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SOME PHYSIOLOGICAL AND BIOCHEMICAL RESPONSES OF GROWING MALE SYRIAN GABALY GOATS AS AFFECTED BY SEASONAL CLIMATIC CHANGES IN THE NEWLY RECLAIMED AREAS.

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ABSTRACT

The present study was carried out at Maryout Research Station (32°n latitude, 35 km southwest of Alexandria) which belongs to the Desert Research Center, Ministry of Agriculture and Land Reclamation. Ten male Syrian Gabaly goats, aged 2 months on average were used to study the effects of seasonal climatic changes on some physiological and blood biochemical parameters throughout a year in such newly reclaimed area.

Results demonstrated that season had a significant effect on RT, ST, RR and CT goats. The highest overall mean value of rectal temperature was observed in summer followed by winter, autumn and spring, respectively, while spring had the highest values of skin and coat temperatures. The higher value of respiration rate was recorded in summer followed by spring season, especially in the afternoon, which indicated that this parameter was more affected by the ambient temperature. The mean values of the physiological responses of goats during different seasons showed a trend of increase from CT via ST to RT, and it also increased from 08.00 hr to 14.00 hr parallel to increasing AT.

Season had a significant effect on plasma concentrations of TP, A, G and plasma concentrations of T_4 while it did not affect T_3 levels in goats. In summer, the kids had the highest values of total protein, albumin and globulin. The A/ G ratio did not significantly vary among seasons. The lowest concentrations of T_3 and T_4 were recorded in summer, while the highest values were observed in spring and winter, respectively.

It could be concluded that season had a significant effect on the thermo-respiratory responses and some blood biochemical parameters under consideration of the growing male Syrian Gabaly goats, which in turn may associate with the change in thyroid gland activity.

Keywords: Season, Male Syrian Gabaly goats, Thermo-respiratory responses, blood proteins, Thyroid function

INTRODUCTION

Small ruminants are believed to have the widest ecological range of domestic livestock, ranging from extremes of tropical rain forests to dry deserts where other animals cannot exist. Goats have a higher ability to survive under unfavorable conditions and exceed sheep and cattle in their tolerance (Shelton, 1977). Hence, goats form an important segment of animal resources in the desert regions. Goat populations in Egypt are 3.5 million heads (FAO, 2004).

The majority of goats' population is raised mainly in the desert of Egypt. Goats possess relative privileges in harsh environment due to their unique characteristics and adaptability. In Egypt, a flock of Syrian Gabaly goats was imported in 1997. However, the effect of seasonal changes on the physiological responses and blood metabolites especially for kids of this breed were not investigated yet under Egyptian desert conditions.

Therefore, this investigation was carried out to study the possible effects of seasonal variations on the thermo- respiratory responses and some blood metabolites of Syrian goats.

MATERIALS AND METHODS

1- Location:

The present study was carried out at Maryout Research Station (32°n latitude, 35 km southwest of Alexandria) which belongs to the Desert Research Center, Ministry of Agriculture and Land Reclamation.

2- Experimental purpose:

This work was carried out to study the effects of seasonal variations throughout the whole year on the thermo- respiratory responses and some blood metabolites of male Syrian Gabaly goats.

3- Experimental animals and treatments:

Ten male Syrian Gabaly kids, aged 2 months on average, were housed indoors inside a semi-closed pens, roofed with metal and walled in the four directions with concrete.

Drinking water was available for the animals twice a day. All animals were fed on Berseem (*Trifolium alexandrinum*) hay offered *ad libitum* plus a concentrate mixture contained at least 61% total digestible nutrients (TDN) and 11.5% digestible proteins according to NRC (1985) requirements.

4- Meteorological, physiological and hematological measurements:

4-1- Meteorological data:

Meteorological data in terms of ambient temperature (AT,°C) and relative humidity (RH,%) were recorded twice daily at 08.00 and 14.00 hr throughout the experimental period. Both AT and RH were monitored using hygro-thermographs (Model 8368– 60, Cole- Parmer instrument Co., Chicago, IL, USA). The instruments were fixed in each pen about two meters above the floor.

4-2- Physiological parameters:

Rectal temperature (RT, °C), respiration rate (RR, breaths/min), skin temperature (ST, °C) and coat temperature (CT, °C) were recorded for all animals twice a day (at 08.00 and 14.00 hr) for two successive days every 90 days throughout the experimental period. Respiration rate (RR) was recorded by counting the flank movements for a minute. All possible precautions were taken into consideration to avoid disturbing the animals during counting. Rectal temperature (RT, °C) was measured by using a standard clinical thermometer inserted gently into the animals' rectum for approximately two inches, then after a minute body temperature was recorded to the nearest 0.1 °C. Skin temperature (ST, °C) was measured on a shaved area in the mid-side position using an electronic digital tele-thermometer (Model 43 TD, Yellow Springs Instrument Co., Ohio, USA).

Table (1): Mean values of meteorological data recorded at 8.00 and 14.00 hr. throughout the year seasons.

Season	08.00 hr	14.00 hr	Change	Overall mean
	Ambient temperature (AT,°C)			
Summer	27.00	29.50	+2.50	28.25
Autumn	22.00	26.50	+4.50	24.25
Winter	12.00	18.00	+6.00	15.00
Spring	16.00	23.00	+7.00	19.50
	Relative humidity (RH, %)			
Summer	65.50	57.00	-08.50	61.25
Autumn	76.00	58.00	-18.00	67.00
Winter	83.00	64.00	-19.00	73.50
Spring	65.00	57.00	-08.00	61.00

Coat temperature (CT, °C) was measured on the mid- side position at a side close to that of the measuring skin temperature using the same previous electronic digital tele-thermometer. The probe was located gently on the coat surface.

4-3- Hematological parameters:

4-3-1- Blood sampling:

Blood samples were collected monthly using a clinical needle through vein puncture of the jugular vein into clean tube containing EDTA (Na^2 ethylene diaminetetra acetic acid). Blood samples were taken in the early morning just before feeding and drinking.

The blood samples were centrifuged for 15 minutes at 3000 rpm and plasma was collected and stored at -20 °C until analyzed.

4-3-2- Total proteins concentration (g/dl):

Assay of total protein (TP) was carried out using a test kit (Egyptian-American Company for Laboratory Services) according to the Biuret method as described by Armstrong and Carr (1964). Albumin (A) was determined according to Doumas et al. (1971). Concentration of globulin (G) was calculated by subtracting the value of albumin from the total protein value.

4-3-3- Triiodothyronine (T_3) and thyroxine (T_4) concentrations:

Plasma concentrations of T_3 (nmol/L) and T_4 (nmol/L) were determined by a solid - phase radioimmunoassay (RIA) kits (Diagnostic Products Corporation, Los Angeles, CA, USA). The standard curve of T_3 ranged from 0.0 to 12.0 nmol/L, while the sensitivity value was 0.11 nmol/L. On the other hand, the standard curve of T_4 ranged from 0- 400 nmol/L, while the sensitivity value was 0.16 nmol/L. The antibody-coated tubes were labeled in duplicate for the different concentrations of calibrators and samples.

5- Statistical procedure:

Data were analyzed using General Linear Model procedure (SAS, 1998).

RESULTS AND DISCUSSION

1- Thermo-respiratory responses:

1-1- Rectal temperature (RT, °C):

The overall mean values of rectal temperature during different seasons indicated that Syrian Gabaly goats were able to sustain homethermy keeping their body temperature within a narrow range (39.13 and 39.78 °C in the morning and the afternoon, respectively) regardless of the considerable difference in ambient temperature and relative humidity (Tables 1 and 2).

Regardless of the effect of daytime, the mean values of RT of Syrian Gabaly goats showed a significant seasonal rhythm with values being 39.65, 39.31, 39.60 and 39.26 °C in summer, autumn, winter and spring, respectively. These results revealed that the changes in RT of goats followed the fluctuations observed in AT throughout the four seasons (Tables 1 & 2). Similar seasonal variations in RT were reported in sheep and goats (Shaker, 2003; Taha, 2004 and Shaker et al., 2005).

Since the lowest AT was observed in winter season, animals try to raise their metabolic rate and subsequently their RT to compensate the higher difference between the body- coat temperature and the temperature of the surrounding environment which accelerates the heat dissipation from animal's body to the environment. In accordance, El-Shafie (1997) revealed that young kids had higher values of rectal temperature brought into being by higher metabolic rate to compensate the great heat loss due to the lower insulation efficiency of coat and larger ratio of surface area to body weight.

Concerning the effect of daytime, the RT of Syrian Gabaly goats increased significantly ($p<0.01$) as the daytime progressed. The overall mean of RT was 39.13 and 39.78 °C in goats at 08.00 and 14.00 hr, respectively. Similar trend was obtained by Abou El- Ezz (2000), El- Ganaieny et al. (2001) and Shaker et al. (2005).

It is interesting to note that the diurnal changes in RT in male Syrian Gabaly goats was the highest in spring season, being 1.54 °C (Table 2) which might be due to the highest diurnal changes in AT that observed in spring (Table 1). Consistently, El- Rayis (2005) found observed that RT values in spring and summer seasons were nearly similar in spite of the higher maximum AT (39.9 vs. 34.3 °C) and TSR (44.6 vs. 36.3 °C) in summer versus spring.

Table (2): Least square means± SE of rectal temperature (°C) of Syrian Gabaly goats throughout the year seasons.

Season	Daytime		Change (%)	Overall mean
	08.00 hr	14.00 hr		
Summer	39.46 ± 0.126^{Aa}	39.83 ± 0.126^{Bab}	+0.37 (0.94)	39.65 ± 0.089^{a}
Autumn	39.12 ± 0.178^{Aab}	39.50 ± 0.178^{Ab}	+0.38 (0.97)	39.31 ± 0.126^{bc}
Winter	39.46 ± 0.178^{Aa}	39.74 ± 0.178^{Aab}	+0.28 (0.71)	39.60 ± 0.126^{ab}
Spring	38.49 ± 0.126^{Ac}	40.03 ± 0.126^{Ba}	+1.54 (4.00)	39.26 ± 0.098^{c}
Overall mean	39.13 ± 0.077^{A}	39.78 ± 0.077^{B}	+0.64 (1.66)	39.45 ± 0.084

Change (%) = change due to 14.00 hr
Means within the same row having the same capital letter do not differ significantly.
Means within the same column having the same small letter do not differ significantly.

1-2- Skin temperature (ST, °C):

The mean values of skin temperature of Syrian Gabaly goats almost showed the same trend of RT where the highly significant differences among the four seasons were related to those in AT. The mean values of ST were 31.88, 26.10, 24.20 and 33.85 °C in summer, autumn, winter and spring, respectively (Table 3). These results are in accordance with those obtained by Badawy et al. (1999), El-Ganaieny et al. (2001) and Shaker (2003). Barghout et al. (1995) reported that there was a highly significant correlation between ST and both AT and RH. El-Ganaieny et al. (2001) demonstrated that ST values in goats were the highest in summer followed by spring and winter.

In all seasons of the year, the highly significant increase of ST values from morning tc afternoon in goats (26.94 vs. 31.08°C) was correlated with the increase occurred in AT values (Tables 1 and 3). Similar results were reported by many authors (Barghout *et al.*, 1995; Azamel *et al.*, 1996; El-Shafie, 1997; El-Sayed et *al.*, 1999; Hekal, 2001; Shaker et al. 2005).

Badawy et al. (1999) declared that ST of goats tended to increase from the morning to the midday and then declined gradually as the AT decreased eventually throughout the day.

In the morning, spring season had the highest ST, which might be due to high RH% as shown in Table (1). This finding could be supported by results of Pagot (1992), who demonstrated that level of the RH affects the efficiency of evaporative cooling function either by skin or respiratory system. Consistently, Morrison (1983) reported that the heat stress of high air temperature could be intensified by high humidity and low air movement surrounding the animals. Moreover, AT values in winter and spring at the morning times were nearly below the thermoneutral zone of goats (20-30 °C) as reported by El-Sherbiny (1983). In the afternoon, the present results also showed that spring had the highest ST in goats.

1-3- Coat temperature (CT, °C):

Spring had the highest coat temperature values (29.55 °C) followed by summer (28.75 °C) then autumn (20.40 °C) and winter (15.20 °C) (Table 4). The highly significant differences among the four seasons of coat temperature values showed that coat temperature of Syrian Gabaly goats followed their skin temperature recorded throughout the different seasons.

Table (3): Least square means±SE of skin temperature (°C) of Syrian Gabaly goats throughout the year seasons.

Season	Daytime		Change (%)	Overall mean
	08.00 hr	14.00 hr		
Summer	30.85±0.257^{Aa}	32.90±0.277^{Ba}	+2.05 (6.65)	31.88±0.196^{a}
Autumn	23.60±0.392^{Ab}	28.60±0.392^{Bb}	+5.00 (21.19)	26.10±0.277^{b}
Winter	21.40±0.392^{Ac}	27.00±0.392^{Bc}	+5.60 (26.17)	24.20±0.277^{c}
Spring	31.90±0.277^{Ad}	35.80±0.277^{Bd}	+3.90 (12.23)	33.85±0.196^{d}
Overall mean	26.94±0.170^{A}	31.08±0.170^{B}	+4.14 (16.56)	29.01±0.564

Change (%) = change due to 14.00 hr

Means within the same row having the same capital letter do not differ significantly.

Means within the same column having the same small letter do not differ significantly.

Table (4): Least square means±SE of coat temperature (°C) of Syrian Gabaly goats throughout the year seasons.

Season	Daytime		Change (%)	Overall mean
	08.00 hr	14.00 hr		
Summer	27.40±0.540[Aa]	30.10±0.540[Ba]	+2.70 (9.85)	28.75±0.382[a]
Autumn	17.00±0.763[Ab]	23.80±0.763[Bb]	+6.80 (40.00)	20.40±0.540[b]
Winter	12.00±0.763[Ac]	18.40±0.763[Bc]	+6.40 (53.33)	15.20±0.540[c]
Spring	26.50±0.540[Aa]	32.60±0.540[Bd]	+6.10 (23.02)	29.55±0.382[a]
Overall mean	20.72±0.330[A]	26.22±0.330[B]	+5.50 (31.55)	23.47±0.825

Change (%) = change due to 14.00 hr.
Means within the same row having the same capital letter do not differ significantly.
Means within the same column having the same small letter do not differ significantly.

The present results were in consistency with those reported by Bianca (1968), where the decline of ST was inversely correlated with the density of the coat on the different regions of the animal's body (Table 4).

Concerning the effect of the daytime, the mean values of CT increased (P<0.01) from the morning to the afternoon. This increase in CT due to the day- time effect represented about 31.55%. Shaker (2003) found that summer coat temperature of goats increased from the morning (32.66 °C) to the afternoon (38.39 °C). El-Ganaieny *et al.* (2001) reported that coat temperature of sheep increased from the morning to the afternoon in almost all seasons.

1-4- Respiration rate (RR, breaths/min):

Irrespective of the day-time effect, the mean values of RR were 44.20, 31.60, 30.00 and 33.80 breaths/min in summer, autumn, winter and spring, respectively (Table 5). These significant (P<0.01) changes in RR during the different seasons followed in a parallel manner the fluctuations in AT throughout the year. Similarly, Abdel-Fattah (1994) found that seasonal variation in RR of sheep and goats tended to be much higher in summer than winter.

Table (5): Least square means± SE of respiration rate (breaths/min) of Syrian Gabaly goats throughout the year seasons.

Season	Daytime		Change (%)	Overall mean
	08.00 hr	14.00 hr		
Summer	40.20±1.709[Aa]	48.20±1.709[Ba]	+08.00 (19.90)	44.20±1.209[a]
Autumn	30.80±2.418[Ab]	32.40±2.417[Ab]	+01.60 (05.19)	31.60±1.710[b]
Winter	26.80±2.418[Ab]	33.20±2.417[Ab]	+06.40 (23.88)	30.00±1.710[b]
Spring	26.20±1.710[Ab]	41.40±1.710[Bc]	+15.20 (58.02)	33.80±1.209[b]
Overall mean	31.00±1.049[A]	38.80±1.049[B]	+7.80 (26.75)	34.90±1.196

Change (%) = change due to 14.00 hr.
Means within the same row having the same capital letter do not differ significantly.
Means within the same column having the same small letter do not differ significantly.

The respiration rate was more sensitive to changes in ambient temperature and it followed the daily rhythm of ambient temperature (Tables 1 and 5) being higher in the afternoon than that in the morning. This could be explained by the hypothesis that regulation of heat dissipation depends on respiration as a main avenue, which is affected mainly by peripheral- stimuli than by central stimuli (Hardy, 1974). Similarly, Azamel *et al.* (1996) showed that evaporation water loss through the respiratory tract was the main avenue for heat dissipation in heat stressed goats. This response would involve in the peripheral receptors and the heat center of the hypothalamus to stimulate the respiratory musculature work for increasing respiratory vaporization. Moreover, Guirgis *et al.* (1992) stated that respiratory cooling, as a means of heat dissipation, would be achieved by an increase in respiratory rate.

2- Biochemical metabolites:

2-1- Blood plasma proteins:

The overall means of blood plasma biochemical parameters recorded were 7.14, 3.67 and 3.57 (g/dl) for TP, A and G, respectively, with A/G ratio of 1.028 (Table 6). Shebaita *et al.* (1993) reported that concentrations of TP, A and G in male goats were 7.2, 5.3 and 1.9 g/dl, respectively.

The summer season achieved the highest mean values of TP, A and G (Table 6). The differences in TP, A and G concentrations due to the season effect were highly significant.

The lowest values of TP and G were observed in autumn. However, the highest values of A/G ratio were reported in autumn. Rowlands *et al.* (1979) reported that seasonal changes in blood proteins could be attributed to differences in environmental temperature, relative humidity, day length and exercise or from the changes in nutrition and energy planes. Shoukry (1981) reported that the G concentration followed the same trend of TP concentration, and the increase in the plasma TP concentration occurred via the increase in plasma G concentration. The present results demonstrated that summer season had the highest A value and trended to elevate A/G ratio which might support its role to maintain a constant osmotic pressure. In accordance with the present results, Khalifa (1982) suggested that the higher A/G ratio in summer would increase plasma colloidal osmotic pressure, which may help in conserving water.

Table (6): Least square means± SE of plasma total protein (TP) (g/dl), albumin (A) (g/dl), globulin (G) (g/dl) and A/G ratio for Syrian Gabaly goats throughout the year seasons.

Season	TP	A	G	A/G ratio
Summer	7.81±0.117^{a}	4.03±0.071^{a}	3.77±0.062^{a}	1.069±0.018
Autumn	6.69±0.117^{b}	3.80±0.071^{b}	3.33±0.062^{b}	1.141±0.018
Winter	6.94±0.144^{bc}	3.28±0.087^{b}	3.66±0.076^{ac}	0.896±0.022
Spring	7.13±0.144^{c}	3.59±0.087^{c}	3.54±0.076^{c}	1.014±0.022
Overall mean	7.142±0.628	3.675±0.405	3.575±0.293	1.028±0.090

In each column any two means having the same letter do not differ significantly.

2-2- Triiodothyronine and thyroxine profiles:

The present results demonstrated that spring had the highest T_3 and T_4 concentrations followed by winter then autumn. Summer season had the lowest concentrations of T_3 and T_4 (Table 7). Although differences in T_3 concentrations during the four seasons were not significant, there were highly significant differences (P<0.01) among the seasons in T_4 concentrations of male Syrian Gabaly goats. These significant differences among the seasons could be expected since the thyroid gland is intimately linked to the environmental temperature and the variation in its function is affected by the stressful conditions (El-Shafie, 1997). Moreover, the results revealed that there was an inverse relationship between AT and thyroid secretion where its secretion was lower when the AT reached its highest values (Tables 1 and 7).

These results were in accordance with those early reported by Ryder (1979) where the serum thyroxine level in ewes and rams increased from December to May, which demonstrated a seasonal cycle in thyroxine level. In a harmony with the present results, Macferlane (1982) reported that thyroid secretion rate was higher in goats, sheep, cattle and camel when green feed was available in spring. Thompson *et al.* (1963) reported that thyroxine secretion, turnover rates and protein iodine values decreased under hot conditions. In consistency, a relationship has been found between thyroid activity and environmental temperature, in which thyroid function is dependent mainly on environmental temperature and not on feed intake (Johnson and Yousef, 1966). Hafez (1968) stated that the intimate relationship between thyroid activity and environmental temperature is one of the means by which animals adapt themselves to an environment above or below the thermoneutral temperature.

Table (7): Least square means± SE of plasma triiodothyronine (T_3) and thyroxine (T_4) (nmol/L) of Syrian Gabaly goats throughout the year seasons.

Season	T_3	T_4
Summer	1.75±0.134	41.79±3.666[a]
Autumn	2.48±0.189	55.84±5.185[b]
Winter	2.85±0.189	78.76±5.185[c]
Spring	3.05±0.189	84.37±5.185[c]
Overall mean	2.53±0.110	65.19±3.510

In each column any two means having the same letter do not differ significantly.

In addition, the present results were in consistency with those reported by Aboul-Ela *et al.* (1987) who found that both T_3 and T_4 concentrations in plasma of sheep were the highest in winter and the lowest in summer. The reduced plasma T_3 and T_4 concentration levels in summer may be resulted from a decline in the feed intake or rising both core and skin temperatures rather than a direct environmental heat load effect on thyroid releasing hormone (TRH) according to Johnson (1980). Additionally, Abdalla *et al.* (1991) found that hyperthermia (35 °C, 55% RH) decreased calorigenic hormones (cortisol and T_3) in pregnant and lactating ewes. Moreover, Jindal (1980) reported that there is an agreement about the fact that the thyroid gland activity in different breeds of goats increased in moderate cold environment and is depressed in high temperatures. Consistently, Johnson and Vanjonack (1976) observed that the plasma T_4 was significantly lower in the hot afternoon than in the cooler early hours. However, the low value of T_3 in winter might be attributed to the high utilization of T_3 during cold season as a result of increasing metabolic rate in order to cope with the low ambient temperature in winter. However, Abdel-Bary (1982) reported that no clear trend was observed in this concept in adult ewes.

It could be concluded that season could affect the physiological and biochemical responses of the growing male Syrian Gabaly goats that may associate with the thyroid gland functions.

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بعض الاستجابات الفسيولوجية والبيوكيميائية لذكور الماعز الجبلى السورى النامية لتأثير التغيرات المناخية الموسمية فى المناطق حديثة الاستصلاح

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أجريت هذة الدراسة فى مجطة بحوث مريوط (٣٥ كيلومتر جنوب غرب الاسكندرية) والتابعة لمركز بحوث الصحراء واستخدم فى هذة التجربة عشرة ذكور ماعز جبلى سورى نامية بمتوسط عمر شهرين لدراسة تأثير التغيرات الموسمية على الصفات الفسيولوجية والبيوكيميائية خلال عام كامل.

اوضحت النتائج ان للموسم تاثير معنوى على كل من درجة حرارة المستقيم والجلد وغطاء الجسم وكذلك معدل التنفس. وان اعلى درجة حرارة للجسم والغطاء وكذلك معدل التنفس سجلت فى فصل الصيف بينما اعلى درجة حرارة للجلد سجلت فى فصل الربيع. كما اوضحت النتائج ارتفاع القياسات الفسيولوجية خلال النهار نتيجة لارتفاع درجة حرارة البيئة المحيطة. كما اوضحت النتائج تاثير الموسم على تركيز كل من البروتينات الكلية والالبيومين الجلوبيولين وكذلك نسبة الالبيومين/ الجلوبيولين وتركيز هرمون الثيروكسين بينما لم يتاثر مستوى هرمون ثلاثي اليود.

الخلاصة: نستلخص من هذا البحث أن هناك تأثير معنوى لفصل السنة على الاستجابات الحرارية والتنفسية وكذلك القياسات البيوكيميائية للدم فى ذكور الماعز الجبلى السورى النامية والتى ترتبط بنشاط الغدة الدرقية.