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Changes in Body Fluids and Plasma Electrolytes (Na^+ and K^+) Concentrations of Balady and Damascus Goats Exposed to Heat Stress in Desert of Sinai, Egypt

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Abstract: A comparative study was carried out to evaluate body fluids distribution and plasma electrolytes (Na^+ and K^+) concentrations of two breeds of goat (Balady and Damascus) exposed to direct solar radiation during summer season. A total 10 Bucks of two breeds of goat (five Balady and five Damascus) were provided for this study. The animals were at 18 months of age at the commencement of the study, the live body weights (LBW) were 29.86 ± 2.41 and 49.22± 1.74 kg for Balady and Damascus breeds respectively. The study was a part of project entitled "effect of acclimatization on energy requirements of goats" and performed at the Experimental unit of the small ruminant research (at a small village namely Abou-Elfeta, east of Al-Arish City, Northern Sinai, Egypt) which belongs to Desert Research Center (DRC), Egypt. Total body water (TBW), Extra-cellular fluids (ECF), Plasma volume (PV) and Hematocrit percentage (Ht) were determined. Blood volume (BV), erythrocyte volume (RCV), Intra-cellular fluid (ICF) and interstitial fluid (ISF) were calculated. In addition, plasma electrolytes (Na^+ and K^+) concentrations were estimated. The results indicated that, heat stress for 4-days consecutively caused 2.85 and 3.33% loss in LBW for Balady and Damascus breeds, respectively. Both breeds lost about 6.31 and 0.0 vs. 7.29 and 1.35% from the ECF and ICF fluids, for Balady and Damascus respectively at the end of heat stress period. Thus, Damascus breed showed a tendency to loss more fluid from ECF and ICF fractions compared with Balady breed, while ISF was uniform in both breeds (-11.6% vs. -11.4%). Plasma and blood volumes increased significantly ($P<0.001$), while hematocrit percentage decreased significantly ($P<0.01$), indicated a reverse response ($P<0.001$) at the end of heat stress period in both Balady and Damascus breeds. The results indicated that, breed differences for plasma Na^+ and K^+ concentrations were found at the commencement of the study with Damascus (147.76±1.19 and 4.94±0.102 mEql/l) being greater values than Balady (137.58±0.959 and 4.5±0.100 mEql/l). Regarding the effect of heat stress, the results indicated that Plasma Na^+ concentration increased significantly ($P<0.001$) at the fourth day of heat stress in both breeds while plasma K^+ concentration decreased significantly ($P<0.05$) in Damascus breed.

Key words: Body Fluids · Goat · Heat stress · K^+ levels · Plasma Na^+

INTRODUCTION

Adaptability is a trait with low heritability and therefore difficult to improve by selection. Although the goat has proven to be the most adaptable of all domesticated livestock and survives in a wide range of environments worldwide, it does not always realize its production potential when taken out of one environment and placed in another. Adaptive traits which enable goats to survive and be productive, including disease resistance, heat tolerance, endure prolonged water deprivation, ability to cope with poor feed quality [1]. Mcdowell and Woodward [2] reviewed that goats appear to have lower metabolic rate, higher tolerance to dehydration, less susceptibility to respiratory alkalosis resulted from high respiration rate and fewer metabolic disorders than cattle and sheep. These traits could favor the goat's survival in hot climate, especially where water resources are restricted. Panting and evaporation from respiratory tract seem to be the most important mechanism for heat loss in goat during heat load, which discharge only small amount of sweat [3]. Body water is known to

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play a central role in heat dissipation mechanisms [4]. Heat stress induces a significant alteration in the body water balance and distribution. It has been reported that heat stress in ruminants results in the expansion of extra cellular fluid compartment [5-7].

Measurement of body water has been the basis of several indirect methods for estimating body composition because water is the single largest component in the fat-free body and there are several markers available to measure water. The early attempts to use water to estimate body composition have been reviewed by Brodie *et al.* [8], Panaretto and Till [9] seemingly were successful in using antipyrine-space technique to estimate body water in biological materials. Goats are considered highly suitable animals for rising in such areas, as they were the first domesticated in the hot and arid regions of the world [10]. They use body water more efficiently and are considered less sensitive to water scarcity than other ruminants [11]. Bedouin goats have ability to store water in the extra-cellular space when they are fully hydrated, low metabolic rate and small evaporative water losses in the heat [12]. Heatstroke is more common in the summer and especially when the environmental temperature and relative humidity are high and with prolonged exposure to direct sunlight [13].

Balady goat is well-adapted to the environmental conditions in North and South Sinai of Egypt, while, Shami goat is originated in Syria and it is imported to North Sinai Bedouin due to its high productivity of milk and meat. It is called by other names such as Damascus, Balani and Damascuscene. In addition, it is present in Palestine, Iraq, Lebanon and Cyprus [14]. These two breeds are varying in their colour, body weight, size, morphological traits, shape of horns, presence or absence of horns and wattles [15]. However, in a review on goat, comparing the Shami (Damascus) with Balady goat breeds in dealing with body fluids changes under heat stress is unavailable. Therefore, this work was designed to estimate *in-vivo* body fluids distribution and plasma electrolytes (Na^+, K^+) concentrations in comparison between Balady and Damascus breeds of goat exposed to direct solar radiation during summer season in Northern Sinai.

MATERIALS AND METHODS

Animals and Experimental Design: The study was performed during summer season and lasted 11 days on two breeds of goat (five Bucks of each Balady and Damascus). The animals were at 18 months of age, the live weights were 29.86 ± 2.41 and 49.22± 1.74 kg at the commencement of the study for Balady and Damascus breeds respectively. The animals were placed in the individual metabolic cages throughout the experiment. The study was divided into two periods. Period I: The animals were kept in two sheltered enclosures (indoors) for seven days; this period was served as pre-exposure to direct solar radiation. Period II: the animals were kept unsheltered enclosures (outdoors) and exposed to direct solar radiation (from sunrise till sunset daily) for 4 days consecutively. The animals were fed Alfalfa hay based on LBW to meet the metabolic energy maintenance requirement according to Kearl [16]. On average hay samples contained 87.5% DM, 12.9% ash, 14.2% crude protein (CP), 30.2% crude fiber (CF) and 3.2% ether extract (EE) on a dry matter (DM) basis to A.O.A.C. [17]. Fresh water was in fixed Buckets in each metabolic cage (10 liters capacity of each). Mean climatological values (Fig. 1) of ambient temperature (AT,°C), relative humidity (RH, %) were recorded three times daily (at morning, midday and evening), using Hygro-thermometer instrument. The mean temperature-humidity index (THI) was calculated according to Amundson *et al.* [18] using the following equation:

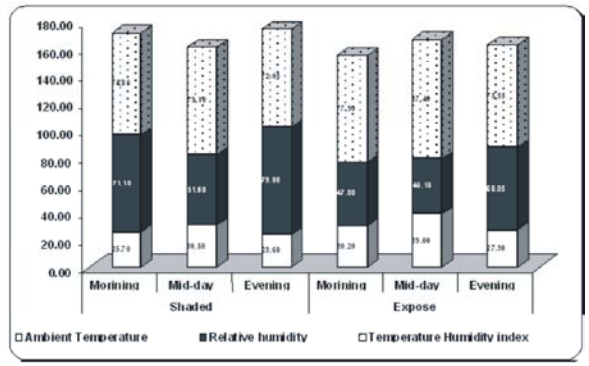

Fig 1: Meteorological data during the experimental periods.

$$THI = 0.8 \times AT°C + (RH, \%) \times (AT°C - 14.4) / 100) + 46.4$$

Live Body Weight (LBW): Live body weight (LBW, kg) was measured at the beginning and end of each experimental period using a digital scale. The rate of change in LBW was calculated.

Analytical Methods and Calculations:

Determination of Total Body Water (TBW): An ideal material should be nontoxic, slowly transformed in the body, slowly excreted from the body, rapidly distributed and readily measured (antipyrine, N-acetyl-1-4-aminoantipyrine) was employed in a dilution technique for the determination of total body water during pre and post exposure to direct solar radiation according to Brodie *et al.* [8]. At the day of blood sampling and injections, animals were catheterized in both jugular veins using an I.V. canola (14G×57mm). An initial blood sample was taken from the right jugular vein into 10 ml test tubes contained Li-heparin as anti-coagulant. Post injection with 1g/kg body weight of antipyrine dissolved in physiological saline solution (20%, w/v), drinking water source was removed once the administered antipyrine had equilibrated with body water (about 6 hrs), blood samples were obtained at 30min, 6 hr and 24 hrs post injection and then blood samples were centrifuged at 3500 rpm for 20 minutes to obtain plasma and stored at -20°C for biochemical analysis. The absorbance of antipyrine-space was measured at 350 nm TBW was calculated according to the following equation suggested by Panaretto and Till [9]:

TBW= antipyrine-space - 0.03 x body weight.

Determination of Extra Cellular Fluids (ECF): Extracellular fluids (ECF) were estimated using sodium thiocyanate (NaSCN) dilution method according to Bowler [19]. Briefly, after withdrawing a 5 ml blood in heparinised vaccutainer tubes from the jugular vein served as zero time, 2 mg/kg body weight in 0.9% physiological saline solution was injected into the jugular vein over a 2 minute period. Thereafter, blood samples after 1 hour and 6 hours was taken from the opposite jugular vein, blood samples was centrifuged at 3500 rpm for 20 minutes. Plasma will be obtained and kept frozen until used for biochemical analysis. Thiocyanate (SCN) space was measured at wavelength 460 nm and was calculated according to the following equation:

SCN-space (liters) = Injected SCN (mg)/concentration of SCN at zero time (mg/l)

Determination of Hematocrit Percentage (Ht, %): A portion of the blood samples was transferred to a Wintrobe tubes, centrifuged for 20 minutes at 3500 rpm and the hematocrit (Ht) percentage was determined according to Dacie and Lewis [20].

Determination of Plasma Volume (PV): Plasma volume was determined by the method of Kenndy and Millikan, [21] by injecting Evan's blue dye (T-1824, E2129, Sigma, Saint Louis, MO, USA) in the jugular vein at a concentration of 0.3 mg/kg body weight in 0.9% saline solution. Blood sample was withdrawn and served as zero time, thereafter, Evan's blue solution was injected into the jugular vein and blood sampling was taken from the opposite jugular vein at 10,20,30,40, 50 and 60 min). Blood samples were centrifuged at 3500 rpm for 20 minutes. Plasma will be obtained and kept frozen until measured at wavelength 620 nm. Standards of injected dye were prepared by adding 5, 10, 15 and 20 μl of injected solution to 10ml blank plasma (before injection). Values were fitted to a logarithmic decay curve of plasma dye concentrations over time using linear regression to extrapolate to a calculated dye concentration at the time of injection. Blood volume (BV) was derived from the plasma volume according to Chaiyabutr *et al.* [22] by the following equation:

Blood volume (BV, ml) = Plasma volume (PV, ml)/ (100 - Ht X 0.94) x 100

Where, 0.94 = correction factor for trapped plasma

Erythrocyte volume (RCV, ml) was calculated by subtracting plasma volume from blood volume, intracellular fluid (ICF) volume was calculated by deduction (TBW- ECF), interstitial fluid (ISF) volume was obtained by subtracting PV from ECF.

Determination of Plasma Electrolytes (Na^+, K^+) Concentrations: Plasma electrolytes (Na^+, K^+) concentrations were estimated using Flame photometric method [23].

Statistical Analysis: Data were analyzed with the general linear model (GLM) of SAS, [24]. Sources of variation for all dependent variables were tested. All effects were assumed fixed (breed and treatment). Animals within breeds considered as repeated measurements to avoid the individual differences among animals. Comparisons among means within each classification were tested using Duncan's New Multiple Range Test [25].

RESULTS AND DISCUSSION

Climatic Conditions: Mean climatological values of ambient temperature (AT,°C), relative humidity (RH, %) and temperature-humidity index (THI, unit) for the experimental periods are shown in Fig. 1. From these data we can notice that, climatic conditions values in the

Table 1: Means ± SE of live body weight, total body water, extra-cellular fluids, intra- cellular fluids, interstitial fluids and plasma electrolytes (Na^+, K^+) concentrations in Balady and Damascus goats exposed to direct solar radiation and watered.

	Breed								
	Balady			Damascus			Probability		
Traits	PRE	POST	Average	PRE	POST	Average	B	TRT	B xTRT
LBW (kg)	29.86	29.01	29.43	49.2	47.58	48.39	**	NS	NS
SE±	2.11		1.50	2.11		1.50			
Change%	-2.85			-3.33					
TBW	15.95	15.46	15.70	30.1	28.82	29.48	**	NS	NS
SE±	1.46		1.03	1.46		1.03			
Change	-3.07			-4.38					
ECF	8.08	7.57	7.82	15.4	14.25	14.81	**	NS	NS
SE±	0.52		0.37	0.52		0.37			
Change%	-6.31			-7.29					
ICF (l)	7.90	7.90	7.88	14.8	14.57	14.67	**	NS	NS
SE±	0.98		0.58	0.98		0.58			
Change	0.0			-1.35					
ISF (l)	6.56	5.80	6.18	13.1	11.60	12.34	**	**	NS
± SE	0.47		0.49	0.47		0.49			
Change%	-11.60			-11.40					
Na^+	137.6	154.44	146.01	147.8	153.64	150.7	**	**	*
SE±	1.65		1.17	1.65		1.17			
Change%	12.25			3.98					
K^+	4.5	4.5	4.5	4.9	4.86	4.81	*	NS	NS
SE±	0.14		0.09	0.14		0.09			
Change	0.00			-1.62					

LBW = live body weight, TBW = total body water, ECF = extra-cellular fluid, PRE = pre-exposure;
POST = post-exposure ; ICF = intra-cellular fluid, ISF = interstitial fluid, Na^+ = sodium (mEql/l).
K^+ = potassium (mEql/l); B = Breed; TRT = treatment; * = significant (P<0.05); ** =highly significant (P<0.001);
NS = non-significant Average = Breed effect (B)

Table 2: Means ±SE of plasma, blood, erythrocyte volumes and hematocrit value in Balady and Damascus goats exposed to direct solar radiation and watered.

	Breed								
	Balady			Damascus			Probability		
Traits	PRE	POST	Average	PRE	POST	Average	B	TRT	BxTRT
PV	1.52	1.77	1.64	2.28	2.65	2.47	**	**	NS
SE±	0.09		0.06	0.09		0.06			
Change %	16.45			16.23					
BV	2.21	2.31	2.26	2.99	3.45	3.22	**	**	*
SE±	0.08		0.06	0.08		0.06			
Change %	4.5			15.38					
RCV (l)	0.69	0.538	0.614	0.71	0.796	0.752	NS	NS	NS
SE±	0.07		0.05	0.07		0.05			
Change %	-22.03			12.43					
Ht	26.8	24.8	25.8	25.2	24.6	24.9	**	**	NS
SE±	0.38		0.27	0.38		0.27			
Change %	-7.43			-2.38					

PV = plasma volume, BV = blood volume, RCV = erythrocyte volume, Ht = hematocrit, B = Breed
TRT = treatment * = significant (P<0.05); ** =highly significant (P<0.001); NS = non-significant

mid-day were higher than the critical temperature of 24 to 27°C, for most species [26]. A THI of 74 or less is considered normal, 75 to 78 is alert status, 79 to 83 is danger status and a THI equal to or above 84 is an emergency [27]. In the present study the mean daily THI increased by 3.1, 8.3 and 3.5 units at morning, mid-day and evening, respectively during post-exposure to sunlight compared with pre-exposure periods. These perhaps explain that animals voluntary decrease their feed and water intakes during the day hours when THI increases.

Body Weight Changes: Means ± S.E of live body weight (LBW) during pre and post exposure to direct solar radiation for Balady and Damascus goats are presented in Table 1. The results indicated that, LBW differed significantly ($P<0.001$) where Damascus was heavier than Balady breed. Regarding the effect of exposure to direct solar radiation, the results indicated that 4-days of heat stress caused loss in body weight, the fall in LBW was-2.85 and -3.33% for Balady and Damascus breeds, respectively. This finding indicated that Balady breed posses' great ability to withstand heat stress compared with Damascus breed. The results presented in Table 1 indicated that, the loss of LBW under heat stress was accounted to losses in body fluids from various compartments (TBW, ECF, ICF and ISF). Al-Amer and Al-Hozab [28] found that variations in body weight loss of sheep during winter, spring and summer seasons, was mostly contributed to body water loss related to differences in environmental temperature. The greatest body loss that was observed during summer was in association with respiratory and cutaneous water losses. On contrast, Chaiyabutr *et al.* [29] found that no significant effect in the body weight of buffaloes during exposure to direct solar radiation for 10-days period compared with animals under shade.

The highest weight loss (3.33%) was recorded in Damascus breed, therefore Balady breed have a high adaptation to heat stress and can tolerate 4-day of exposure to direct solar radiation. A possible explanation for the physiological mechanism behind the reduction in LBW under heat stress mainly attributed to two reasons, Firstly, to body water losses [30]. Secondly, may be due to the consequent mobilization of fat (and possibly muscle) used for energy metabolism to compensate the absence of concentrate intake [30].

Body Fluids Response: Means ± SE of total body water (TBW) and their fractions (ECF, ICF, ISF, PV and BV) during pre and post heat stress for Balady and Damascus breeds are presented in Tables 1 and 2. The results indicated that, breed differences ($P<0.001$) were found at the commencement of the study where mean absolute values of TBW, ECF, ICF, ISF, PV and BV recorded the highest for Damascus (30.14, 15.37, 14.77, 13.09 2.285 and 2.99 l) compared with Balady breed (15.95, 8.08 7.9, 6.56, 1.52 and 2.206 l). At the fourth day of exposure to direct solar radiation, TBW, ECF, ICF and ISF fell by -4.38, -7.29, -1.35 and -11.4% fluids lost, respectively for Damascus breed. The corresponding values for Balady breed were-3.07,-6.31, 0.0 and -11.6% fluids lost, respectively. From these results, body fluid losses appeared to be drawn primarily from the ECF and ISF space in both breeds. The percentage changes as a result of 4-days of heat stress were more for Damascus than Balady breed. These results showed that Damascus breed are able to face the imposed heat stress by their greater fluid losses from the ECF, ICF and ISF compartments to increase PV and vasodilation to the skin surface which could reduce the rate of rise in core temperature and enhance thermal stability. Therefore, Balady breed showed enhanced water-conserving ability under heat stress to withstand heat stress with minimal fluid loss compared with Damascus breed. The exposure of animals to direct solar radiation is known to cause a great loss of body water, which lead to a water deprivation if not replaced by drinking water, in the present study during the daylight hours (4-days of heat stress period), animals showed an adaptive mechanism, where animals prevented voluntary drinking water because sunlight caused increase in water temperature and subsequently drinking water became warm water, while at the evening the temperature of drinking water was declined, then the animals enhanced water intake to compensate body fluids lost in heat dissipation mechanisms via breathing and sweating during day hours. Katoh *et al.* [31] reported that sheep enhanced water intake under hot environment because increasing evaporation by panting and salivation, the rate of passage of water drunk increased from reticule-rumen into the lower part of digestive tract (small intestine) and water absorption increased into the intravascular compartment resulting increase in blood volume. Similar results were also indicated by Shebaita and El-Benna [32] and El Nouty *et al.* [33], they reported that, the increase in TBW in a hot environment may be an adaptive mechanism for heat tolerance, since it will allow the animal to store a great amount of heat during the hot hours of the day and dissipate it during the cool hours of the night.

Changes in Plasma Electrolytes (Na^+ and K^+) Levels: Sodium is the main cation in the extra-cellular fluid and by its osmotic action it plays the dominant role for the regulation of body fluid homeostasis. Excess of sodium is mainly excreted by the kidneys. According to the classical view, an increased plasma sodium concentration stimulates vasopressin secretion and thirst which leads to enlarged plasma volume [34]. Means ± SE of plasma Na^+ and K^+ concentrations during pre and post exposure to direct solar radiation are presented in Table 1. The results indicated that, the breed differences in plasma Na^+ and K^+ concentrations were observed at pre-exposure to direct solar radiation with means being greater values in Damascus (147.76±1.19 and 4.94±0.102 mEql/l) compared with Balady (137.58±0.959 and 4.5±0.100 mEql/l) for Na^+ and K^+ concentrations, respectively. Regarding the effect of exposure to direct solar radiation, both breeds increased significantly (P<0.001) plasma Na^+ concentration after 4-days of heat stress. Interestingly, Balady breed showed the larger increase (12.25%) compared with Damascus (3.98%). On the other hand, no change occurred in plasma K^+ concentration of Balady breed, while Damascus decreased plasma K^+ concentration. Silanikove [35] reported that increase of electrolyte concentration in the body fluid of mammals exposed to heat will reduce their thermoregulatory evaporation and allow the body temperature to rise. El-Nouty *et al.* [5] found that serum K^+ concentrations were reduced in cows during prolonged heat stress and they suggested that reductions in serum K^+ was due to loss of potassium in sweat. Also, Singh *et al.* [36] found a decrease in serum potassium concentration of buffalo heifers exposed to heat stress and refer this decrease to potassium loss by sweating through surface evaporation. Therefore, expectation in the present study was that Damascus breed has a greater sweating rate under heat stress than Balady breed, this expectation was evidenced by the rate of TBW loss (-3.07 vs. -4.38 %) for Balady and Damascus breeds, respectively. Previous study by Chaiyabutr *et al.* [37] found that non-shaded Swamp buffaloes showed a marked decrease in plasma K^+ concentration during exposure to the sun, which coincided with an increase of urinary fractional excretion of potassium.

During heat stress, several studies indicate that, many factors could affect the potassium metabolism and balance. Increased urinary excretion of potassium during heat stress has been suggested to be an increase in urinary aldosterone in dairy cattle [38]. It can be concluded that, heat stress for 4 days affect primarily the internal balance of potassium homeostasis in Damascus breed compared with Balady breed, which may include the distribution of potassium between extra-cellular and intra-cellular fluids.

Plasma, Blood, Erythrocyte Volumes and Hematocrit (%) Responses: Means ± SE of PV, BV, RCV and hematocrit percentage during pre and post exposure to direct solar radiation for both breeds are presented in Table 2. The results indicated that the absolute values of PV and BV of the Damascus breed were significantly (P<0.001) higher than that of Balady breed in both pre and post heat stress with available drinking water.

The results indicated that, both breeds were similar in the rate of increase in PV (16.45 vs. 16.23% for Balady and Damascus, respectively), which has advantage for vasodilation process to dissipate heat into the environment without any stress on the heart muscle and to regulate blood flow, where regulation of blood flow is essential for the biological cell functions. The ability of both breeds to maintain their internal temperature is an evolutionary adaptation that allows homeotherms, preventing sunstroke and control of physiological processes. In accordance with the present results, El-Sherif *et al.* [39] found that sun-exposed of watered non-pregnant Barki ewes increased significantly blood and plasma volumes, the increase in plasma volume accounted 10% of ICF. Likewise, Chaiyabutr *et al.* [29] found that on the 5th day of exposure to direct solar radiation, a marked decrease in TBW was noted although it was not reflected in the amounts of plasma volume since fluids might be supplied to the circulation at a similar rate as it was drawn for heat dissipation mechanism of buffaloes. On the contrary, Silanikove [35] reported that increased body fluid loss due to sweating and panting in heat-stressed ruminants under severe dehydration can increase the risk of cardiovascular dysfunction and an inability to maintain euthermia.

Blood volume increased during post heat stress (P<0.001) in both breeds primarily because of a PV increase (P <0.001), the increase in plasma water may also come from the digestive tract, since the digestive tract of watered ruminants contains considerable amounts of water, particularly in the rumen. However, absorption of water from the rumen is relatively slower compared to the lower part of the digestive tract [40]. Therefore, even though there was a possibility of an increased flow rate of rumen fluid resulted from increasing water intake, but the increase was apparently proportional to an increased rate of water absorbed from the lower part of digestive tract. Similarly, Rahardja [3] reported that, the increase in the plasma volume were apparently in proportion to the thermoregulatory requirement of the Jeneponto goat.

This response may be interpreted as a strategy of the Jeneponto goat to cope with the outdoor environment (higher temperature and solar radiation) in which drinking water was provided unrestrictedly.

There are two basic receptors sensing the plasma volume changes, volume and baro-receptors in the atria. Macfarlane and Howard [41] indicated that the mechanism of this response begins with a fall in blood volume brought about by increasing respiration rate-water evaporation. An increase of urine sodium concentration detected by macula densa and blood pressure by Juxtaglomerular apparatus of the kidney, to release rennin, the enzyme which generates ultimately a release of aldosterone which decrease sodium excretion in urine and saliva [42]. With sodium retention in the plasma, water is kept in the plasma and extra-cellular space, which resulted in increasing the plasma volume. Rahardja *et al*., [43] exposed sheep and goat to sunlight over 10 days and found that goat apparently used sweating as the predominant mechanism for cooling. Moreover, goat seemed to be more tolerable to higher heat storage and body temperature than sheep with a significant increase in plasma volume ($P<0.001$) and this may be beneficial to the animals for the prevention of water loss. The results indicated that, the change in blood volume paralleled those of the plasma volume and subsequently hemodilution resulted in a decreased Ht %. In accordance, El-Nouty *et al.* [44, 45] have reported a significant depression in Ht for the heat stressed cattle and they attributed that to the hemodilution effect where more water is transported in the circulatory system for evaporative cooling. Two mechanisms have been suggested to account to PV expansion after heat acclimation. First, increased renal electrolyte and water retention [46], which would increase the entire ECF space. Second, an elevated plasma protein content [47], which would selectively expand PV at the expense of the ISF.

Finally, both breeds were more uniform in activate the physiological mechanisms during exposure to direct solar radiation (increased plasma Na^+ concentration, plasma volume and decreased Ht percentage) to be maintained in the face of the surrounding heat, but Balady breed showed to be superior in this protective mechanism by resulted the less percentages in LBW loss, fluid regulation mechanism between body fluids compartments (TBW, ECF, ICF and ISF) and maintain of plasma K^+ concentration constant during pre and post heat stress periods compared with Damascus breed.

CONCLUSION

It was concluded that, the results from this study clearly showed that Balady and Damascus breeds were more uniform in their defense against heat stress by the retention of intravascular Na^+ and elevation in plasma volume which accompanied by expansions the other extra-vascular body fluid compartments, but Damascus breed was more susceptible to heat stress compared with Balady breed.

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