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Effects of Wool Coat Length and Water Deprivation on Seasonal Changes in Thyroid and Adrenal Cortical Functions

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TWENTY-NINE Barki ewes (Egyptian fat tailed breed) were used in this study. They were divided according to their wool length into 9 unshorn, 10 half-shorn and 10 shorn. Each of the three groups of sheep was divided into two subgroups : one was given water **ad libitum** and the other was deprived of water for a period of 72 hr in summer and 96 hr in winter. During the experimental period, all ewes were kept under shade and the control group was separated from the water deprived animals. Blood samples were collected every 24 hr for measurements of cortisol, T_3 and T_4. In both summer and winter, cortisol and T_4 were not affected significantly by water deprivation. However, plasma T_3 levels were reduced in the dehydrated group during the summer, perhaps due to direct effect of water deprivation. Thus decreased T_3 levels may be an adaptive mechanism to conserve water. Higher plasma T_3 levels were observed during the winter season in hydrated ewes especially in the shorn ones, which may be due to cold stress at night.

Key words : Sheep, wool length, water deprivation, thyroid and adrenal function.

Thyroxin and triiodothyronine (T_4 and T_3) are recognized as powerful metabolic agents in sheep (Khalil, 1980; Khalifa, 1982 and Abd-el-Bary, 1982). Heat acclimation and/or acclimatization causes an increase in body temperature and a decrease in thyroid activity of many animals including sheep (Valtorta *et al.*, 1982). Reduced Feed intake was found not to be a primary factor in decreased thyroid function during acclimation to heat (Yousef *et al.*, 1968). High ambient temperatures seem to have a direct influence in decreasing thyroid activity and this effect is probably initiated at the hypothalamic level. In contrast to the effect of heat, cold temperature is known to increase thyroid function in sheep (Young, 1981 and Valtorta *et al.*, 1982).

Cortisol is recognized as a calorigenic agent in sheep (Khalil, 1980; Khalifa, 1982 and El-Sherbiny, 1983). Khalil (1980) suggested that reduced plasma levels of cortisol in heat acclimated animals may be a beneficial regulatory mechanism for reducing the animal's heat production.

Few studies have reported the effects of water restriction or dehydration on thyroid and adrenal cortical functions (Howard *et al.*, 1977; Yagil *et al.*, 1978; El-Nouty *et al.*, 1978; Khalil, 1980; El-Sherbiny, 1983 and El-Sherbiny *et al.*, 1983). These studies suggested that the decreased thyroid function in dehydrated animals was due to a direct effect of lack of water and not due to changes in caloric intake, since diet and appetite remained unchanged during dehydration.

In this paper, the effects of wool coat length and dehydration on the seasonal changes of thyroid and adrenal cortical hormones are described with special reference to sheep. Hormonal output of these glands is known to regulate the amounts of water and energy passing through various mammals, (Assenmacher and Farner, 1978).

Material and Methods

In the present experiments, 29 Barki ewes (a local fat tailed breed of Egypt), 3-3.5 years old with an average body weight of 29.64 ± 0.70 kg were used. The animals were maintained at an experimental station supervised by the Faculty of Agriculture, Al-Azhar University and located at El-Hammam, Matrouh Governorate, Egypt. Before and during conducting these experiments all animals were kept under semi-open sheds day and night. They were fed on hay and concentrates according to their body weight requirements (Morrison, 1959). Water was provided *ad libitum* twice daily during the pre-experimental periods. All animals were healthy and clinically free from diseases.

The experimental animals were divided according to their wool length into 9 unshorn, 10 half-shorn and 10 shorn. The unshorn group had a mean wool length of 14.67 ± 1.07 cm and 11.95 ± 0.52 cm in summer and winter respectively and a mean fibre diameter of 27.77 ± 1.69 um and 31.53 ± 1.15 um in the same respective order. The half-shorn group had a mean wool length of 3.75 ± 0.19 cm and 2.70 ± 0.16 cm in summer and winter respectively and a mean fibre diameter of 32.51 ± 1.58 um and 27.56 ± 0.73 um in the same respective order. In this group shearing was performed about three months prior to the start of the experiments. In the shorn animals shearing was carried out 25 days prior to the start of the experiments in order to avoid the effect of shearing on the measured parameters (Slee and Sykes, 1967 and McNatty *et al.,* 1972).

Experiments were carried out in normal and water deprived ewes during each of the summer (July and August) and winter (January and February) seasons.

In each experiment each of the three groups was divided into two subgroups one was given *ad libitum* water and the other was deprived of water for 72 hr in summer and 96 hr in winter. Animals were weighed at the beginning and every 24 hr thereafter during the experimental period and the percent dehydration was calculated.

Blood was collected by jugular vein puncture at zero time (08.00h) and then again every 24 hr thereafter. Plasma samples were analyzed by radioimmunoassay for cortisol, thyroxin and triiodothyronine using Radioassay System Laboratories kits (1511 East Del Amo Boulevard Carson, California 90746, U.S.A.).

The length and diameter of wool fibres were measured during summer and winter seasons using wool samples that were taken from the right-mid-side position of the animals. Fibre length and diameter were measured according to the I.W.T.O. (1952 and 1961).

Ambient temperature (Ta) (*i.e.* dry bulb temperature) and percent relative humidity (RH) were measured by a thermohygrograph located about 1.5 meters from the ground. The meteorological data are presented in Table (1).

The statistical analyses of the multifactor experiments having repeated measures on the same animal were carried out as performed by Winer (1971), "t" test was carried out to test the significance between the normal and dehydrated groups within each time and within each wool length group (Snedecor and Cochran, 1973 and Ronald, 1974).

Results and Discussion

Meteorological data during the experimental periods presented in Table (1) revealed that the animals were exposed to heat stress during the summer season since the upper limit of the thermoneutral zone for sheep is about 24°C (Hahn, 1982). During the winter season, the shorn animals were probably exposed to cold stress at night (Khalil, 1980).

TABLE 1. Meteorological data at the site of the experiments during the course of measurements.

Water deprivation period	Season							
	Summer				Winter			
	Ta Max	C Min	RH% Max	RH% Min	Ta Max	C Min	RH% Max	RH% Min
Zero-24 hrs	33	24	76	36	21	10	70	48
24-48 hrs	32	24	71	40	22	8	78	36
48-72 hrs	33	23	74	46	24	8	83	25
72-96 hrs					24	9	86	32

Body weight

In summer, after 72 hr of water deprivation the percent body weight loss was 11.81%, 12.31% and 15.25% for the shorn, half-shorn and unshorn ewes respectively. Respective figures in the winter season, after 96 hr of water deprivation, were 20.62%, 22.47% and 25.51%. Several workers (More and Sahni, 1978; have reported similar loss in body weight during water deprivation in sheep. In both seasons the percent dehydration (% body weight loss) was greated as wool length increased. This result is perhaps due to higher respiration rates (respiratory evaporation) in the unshorn ewes as they were under shade resulting in greater loss in body fluid content (Khalil *et al.*, 1985 and Khalil, 1990).

Cortisol

The average plasma cortisol levels for all subgroups at different intervals of the water deprivation period in both seasons are presented in Tables (2 and 3). There was no significant differences in plasma cortisol levels between the hydrated (control) and the water deprived groups in both seasons.

In summer the overall mean of plasma cortisol levels for the hydrated (control) subgroups was 2.77 ± 0.28, 2.74 ± 0.20 and 3.11 ± 0.30 ug/dl for the shorn, half-shorn and unshorn ewes respectively. Respective levels in winter season were 1.84 ± 0.31, 1.85 ± 0.20 and 1.84 ± 0.10 ug/dl respectively. These results indicated no differences in plasma cortisol levels between subgroups of different wool lengths, in both seasons.

In summer, regardless of the wool coat, plasma cortisol levels increased after 48 hr of water deprivation stress by 18.7% and 34.0% for the control and water deprived groups respectively. However, after 72 hr of water deprivation cortisol levels were reduced by 11.2% and 4.4% in the same respective order. These results suggest that the initial rise in cortisol level in the dehydrated group was perhaps the result of general stress reaction which is not specific to either the exposure or water deprivation. Long-term water deprivation decreased plasma cortisol levels to approximately its normal levels, a finding similar to long-term effects of heat exposure (Yousef and Johnson, 1967 and Christison and Johnson, 1972 and Yousef, 1979).

Regardless of the wool length, in the hydrated control group, the overall mean plasma cortisol level was significantly higher ($p < 0.05$) in summer (2.87 ± 0.15 ug/dl) than in winter (1.84 ± 0.13 ug/dl). These data disagree with the results obtained using the same breed of sheep at the same location in which the winter season was associated with higher plasma cortisol levels than the summer (Khalifa, 1982 and El-Sherbiny, 1983). The seasonal changes in glucocorticoid activity is perhaps associated with the great daily changes in environmental temperature during the winter (Yousef *et al.,* 1971). In the present study plasma samples were taken every day at 8 a.m. in both seasons. Khalil (1980), found in Barki sheep at the same location that in summer plasma cortisol levels were minimum between 4 p.m. and 12 m.n and maximum at 8 a.m. On the other hand, he also found that the minimum plasma cortisol levels in winter was at 8 a.m., while the maximum was at 12 m.n. with an increase of 52%. This increase was attributed to the cold stress under which the animals were housed at night. Moreover, he also found that at 8 a.m. plasma cortisol levels were higher in summer than that of the winter, while the overall mean for 6 sampling times per day revealed higher cortisol levels in winter

TABLE 2. Means ± standard errors of cortisol, triiodothyronine and thyroxin of hydrated (control) and water deprived shorn, half-shorn and unshorn Barki ewes during 72 hr water deprivation period in summer season.

Wool coat length	Water deprivation period	Cortisol (ug/dl.)		Triiodothyronine (ng/dl.)		Thyroxin (ug/dl.)	
		Control	Water deprived	Control	Water deprived	Control	Water deprived
Shorn	Zero time	2.66 ± 0.57	2.49 ± 0.60	57.63 ± 2.1	54.20 ± 6.30	6.82 ± 0.60	6.56 ± 1.01
	24 hr	2.88 ± 0.36	1.92 ± 0.40	74.00 ± 12.2	79.00 ± 5.5	5.60 ± 0.68	6.18 ± 0.90
	48 hr	3.44 ± 0.49	2.85 ± 0.57	92.50 ± 19.0	110.00 ± 29.00	4.80 ± 0.67	4.98 ± 0.74
	72 hr	2.09 ± 0.28	2.59 ± 0.53	76.30 ± 11.9	78.00 ± 4.30	7.26 ± 0.86	7.06 ± 1.03
Half-shorn	Zero time	3.29 ± 0.70	1.95 ± 0.50	53.80 ± 2.1	50.80 ± 3.10	6.30 ± 0.37	6.60 ± 1.14
	24 hr	2.23 ± 0.69	2.71 ± 0.26	63.30 ± 4.7	68.00 ± 4.8	5.27 ± 0.81	5.94 ± 0.72
	48 hr	2.74 ± 0.57	3.70 ± 0.28	98.00 ± 21.0	68.00 ± 11.30	4.13 ± 0.29	4.28 ± 0.31
	72 hr	2.61 ± 0.84	2.10 ± 0.40	75.50 ± 3.9	85.50 ± 5.60	5.43 ± 0.43	7.43 ± 1.18

TABLE 2. (Cont.).

Un-shorn	Zero time	2.49 ± 0.56	2.84 ± 0.67	52.00 ± 3.4	57.80 ± 2.40	5.43 ± 0.77	5 77 ± 0.79
	24 hr	3.04 ± 0.50	2.18 ± 0.39	67.40 ± 7.7	82.00 ± 8.2	4.20 ± 0.57	7.84 ± 1.64
	48 hr	3.93 ± 0.23	3.58 ± 0.51	166.70 ± 31.90	96.70 ± 19.70	5.47 ± 0.70	5.40 ± 0.63
	72 hr	2.99 ± 0.45	2.46 ± 0.42	75.50 ± 5.50	70.80 ± 4.90	8.48 ± 0.62	5.45 ± 0.27
Over-all mean	Zero time	2.78 ± 0.33	2.50 ± 0.35	56.20 ± 1.6	54.50 ± 2.50	6.17 ± 0.37	6.42 ± 0.47
	24 hr	2.82 ± 0.27	2.24 ± 0.37	68.10 ± 4.6	76.30 ± 3.7	4.98 ± 0.40	6.63 ± 0.65
	48 hr	3.30 ± 0.30	3.35 ± 0.28	112.20 ± 13.4	91.10 ± 12.70	4.80 ± 0.36	4.88 ± 0.34
	72 hr	2.47 ± 0.33	2.39 ± 0.25	74.60 ± 3.6	78.20 ± 3.10	7.21 ± 0.52	6.68 ± 0.55

ug = micro-gram ng = nano-gram dl. = 0.10 liter

TABLE 3. Means ± standard errors of cortisol, triiodothronine and thyroxin of hydrated (control) and water deprived shorn, half-shorn and unshorn Barki ewes during 96 hr water deprivation period in winter season.

Wool coat length	Water deprivation period	Cortisol (ug/dl.).		Triiodothyronine		Thyroxin (ug/dl.)	
		Control	Water deprived	Control	Water deprived	Control	Water deprived
Shorn	Zero time	2.00 ± 0.25	2.03 ± 0.38	136.50 ± 16.5	143.00 ± 17.10	5.27 ± 0.37	5.13 ± 0.49
	24 hr	0.76 ± 0.24	1.92 ± 0.40	134.30 ± 10.6	155.20 ± 33.5	7.07 ± 1.20	7.78 ± 1.10
	48 hr	2.62 ± 0.16	2.57 ± 0.46	147.00 ± 33.8	162.20 ± 29.50	6.33 ± 3.16	5.20 ± 0.81
	72 hr	1.67 ± 0.43	2.36 ± 0.53	162.70 ± 50.4	150.60 ± 30.10	6.53 ± 0.72	5.06 ± 0.54
	96 hr	2.15 ± 0.31	2.87 ± 0.54	208.30 ± 30.3	128.30 ± 13.60	5.20 ± 0.23	6.68 ± 1.23
Half-shorn	Zero time	1.87 ± 0.18	2.30 ± 0.77	148.40 ± 20.5	122.00 ± 11.2	3.68 ± 0.25	5.04 ± 0.90
	24 hr	1.66 ± 0.62	1.67 ± 0.41	97.60 ± 3.6	140.00 ± 23.7	4.10 ± 0.98	3.53 ± 0.26
	48 hr	1.98 ± 0.19	2.51 ± 0.50	85.50 ± 11.3	119.00 ± 22.90	5.38 ± 0.53	5.55 ± 0.86
	72 hr	1.24 ± 0.31	2.55 ± 0.56	91.00 ± 16.8	134.80 ± 21.80	5.26 ± 0.66	3.28 ± 0.33
	96 hr	2.49 ± 0.09	2.78 ± 0.11	89.30 ± 7.5	198.60 ± 47.80	4.58 ± 0.59	5.55 ± 1.28

TABLE 3. (Cont.).

	Zero time	1.30 ± 0.32	2.25 ± 0.32	135.00 ± 18.2	133.00 ± 34.50	5.63 ± 1.53	4.78 ± 2.17
Un-shorn	24 hr	2.08 ± 0.45	1.52 ± 0.68	117.00 ± 21.8	103.00 ± 5.7	6.50 ± 0.17	3.73 ± 0.27
	48 hr	2.07 ± 0.41	2.75 ± 0.79	99.00 ± 11.50	107.00 ± 20.00	4.03 ± 0.67	5.60 ± 0.78
	72 hr	1.45 ± 0.31	2.60 ± 0.41	142.30 ± 34.90	96.00 ± 11.00	5.27 ± 0.83	5.05 ± 1.27
	96 hr	2.29 ± 0.30	3.06 ± 0.35	114.30 ± 10.6	123.30 ± 33.40	4.93 ± 1.22	5.10 ± 0.64
	Zero time	1.75 ± 0.15	2.19 ± 0.16	140.90 ± 10.5	131.80 ± 11.70	4.73 ± 0.55	4.98 ± 0.70
Over-all	24 hr	1.56 ± 0.30	1.79 ± 0.24	116.40 ± 9.7	134.50 ± 15.2	5.41 ± 0.61	5.15 ± 0.73
mean	48 hr	2.14 ± 0.21	2.60 ± 0.30	112.70 ± 14.7	134.00 ± 15.90	5.25 ± 0.47	5.45 ± 0.43
	72 hr	1.40 ± 0.25	2.50 ± 0.28	126.00 ± 18.8	131.90 ± 14.80	5.61 ± 0.42	4.42 ± 0.45
	96 hr	2.32 ± 0.13	2.89 ± 0.21	130.80 ± 18.8	158.90 ± 24.90	4.86 ± 0.37	5.91 ± 0.66

ug = micro-gram ng = nano-gram dl. = 0.10 liter.

season. This may explain the higher plasma cortisol levels in summer than in winter season. This observed reduction in plasma cortisol in spite of the continued cold (Table 1) may not be of adaptive significance since other calorigenic hormone levels such as T_3 (Table 3) were elevated. This finding agrees with earlier work (Khalil, 1980).

Thyroxin (T_4) and Triiodothyronine (T_3)

The average plasma T_4 and T_3 levels for all subgroups at different intervals of the water deprivation period in both seasons are presented in Tables (2 and 3). There was no significant differences in plasma T_4 levels between the normal (hydrated) and dehydrated groups in both seasons.

In winter regardless of the wool coat, the rate of change in plasma T_4 and T_3 levels in the water deprived group after 96 hr of water deprivation was 18.6% and 20.6% respectively. This may be due to the reduction in plasma volume caused by dehydration (Khalil, 1980).

In summer, regardless of the wool coat the overall mean plasma T_3 level after 48 hr of water deprivation was significantly ($p < 0.05$) higher (18.8%) in the normal (hydrated) than that of the dehydrated group. T_3 is recognized as a powerful metabolic agent for increasing heat production in sheep (Khalifa, 1982 and Abdel-Bary, 1982) and in dairy cattle (Yousef and Johnson, 1966). Thus, dehydration during exposure to heat in summer (33°) reduced plasma T_3 in order to perhaps reduce heat production, since these animals were not capable of increasing heat dissipation similar to that of the hydrated (normal) animals. It is suggested that the decreased plasma T_3 level in dehydrated ewes may be a direct effect of lack of water, which can be of adaptive significance for water conservation.

In the control (hydrated) group, season and wool coat length had no significant effect on plasma T_4 levels. In winter, in the control (hydrated) group, wool coat length had a significant effect ($p < 0.05$) on plasma T_3 levels. In winter the overall mean plasma T_3 levels for the hydrated (control) subgroups was 157.76 ± 13.6 ng/dl, 102.4 ± 11.6 ng/dl and 121.5 ± 7.7 ng/dl, for the shorn, half-shorn and unshorn ewes respectively. During the winter season, the shorn animals were probably exposed to cold stress at night (Table 1). Sheep tended to increase thyroid function (*i.e.*, T_3 level) during cold acclimation (Young, 1981) to elevate its heat production, which is an adaptive mechanism against cold.

In the summer season the hydrated ewes had an average plasma T_3 of 79.1 ± 8.9 ng/dl as compared to 127.2 ± 8.6 ng/dl in the winter.

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اثر الاختلافات الموسمية وطول الغطاء الصوفى والتعطيش على مستوى هرمونات الكورتيزول وهرمونى الغدة الدرقية رباعى اليود (الثيروكسين) وثلاثى اليود (الترای أيـــود وثيرونين)

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أجريت هذه الدراسة على عدد ٢٩ من نعاج البرقى المصرية (غليظـــة الالية) . قسمت النعاج حسب طول الغطاء الصوفى الى ثلاثمجموعات : مجموعة مجزوزة من ١٠ حيوانات وعشرة حيوانات عليهم غطاء صوفىمتوسط الطول وتسعة حيوانات عليهم غطاء صوفى كامل الطول (نمو عامتقريبا) .

قسمت كل مجموعة من المجموعاتالسابقة الى مجموعتين احداهااعطيت لها المياه بكميات مفتوحة والاخرى منع عنها الماء لمدة ٧٢ ساعة فى الصيف و ٩٦ ساعة فى الشتاء . وأثناء هذه الفترات كانت كل النعاج تحت الظل مع فصل المجموعة المعطشة عن المجموعة المقارنة ـ وتم اخذ عينات الدم كل ٢٤ ساعة لتقدير الكورتيزول وهرمونى الغدة الدرقية .

أوضحت النتائج عدم تأثر كلا من الكورتيزول وهرمون الغدة الدرقية رباعى اليود (الثيروكسين) بالتعطيش . بينما نقص مستوى هـرمون الغدة الدرقية ثلاثى اليود بالتعطيش فى موسم الصيف والذى يحتمـل أن يرجع الى الاثر المباشر لنقص المياه . بجانب أن تأقلم للاحتفـــاظ بالمياه نتيجة لنقصهـا .

زاد مستوى هرمون الغدةالدرقية ثلاثىاليود فىالشتاءفى المجموعة المقارنة عن الصيف وكانت الزيادة أوضح فى المجموعة المجزوزة ويحتمل أن ترجع هذه الزيادة الى الصدمة الباردة أثناء الليل فى الشتاء .