtained by Samak et al. (1986), who reported that the decline of MCHC in summer may be due to the reduction of RBC counts. The increase in MCV and the decrease in MCHC might be due to the decrease of salt content in blood plasma during summer. The results of El-Sheiref et al. (2002) on rabbits drinking salty water confirm present results.

Present results also show significant (P<0.01) differences in WBC values between spring and summer. Mean values of WBC in summer months were markedly higher than in spring months (Fig. 3). Such effects are mainly attributed to hot season (Lee et al., 1976) and may be caused by the stress due to pathogens during summer and by the increase in blood viscosity, which may lead to allergic effects that induce the WBC production.

Plasma total protein concentration was significantly (P<0.05) affected by the season. Higher values were obtained during summer (8.72 ± 0.58 gm/dl) than spring (7.31 ± 0.44 gm/dl) (Fig. 4). The increase in TP in summer is mainly due to the increase of globulin fraction, since albumin concentration significantly (P<0.01) decreased during the summer season. Accordingly, the A/G ratio was significantly (P<0.01) decreased in summer (Fig. 4). Our results are in agreement with those of Ayyat et al. (2002), who studied the effect of heat stress on rabbit's growth performance. Albumin, rather than total protein or globulin, has been shown to be the most sensitive indication of protein status (Shetaewi, 1998). The importance of increasing TP in summer may be due to the fact that TP in plasma generates a colloid osmotic pressure which controls the flow of water between blood and tissue fluids (Gomaa, 1996).

Total lipids and cholesterol were significantly (P<0.01) affected by the season (Fig. 4). The values of TL were higher during summer (5.12 ± 0.31 gm /dl) than during spring (3.08 ± 0.23 gm /dl). Additionally, the overall mean of blood cholesterol was increased (P<0.01) during the summer season (Fig. 4). These results are similar to those of El-Masry and Marai, (1991) on dairy cattle and Ayoub et al. (2007) on rabbits. They attributed these changes to variations in thyroidal activity at different seasons, as exposure to low environmental temperature stimulates the secretion of thyroxine. Thyroid hormones stimulate cholesterol synthesis as well as the hepatic mechanisms that remove cholesterol from the circulation. Cholesterol is the precursor in the biosynthesis of sex hormones. The decline in plasma cholesterol level may

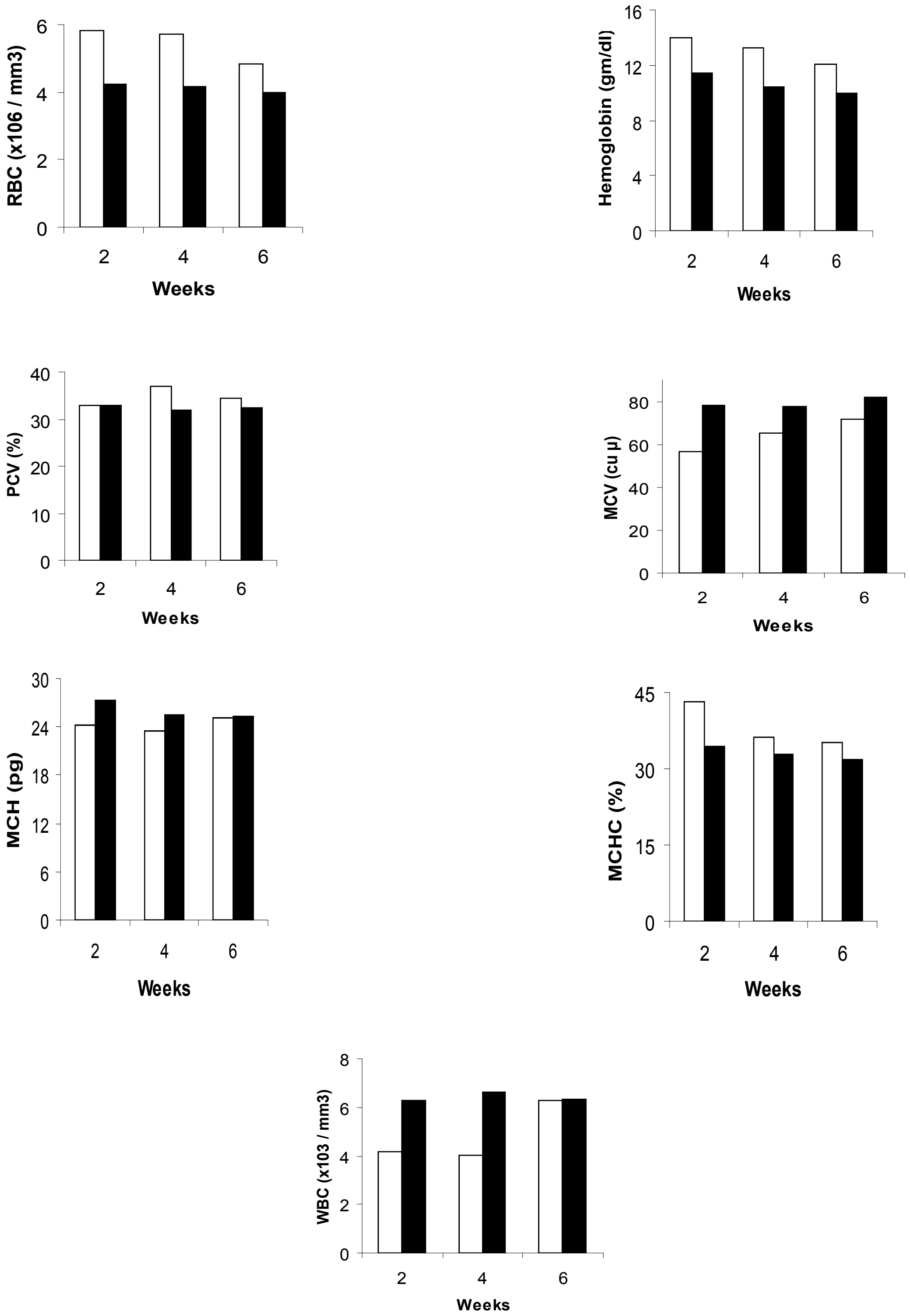

Fig. 3: Weakly variations in red blood cells (RBC's), hemoglobin (Hb), packed cells volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration(MCHC) and white blood cells (WBC's), in New- Zealand male rabbits during spring (○) and summer (●) seasons

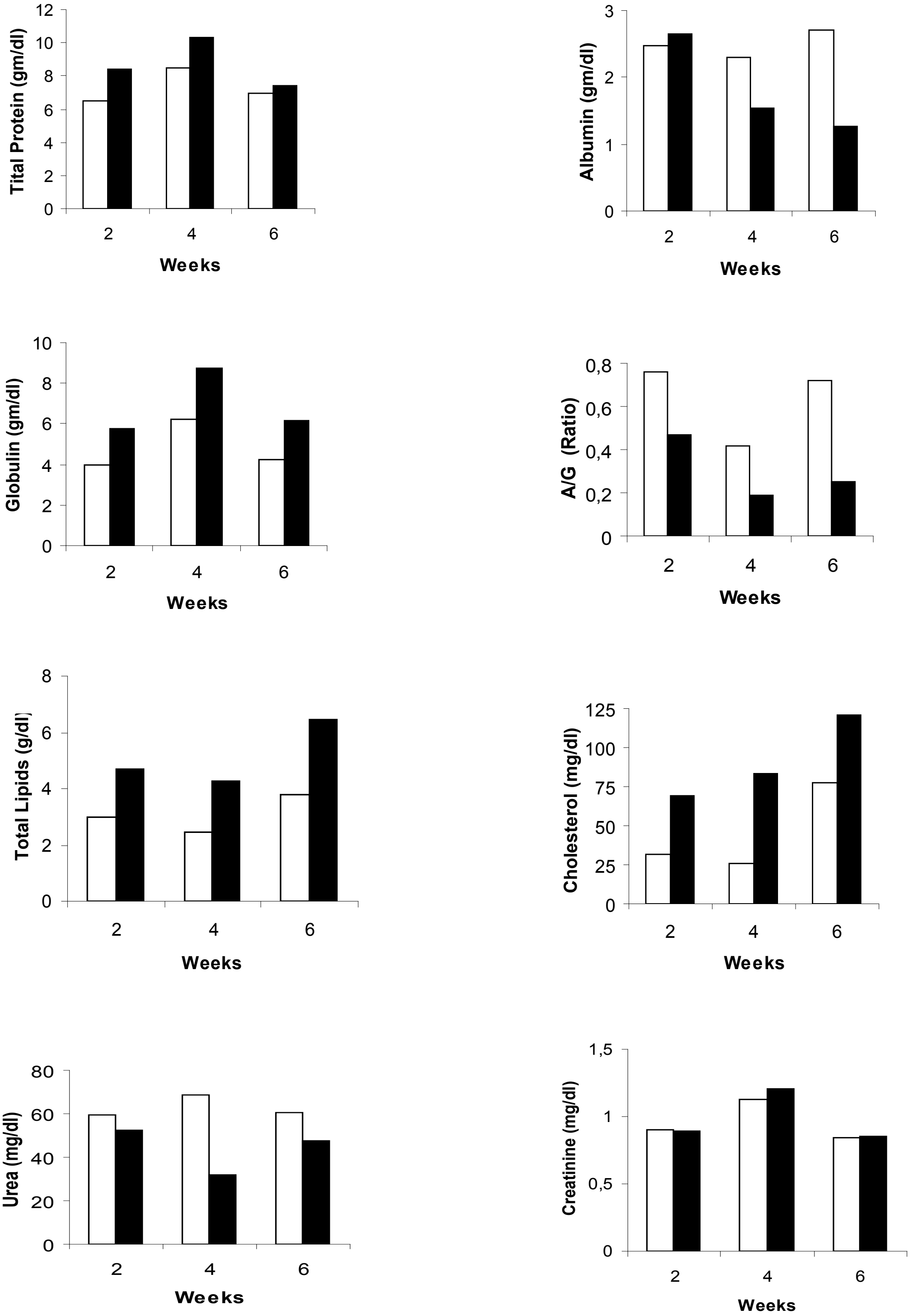

Fig. 4: Weekly variations in plasma total protein (TP), albumin, globulin, albumin/globulin (A/G) ratio, t otal lipids,cholesterol, urea and creatinine in New-Zealand male rabbits during spring (○) and summer(●) seasons

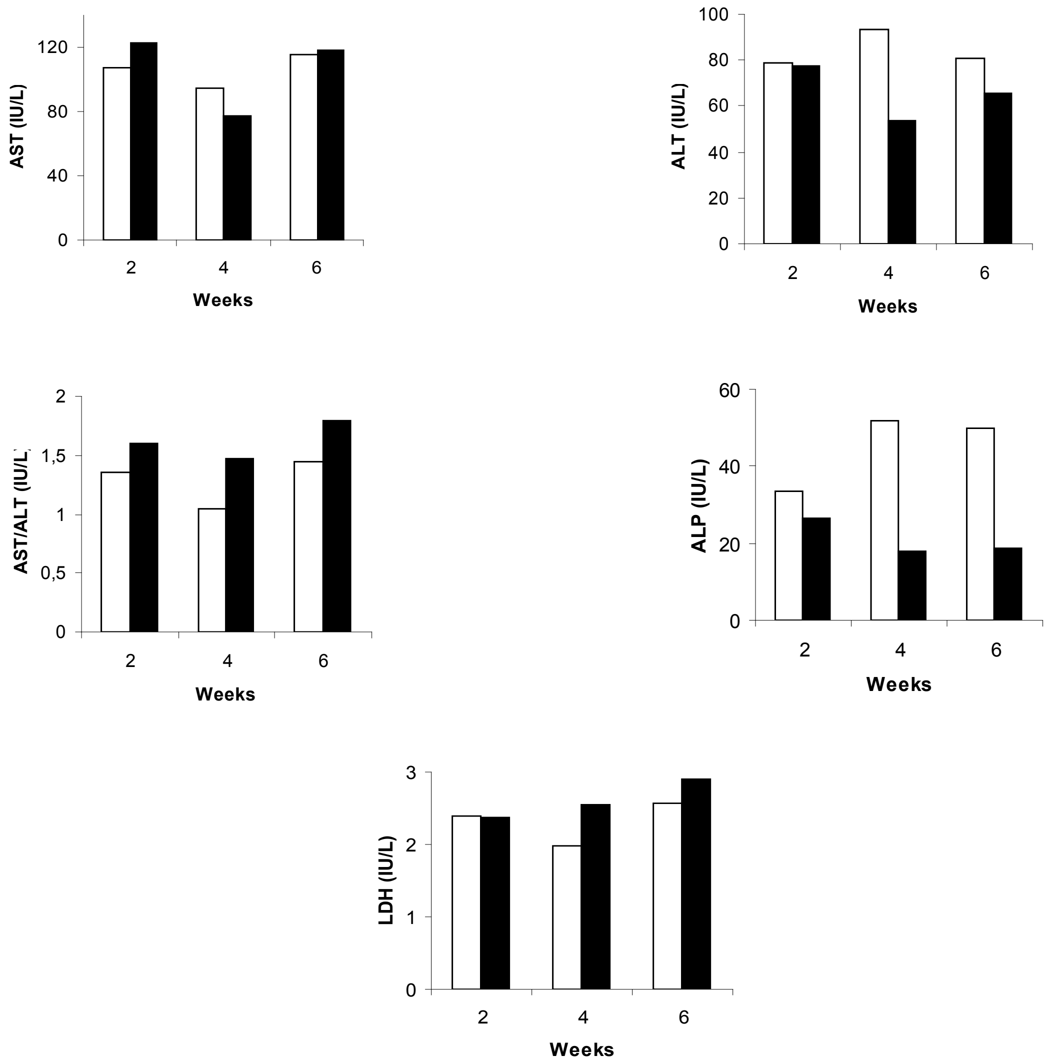

Fig. 5: Weakly variations in aspartate amino transaminase(AST), alanine amino transaminase (ALT), AST/ALT ratio, alkaline phosphatase (ALP) and lactate dehydrogenase (LDH) in New-Zealand male rabbits during spring (○) and summer (●) seasons

be because the rate of the later process exceeds that of the former, the plasma cholesterol level drops before the metabolic rate rises (Guyton, 1981). In addition, those male sex hormones (androgens) were reported to increase blood cholesterol.

Urea concentration was significantly ($P<0.01$) decreased during the hot season. The values during spring months were 62.8 ± 5.07 mg/dl, whereas the values tended to decline during summer to 43.9 ± 2.82 mg/dl (Fig. 4). Plasma creatinine concentration was not significantly affected by the season. As urea and creatinine represent the two main nitrogenous components that are eventually excreted by the kidney, therefore changes in their levels in the blood stream would reflect the insufficiency of kidney tubules or kidney malfunction (Miller, 1966). Creatinine, the anhydride of creatine, is formed due to fragility in muscle by irreversible non-enzymatic dehydration of creatine phosphate, which is now known to be concerned with the energy mechanism of these tissues and serves primarily as a temporary store of energy. On the other hand, serum creatine concentration is a better indicator of glomerular filtration rate (Khalil et al., 2002). The increase in creatinine may indicate changes in kidney function (Soliman et al., 2000). Thus, the negligible increase in creatinine shows insignificant changes in kidney functions during both seasons.

Although, AST activity was not significantly affected by the season, however the 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 (Fig. 5). AST/ALT ratio was significantly ($P<0.01$) increased during summer compared to spring. This ratio indicates the state of aspartate to alanine synthesis in the liver. 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 (El-Maghawry et al., 2000). ALP activity was decreased ($P<0.01$) in summer (20.9 ± 1.93 IU/L) compared to spring (45.2 ± 3.56 IU/L) (Fig. 5). However, LDH levels was increased ($P<0.01$) during summer. The values of LDH during summer were 2.61 ± 0.06 IU/L while they were 2.32 ± 0.10 IU/L during spring (Fig. 5). LDH was found to be an indicator of anemia, renal stress, muscular dystrophy as well as liver damage (Kachmar and Moss, 1976). An increase in LDH indicates the deterioration of different tissues suffering from heat stress during the summer season. The increase in the activities of ALT, AST, ALP and LDH in plasma is mainly due to the leakage of these enzymes from the liver cytosol into the blood stream, which reflects liver damage and disruption of normal liver function (Shakoori, et al. 1994).

It is concluded that rabbits during summer season suffer on 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.

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