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Physiological indicators of adaptation in Awassi and Finn x Texel x Awassi sheep

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SUMMARY - The Awassi breed has long been acknowledged to be highly adapted to semi-arid environments. Attempts to increase productivity had led to raising Awassi under intensive systems of management or crossbreeding it with western prolific breeds. These changes have led to a loss in some of the features of adaptation of the Awassi, so critical for its survival in semi-arid and arid environments. A series of experiments was conducted to assess some physiological and endocrine indicators in Awassi and Finn x Texel x Awassi cross sheep under different management systems. Results indicated that the response of Awassi sheep to environmental stress is system dependent. Pure Awassi raised under extensive systems showed better adaptation signs (lower T_4, rectal temperature and pulse rate) than both pure Awassi and/or cross bred Finn x Texel x Awassi raised under more intensive systems.

Key words: Awassi, physiological indicators, adaptation, management systems.

RESUME - *"Indicateurs physiologiques de l'adaptation chez des brebis Awassi et Finnois x Texel x Awassi". La race Awassi a longtemps été reconnue comme étant très bien adaptée aux milieux semi-arides. Des tentatives visant à augmenter sa productivité ont amené à élever la race Awassi sous des systèmes de conduite intensifs ou à la croiser avec des races occidentales prolifiques. Ces changements ont mené à une perte chez certaines des caractéristiques d'adaptation des Awassi, si cruciales pour leur survie en milieux arides et semi-arides. Une série d'expériences a été menée pour estimer certains indicateurs physiologiques et endocriniens chez les animaux Awassi et croisés Finnois x Texel x Awassi sous différents systèmes de conduite. Les résultats ont indiqué que la réponse des ovins Awassi au stress du milieu est sous la dépendance du système. Les animaux Awassi purs élevés en systèmes extensifs ont montré de meilleurs signes d'adaptation (T_4 plus faible, température rectale et rythme des pulsations plus bas) que les Awassi purs et/ou les croisés Finnois x Texel x Awassi élevés sous des systèmes plus intensifs.*

Mots-clés : *Awassi, indicateurs physiologiques, adaptation, systèmes de conduite.*

Introduction

The Awassi sheep, a multipurpose breed has been bred and raised under extensive nomadic systems of production. The adaptation of the indigenous Awassi breed to semi-arid environments of the Near Eastern region has long been acknowledged (Bhattacharya and Harb, 1973; Epstein, 1985).

Raising the Awassi under intensive management systems and/or cross breeding it with exotic prolific breeds resulted in a tremendous improvement in its productivity (Epstein, 1985). This may have led to a loss of some features of adaptation exhibited by the Awassi sheep under extensive semi-arid environments (Bradford and Berger, 1988).

Body temperature, pulse and respiration rates and thyroid activities are important physiological indicators commonly used to study adaptation to environmental stress in sheep (Dutt and Hamm, 1959; Eyal, 1963; Bhattacharya and Hussein, 1974; Singh *et al.*, 1982; Ross *et al.*, 1985).

The present study was conducted to assess some physiological indicators for environmental adaptation in Awassi sheep under nomadic, semi-sedentary and intensive systems of production.

Materials and methods

Two experiments were conducted in the Beka'a valley of Lebanon between August 1992 and June 1993. The valley, which is the major area for sheep production (56% of sheep in Lebanon) is a typical semi and environment with hot and dry summers, and cold and humid winters. Climatic data over the duration of the study are given in Table 1.

Table 1. Meteorological data in the Beka'a valley from July 1992 until June 1993

	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
Max. T° (°C)	29.7	31.8	26.5	26.7	16.2	6.7	8.7	9.1	13.6	20.3	21.6	29.0
Min. T° (°C)	13.5	15.6	11.6	9.8	5.4	0.2	-1.5	-1.1	2.7	6.6	9.2	13.2
Max. RH†(%)	68	65	69	67	75	74	82	81	63	63	59	57
Min. RH (%)	23	28	33	40	48	53	48	38	39	28	32	27
Precipitation (mm)	--	--	--	--	122	166	119	39	112	7.5	21.5	--

†RH relative humidity

The first experiment included 32 multiparous ewes randomly selected from four Awassi flocks (8 ewes/flock) under different systems of management: (i) a nomadic group (NA) which commuted seasonally between Lebanon and Syria. The nomadic system is an extensive system characterized by continuous travel, total dependence on grazing and lack of shelter; (ii) a semi nomadic flock (SNA group) with seasonal travel to pastures, from March to October, hand feeding (120 kg/head/year) from November to March and rudimentary housing facilities; (iii) an intensively managed pure Awassi flock (IA) at the Agricultural Research and Education Center (AREC) of the American University of Beirut. Under this management, sheep are confined all year round and fed, high quality roughage and concentrate according to the NRC requirements (NRC, 1985); (iv) an intensively managed Finn x Texel x Awassi flock (FTA) initially constituted in 1983 at AREC by crossing native Awassi sheep to prolific Finn x Texel sheep and subjected to the same management as IA group. The four groups were monitored every two weeks for rectal temperature and pulse rate during August and September. Two measurement, morning and afternoon, were recorded on the same day. Rectal temperature (RT) was measured using a clinical thermometer, while pulse rate (PR) was counted using a medical stethoscope. Three consecutive counts of 20 seconds each were taken (Hecker, 1983) then adjusted for 60 seconds and reported. Temperature readings and pulse rate counts were performed by the same person over the whole experimental period-to avoid interobserver variations especially for pulse rate.

In addition jugular blood samples were collected for hormonal analysis following the same regimen. All blood samples were maintained at room temperature until clotting, then centrifuged at 4045 x g; serum was collected and frozen at -20°C until analysis. Triiodothyrosine (T_3) and Thyroxine (T_4) were quantified using a commercial radio-immunoassay kit (Diagnostic Product Corporation, Los Angeles, CA, USA). The analysis was performed by the Endocrinology Laboratory at the American University Hospital.

Rectal temperature, PR, T_3, and T_4 values were statistically analysed according to an analysis of variance for complete randomized design where the management system was considered as the main effect by month.

Experiment 2 included the IA and FTA groups and was carried over until June 1993. Data was collected according to the same procedure described in experiment 1. Analysis of variance for

repeated measurements over time was then performed for T_4, T_3, RT, and PR with breed (IA *vs* FTA) x *sampling time* (*a.m. vs p.m.*) considered as the main effect repeated over month (August-June).

Results and discussions

Levels of T_4, T_3, RT and PR were all influenced ($P<0.05$) by management system irrespective of the month (Table 2). Thyroxine values were lower in SNA and the NA sheep than in the IA and FTA sheep during August and September. Similar trends were observed for rectal temperature and pulse rate. On the other hand triiodothyrosine (T_3) values exhibited a reverse trend in September, as T_3 levels became higher in NA and SNA sheep as compared to the IA and FTA animals.

Table 2. Levels of T_4 (ng/ml), T_3 (ng/ml), rectal temperature (RT; °C) and pulse rate (PR; pulse/min.) in intensively managed Awassi (IA), Finn x Texel x Awassi cross (FTA), semi nomadic Awassi (SNA) and nomadic Awassi (NA) ewes during August and September 1992

	August				September			
System	T_4	T_3	RT	PR	T_4	T_3	RT	PR
IA	68.0^{a}	1.07^{a}	39.5^{a}	95^{a}	67.1^{a}	0.77^{a}	39.2^{a}	92^{a}
FTA	65.5^{a}	1.09^{a}	39.6^{a}	101^{a}	69.9^{a}	0.87^{a}	39.4^{a}	104^{b}
SNA	48.5^{b}	0.98^{ab}	38.9^{b}	85^{b}	50.7^{b}	0.93^{ab}	38.6^{b}	82^{c}
NA	45.6^{b}	0.90^{b}	39.0^{b}	86^{b}	51.8^{b}	0.90^{b}	38.8^{b}	90^{a}
SE	2.4	0.05	0.2	1.2	3.1	0.04	0.1	1.1

a, b, c: Column means with different superscripts differ significantly $P<0.05$

Levels of T_3 during the month of August correlated well with those of T_4. However and in contrast, T_3 levels of IA and FTA animals decreased during September, while being maintained in NA and SNA sheep. Intensively managed Awassi and FTA ewes were flushed with high energy concentrates in September, while SNA and NA sheep were kept on crop residues. A reduction in the thyroid activities was reported in sheep fed high energy feed (Bhattacharya and Uwayjan, 1975) and at the onset of winter (Volcani, 1957).

In general FTA sheep had higher T_4, RT and PR levels than the other three pure Awassi management groups. Similar findings were reported by Ross *et al.* (1985) on crossbred sheep resulting from crossing temperate and tropical breeds.

The present data indicates that Awassi, a well acknowledged breed in terms of adaptation to semi-arid environments (Epstein, 1995), may respond differentially to hot environments if raised under different management systems. Sheep raised extensively (NA and SNA groups) exhibited lower T_4, PR, and RT values than those raised under more intensive systems or crossbred with highly productive breeds (IA and FTA groups, respectively). This may reflect an adaptive thermoregulatory mechanism characterized by a lower physiological and endocrine response to heat stress in adapted animals (Eyal, 1963; Hafez, 1969; Gooden and Weekes, 1981). Moreover T_4 levels observed in the extensive groups (NA and SNA) suggest a similar mechanism of adaptation to that reported by Ross *et al.* (1985). Whereby sheep reduce their circulating T_4 levels in order to reduce heat production and maintain homeothermy in a hot environment.

Experiment 2 included the IA and FTA sheep and monitored T_3, T_4, RT and PR over a period of ten months from August 1992 until June 1993. The analysis of the T_4 concentrations revealed a significant breed x month interaction ($P<0.05$), in addition to a significant month effect ($P<0.01$). Data were therefore considered within month (Table 3).

Table 3. Mean T_4 concentrations (ng/ml) in intensively managed Awassi (IA) and Finn x Texel x Awassi cross (FTA) ewes from August 1992 until June 1993

Breed	Aug	Sep	Oct	Nov	Dec	Feb	Mar	Apr	May	June	SE†
IA	68.0	67.1	51.0	51.8	48.0	52.2	53.5	51.6[a]	75.8[b]	62.0[a]	
FTA	65.5	69.9	48.3	47.2	47.0	49.4	59.0	60.0[b]	63.0[a]	72.2[b]	
Activity		flushing ram introduction mating			pregnancy		pregnancy lactation		weaning shearing milking	milking grazing	3.3

†SE is for month x breed interaction
a, b: Column means with different superscripts differ significantly P<0.05

The T_4 levels were comparable between the two breeds over the whole period except for April and June where T_4 values were highest in the FTA crossbred ewes, than in May where they were highest in Awassi. The T_4 levels fluctuated seasonally; they declined sharply in October to April then increased significantly starting May and June. These seasonal trends agree with morphological observations on the thyroid gland by Volcani (1957) and Injidi *et al.* (1968) who suggested that the thyroid in the Awassi sheep has higher activity in summer than in winter. The general pattern of variation in T_4 levels for the two breeds suggests a comparable adaptation of thermoregulatory mechanisms of the FTA animals to those of the pure bred Awassi.

Mean levels of T_3 (Table 4) were similar (P<0.05) in both IA and FTA animals from August until February levels started decreasing in September, then were up again in October to the same levels observed during August. In December, levels decreased once again, then increased in February to reach their highest values which were maintained until the end of the experiment.

Table 4. Mean T_3 concentrations (ng/ml) in intensively managed Awassi (IA) and Finn x Texel x Awassi cross (FTA) ewes from August 1992 until June 1993

Breed	Aug	Sep	Oct	Nov	Dec	Feb	Mar	Apr	May	June	SE†
IA	1.07	0.72	1.14	1.10	0.84	1.36	1.68[a]	1.45[b]	1.51[a]	1.48	
FTA	1.10	0.87	1.12	1.06	0.86	1.27	1.40[b]	1.69[a]	1.62[b]	1.59	
Activity		flushing ram introduction mating			pregnancy		pregnancy lactation		weaning shearing milking	milking grazing	0.07

†SE is for month x breed interaction
a, b: Column means with different superscripts differ significantly P<0.05

The periods of high T_3 levels corresponded to high physiological activities of the ewes; (late pregnancy (march), early lactation (April and May), as well as shearing (June). This is an indication that T_3 levels were affected by the physiological activity of the animals rather than by ambient temperature fluctuations. Fluctuations in T_3 levels are known to be responsible for the short term adjustments of the metabolic needs of sheep (Hecker, 1983).

Analysis of rectal temperature and pulse rate (Table 5) revealed a significant month effect (P<0.05) as well as a significant sampling time effect (P<0.05). Pulse rate tended to be higher in FTA than IA ewes although rectal temperature was comparable in both breeds. Crossbred FTA animals have higher production rates and finer fleece than to purebred Awassi, thus rendering them less adapted to environmental stress.

Table 5. Rectal temperature (RT; °C) and pulse rate (PR; pulse/min.) in intensively managed Awassi (IA) and Finn x Texel x Awassi cross (FTA) ewes measured in the forenoon (a.m.) and in the afternoon (p.m.) from August 1992 until June 1993

		Breed		Month								
		IA	FTA	Aug	Sep	Oct	Nov	Feb	Mar	Apr	May	SE†
	a.m.	39.0[a]	39.1[a]	38.9	39.4	38.9	39.4	38.7	39.6	38.8	39.1	
RT	p.m.	39.3[b]	39.4[b]	40.2	39.2	39.7	39.7	38.9	39.7	39.2	39.3	
	Difference	0.3	0.3	1.3	-0.2	0.8	0.3	0.2	0.1	0.4	0.2	
												0.1
	a.m.	93[a]	96[a]	89	93	90	95	116	85	85	92	
PR	p.m.	101[b]	104[b]	107	103	104	103	125	97	90	98	
	Difference	8	8	18	10	14	8	9	12	5	6	
												1.38

†SE is for month x breed interaction
a, b: Column means with different superscripts differ significantly P<0.05

As to the variations between morning and afternoon, both RT and PR increased significantly in the afternoon throughout the study with the highest increase observed in the summer months. Similar results were reported by various studies investigating semi-arid sheep (Eyal, 1963; Singh *et al*., 1982; Ahmed and Abdelatif, 1994).

Conclusion

The findings of the present study seem to indicate that the response of Awassi sheep to environmental stress is system dependent. Awassi ewes raised under extensive systems showed better adaptation signs (lower T_4, RT and PR levels) than those raised under intensive management systems. Moreover pure Awassi and its FTA cross (50% Awassi) showed comparable physiological response to seasonal changes, with their thyroid activity being related to production requirement rather than environmental variations. Further studies are needed to differentiate short term adaptation mechanisms from long term ones in Awassi sheep raised under different managements systems.

References

Ahmed, M. and Abdelatif, A. (1994). Effects of restriction of water and food intake on thermoregulation, food utilization and water economy in desert sheep. *J. Arid Environ*., 28: 147-153.

Bhattacharya, A.N. and Harb, M. (1973). Sheep production on natural pasture by roaming Bedouins in Lebanon. *J. Range Mange.*, 26: 266-269.

Bhattacharya, A.N. and Hussain, F. (1974). Intake and utilization of nutrients in sheep fed different levels of roughage under heat stress. *J. Anim. Sci*., 38: 877-886.

Bhattacharya, A.N. and Uwayjan, M. (1975). Effect of high ambient temperature and low humidity on nutrient utilization and on some physiological responses in Awassi sheep fed different levels of roughage. *J. Anim. Sci.,* 40: 320-328.

Bradford, G.E. and Berger, Y.M. (1988). Breeding strategies for small ruminants in arid and semi-arid areas. Increasing ruminant productivity in semi-arid areas. *ICARDA Publication*, pp. 1-25.

Dutt, R.H. and Hamm, P.T. (1959). Effect of exposure to high temperature and shearing on semen production in winter. *J. Anim. Sci.,* 19: 328-334.

Epstein, H. (1985). *The Awassi Sheep with Special Reference to the Improved Dairy Type* . Food and Agriculture Organization, Rome, pp. 25-40.

Eyal, E. (1963). Shorn and unshorn Awassi sheep. I. Body temperature. *J. Agric. Sci.,* 60: 159-176.

Godden, P.M. and Weekes, T.C. (1981). Influence of diet on plasma thyroxine response to thyroid stimulating hormone in growing lambs. *J. Agric. Sci.,* 96: 599-602.

Hafez, E.S. (1969). *Adaptation of Domestic Animals*. Lea & Febiger, Philadelphia, pp. 3-18 and pp. 164-182.

Hecker, J.F. (1983). *The Sheep as an Experimental Animal*. Academic Press, London, pp. 56-61 and pp. 177-190.

Injidi, M., Kassab, A., and Rollinson, D.H.L. (1968). *Studies on the effect of climate on domestic animals in Iraq*. I. *Seasonal changes in the thyroid gland of Awassi sheep*. Animal Husbandry Research and Training Project, Baghdad, Government of Iraq, Technical Report No. 13, pp. 3-20.

NRC. (1985). *Nutrient Requirements of Domestic Animals. Nutrient Requirements of Sheep.* (6^{th} Ed.). National Academy of Science, National Research Council, Washington DC.

Ross, T.T., Goode, D. and Linnerud, A.C. (1985). Effects of high ambient temperature on respiration rate, rectal temperature, fetal development and thyroid gland activity in tropical and temperate breeds of sheep. *Theriogenology*, 24: 259-269.

Singh, M., More, T., Rai, A.K. and Karim, S.A. (1982). A note on the adaptability of native and cross bred sheep to hot summer conditions of semi arid and arid areas. *J. Agric. Sci.,* 99: 525-528.

Volcani, R. (1957). *The seasonal activity of the gonads and the thyroid of the camel, cattle, sheep and goats*. PhD Thesis, Bulletin No. 8, Agreicultutal Research Station, Rehovot, Israel.