

## Tunica dartos thermoregulatory index in bull and ram in Egypt

A A EL-DARAWANY<sup>1</sup>

Zagazig University, Zagazig, Egypt

Received : 10 May 1998; Accepted: 14 April 1999

### ABSTRACT

This study was carried out on Holstein-Friesian bulls and Ossimi rams. Measurement of Tunica dartos index (TDI) was estimated by circulating the scrotum in cold and warm water bath. Significant categories of TDI differences were demonstrated in libido, wave motion, sperm motility, dead sperm %, sperm abnormalities (pyriform cells, midpiece and acrosomal abnormality), sperm concentration and acrosomal reaction in bull and ram, and serum testosterone concentration in ram only, and, conception rate and cows calving and ewes lambing. The TDI studied may have some value in reflecting the status of semen quality and reproductivity.

**Key words :** Bulls, Rams, Reproductivity, Semen quality, Tunica dartos index

The difference between abdominal and testicular temperatures is about 4°C in bulls and rams. The scrotum can actively control its own temperature. Tunica dartos is largely responsible for the state of the scrotum. It determines the distance between the testes and the abdominal wall, and thus the magnitude of vascular heat exchange (Curtis 1983). When the environmental temperature is low, the *Tunica dartos* muscle of the scrotum contracts, pulling the testicles toward the body and its warmth; when the environmental temperature is high, this muscle relaxes, permitting the testicles to drop away from the body and its warmth (Taylor and Bogart 1988). The aim of the present study was to see the effect to Tunica dartos thermoregulatory mechanism (index) and each of semen quality and reproductive

### MATERIALS AND METHODS

Holstein-Friesian bulls (18), 3 and 4 years old and 450-550 kg, 15 Ossimi rams aging between 1.5 and 2.5 years (55-60 kg) were studied for 1 year. The data were collected from the Salheya Project for bulls and El-Khatara area for ram (Farm of Animal Production, Faculty of Agriculture), Sharkeya Province, Egypt. The clinical examination of animals did not reveal any detectable genital lesions and were having normal rectal temperature (Roberts 1971). The animals were kept free in an open shelter all over the year. The nutritional requirements were calculated (NRC 1985) and each

bull was supplied daily with a pelleted concentrate mixture and either alfa alfa or Egyptian clover, in addition to, suitable amounts of wheat straw in winter or rice straw in summer. Each ram was supplied daily with a pelleted concentrate mixture, elephant grass and rice straw. The animals were watered *ad lib*.

The animals were lighted 14-16 and 8-12 hr daily throughout summer and winter seasons respectively. Temperature-humidity index (THI) was above  $84.3 \pm 3.8$  for 10 hr at least daily during the summer but it was  $54.11 \pm 1.3$  during the winter, indicating exposure of the animals to severe heat stress during hot season. THI values were calculated according to Livestock and Poultry Heat Stress, Agriculture Engineering Technology Guide Clemson University Sc. 29634, USA.

### (TDI) in bull and ram

TDI was estimated by circulating warm and cold water around the scrotum. Putting the scrotum in warm water bath at different temperatures (32,33,34,35 or 36 °C) for 5 min to each degree and 1 hr apart or more, resulted in *Tunica dartos* relaxation, thus the testicles away from the body and then the length of testicles and scrotum were recorded. Whereas putting the scrotum in cold water bath at different temperatures (16, 17, 18, 19 or 20°C) for 5 min to each degree and 1 hr different temperatures (16, 17, 18, 19 or 20°C) for 5 min to each degree and 1 hr apart or more, resulted in *Tunica dartos* contraction which permitted the testicles pulling from the body and the length of scrotum was recorded. The length of scrotum and testes were measured with a flexible metal tape. The length of scrotum defining from origin of the scrotum at middle line till the tip of it. TDI was calculated by using the

Present address : <sup>1</sup>Animal Production Department, Faculty of Agriculture, activity and performance in bulls and rams in Egyptian condition.

following formula:

$$\text{TDI} = \frac{\text{Max SL} - \text{Min SL}}{\text{Max SL} - \text{TL}}$$

Max SL, maximum scrotal length after relaxes; Min SL, minimum scrotal length after contracts; and TL, testicles length.

The TDI obtained were classified into 3 categories i.e A $\geq$ 0.91, B= 0.80-0.89 and C  $\leq$  0.79. TDI was recorded 10-times for each animal. Libido was assessed according to Chenoweth (1981). Semen was collected 10-times at TDI, recorded within experimental period by means of an artificial vagina from bull and ram. At each collection, semen volume (ml), wave motion (score 0-5), sperm motility (%), dead spermatozoa (%), abnormal spermatozoa pattern (per cent of coiled tail, pyriform cells, midpiece and acrosomal abnormality) and sperm concentration ( $\times 10^9$  ml<sup>-1</sup>) determined according to Smyth and Gordon (1967). Acrosome reaction of sperm was assessed by staining sperm smear slides (Lenz *et al.* 1983). Serum testosterone concentration was measured in serum samples collected from all bulls and rams at the same day time (10.00 hr) once a semen collection. After coagulation serum was separated by centrifugation (800 g) and kept at -20°C for the hormone analysis. Serum testosterone levels were determined by using radioimmunoassay kits. Validation was done in our laboratory for use in bull and ram serum. Intra-assay variation was less than 2.9% and inter-assay variation was less than 9.9%. Data were statistically

analyzed by analysis of variance according to Snedecor and Cochran (1982). Duncan's New Multiple range test was used for multiple according to Fleiss (1981). Correlation coefficients (r) between traits and categories of TDI were also estimated.

## RESULTS

The minimum scrotal length occurred with water at 18 and 17°C circulating around it in bull and ram respectively (Tables 1, 2). While, the maximum scrotal length was observed with water at 35 and 34°C circulating around it in bull and ram respectively; both minimum and maximum scrotal length had the same standard deviation and equal zero. Furthermore, there is great variation among bulls or rams in testicles length and TDI.

The test of significance showed (Table 3) the effect of TDI was high (P<0.01) on semen quality and fertility traits in bull and ram. The highest of libido, wave motion, sperm motility %, sperm concentration and acrosomal reaction at 10 hr (and at 0 hr and serum testosterone level in rams only), and conception rate and calving and lambing were recorded with bull and ram that have TDI more than 0.90. In the same time, the lowest percentage of dead spermatozoa, coiled tail, pyriform cells, midpiece and acrosomal abnormality were recorded with bull or ram that have the same category. However, no differences were observed between categories in values of ejaculated volume in bull and ram and acroso-

Table 1. Length of scrotum and testicles (cm) having water at different temperature circulated around scrotum and Tunica dartos index (TDI) calculated at 18 and 35° in bulls.

Bull No.	Water temperature °C										Testicles length	TDI 17°C, 34°C
	Contraction					Relaxation						
	16	17	18	19	20	32	33	34	35	36		
1	22.1±0.1	22.1±0.5	22.1±0.0	22.3±1.3	22.9±2.1	36.8±1.8	36.2±1.2	37.6±1.2	38.1±0.0	33.1±1.6	21.0	93.6
2	20.9±0.3	20.9±0.2	20.1±0.0	21.6±0.6	22.3±0.8	34.1±2.3	35.2±1.8	35.6±1.6	36.1±0.0	36.0±0.8	19.1	94.1
3	18.3±1.0	18.6±1.1	18.3±0.0	19.0±1.2	19.0±1.1	33.6±0.8	33.8±1.6	34.1±0.6	34.0±0.0	34.0±1.3	15.2	83.8
4	21.5±2.0	21.8±3.0	21.4±0.0	22.6±1.9	22.6±4.2	34.2±5.0	36.1±3.0	36.2±2.0	36.8±0.0	36.8±3.5	20.2	92.5
5	17.1±1.0	17.3±2.0	17.1±0.0	17.9±2.3	17.9±5.3	31.6±3.0	32.0±4.0	32.5±3.4	32.8±0.0	32.8±3.5	16.1	94.0
6	20.3±1.3	20.5±0.6	20.3±0.0	20.9±1.8	20.8±1.6	32.0±1.6	32.2±2.0	33.1±3.0	33.1±0.0	33.1±1.8	16.1	94.0
7	16.1±2.0	16.2±1.8	16.1±0.0	16.6±2.0	17.1±2.0	29.1±2.3	29.6±2.1	29.9±2.4	30.2±0.0	30.2±1.3	13.0	82.0
8	14.1±2.3	14.3±1.1	14.1±0.0	15.6±2.1	15.8±3.0	27.1±1.4	27.6±3.0	28.1±2.1	28.3±0.0	28.4±1.8	11.0	82.1
9	16.3±1.8	16.4±1.0	16.2±0.0	17.0±2.5	17.4±3.0	28.1±1.1	28.2±0.8	29.1±0.3	29.8±0.0	29.8±2.0	15.1	91.8
10	16.3±1.8	19.9±1.3	19.8±0.0	19.9±1.6	20.2±2.8	30.2±3.0	31.8±1.9	32.1±1.8	33.2±0.0	33.2±1.6	18.7	92.4
11	19.3±2.6	19.4±1.6	16.2±0.0	19.9±1.4	20.1±1.3	30.9±3.0	31.0±2.3	31.2±1.8	32.3±0.0	32.4±2.0	13.2	68.6
12	22.6±2.1	22.4±1.8	22.6±0.0	22.1±1.3	22.8±1.9	34.8±1.9	34.6±3.1	35.1±1.7	36.3±0.0	37.4±2.1	19.1	80.5
13	21.1±1.6	21.3±1.3	21.1±0.0	21.8±1.6	22.1±2.3	33.0±4.1	33.0±1.8	34.2±1.9	35.4±0.0	35.2±1.4	16.2	73.9
14	20.3±1.3	20.3±2.1	20.3±0.0	20.8±1.0	21.1±1.6	32.8±3.2	34.1±2.1	35.1±0.0	35.5±0.0	35.6±1.8	13.6	69.4
15	21.6±1.2	21.7±2.3	21.6±0.0	21.8±1.6	21.9±1.3	33.2±3.1	34.0±2.1	34.8±3.1	35.1±0.0	35.0±1.8	17.2	75.6
16	17.1±1.3	17.2±1.0	17.1±0.0	17.6±1.2	17.8±1.8	29.1±1.6	29.2±1.3	29.9±1.32	30.1±0.0	30.2±1.0	15.1	86.7
17	19.3±1.1	19.8±1.4	19.4±0.0	17.9±1.3	20.1±2.1	31.0±1.1	31.6±1.2	32.0±1.3	32.9±0.0	32.8±1.9	16.0	79.9
18	22.1±1.5	22.6±1.2	22.1±0.0	22.3±1.3	22.5±1.8	34.2±1.3	35.2±1.4	35.8±0.4	35.9±0.0	35.4±1.6	18.3	77.5

± Standard deviation.

Table 2. Length of scrotum and testicles (cm) having water at different temperature circulated around scrotum and Tunica dartos index (TDI) calculated at 18 and 35° in rams

Bull No.	Water temperature °C										Testicles length	TDI 17°C, 34°
	Contraction					Relaxation						
	16	17	18	19	20	32	33	34	35	36		
1	9.6±1.1	9.6±0.0	9.7±2.0	9.9±2.1	10.2±1.1	15.1±1.2	15.3±2.1	15.4±0.0	15.5±0.3	15.7±1.8	9.0	0.91
2	7.3±2.1	7.4±0.0	7.6±1.8	7.9±1.9	8.2±1.1	14.3±2.1	14.5±1.6	14.6±0.0	14.7±1.2	14.7±1.6	6.7	0.91
3	8.3±1.7	8.4±0.0	8.6±1.5	8.9±2.1	9.0±1.1	14.1±1.8	4.2±1.6	14.3±0.0	14.4±1.6	14.4±1.8	7.1	0.82
4	9.0±1.6	9.1±0.0	9.2±1.2	9.3±1.6	9.4±1.0	14.1±1.7	14.2±1.1	14.3±0.0	14.5±1.2	14.5±1.3	8.2	0.85
5	10.1±1.6	10.2±0.0	10.4±1.0	1.5±1.3	10.5±1.6	16.2±1.1	16.3±1.7	16.5±0.0	16.9±1.1	19.0±1.3	9.0	0.84
6	7.1±1.5	7.2±0.0	7.3±1.6	7.4±1.2	7.4±1.6	12.1±1.2	12.6±1.2	12.9±0.0	13.1±1.3	13.1±1.6	6.2	0.85
7	6.3±1.5	6.4±0.0	6.5±1.2	6.9±1.3	9.0±2.0	12.1±1.0	12.4±1.3	12.6±0.0	12.7±1.4	16.7±1.5	5.1	0.83
8	5.1±1.3	5.2±0.0	5.3±1.9	5.4±1.8	5.5±1.6	11.3±1.4	11.3±1.6	12.5±0.0	11.6±1.1	11.6±1.2	3.4	0.77
9	8.0±1.3	8.2±0.0	8.3±1.6	8.4±1.9	8.4±1.8	14.1±1.6	14.3±1.3	14.4±0.0	14.5±1.1	14.5±2.1	7.9	0.95
10	8.9±1.3	8.9±0.0	8.9±1.6	9.1±1.3	9.2±1.6	15.1±1.3	15.1±1.6	15.2±0.0	15.3±1.6	15.3±1.8	7.8	0.85
11	9.4±1.2	9.3±0.0	9.6±1.8	9.6±1.9	9.7±1.8	16.1±1.4	16.2±1.2	16.3±0.0	16.5±1.8	16.5±1.3	9.0	0.96
12	5.7±1.2	7.5±0.0	7.7±1.8	9.8±1.2	7.8±1.8	13.7±1.6	13.9±1.6	14.0±0.0	14.1±1.5	14.1±1.8	5.1	0.73
13	8.1±1.2	8.2±0.0	8.3±1.6	8.4±1.9	8.5±2.1	14.1±1.7	14.2±1.6	13.3±0.0	14.9±1.63	14.9±1.9	5.8	0.72
14	9.1±1.8	9.2±0.0	9.3±1.3	9.4±1.6	9.5±1.6	15.1±1.1	15.2±1.4	15.3±0.0	15.4±1.1	15.4±2.0	9.0	0.97
15	8.8±1.4	8.9±0.0	9.1±1.0	9.2±1.3	9.3±1.3	14.1±1.2	14.6±1.2	14.7±0.0	14.8±1.1	14.9±1.1	6.4	0.70

± Standard deviation.

mal reaction at 0 hr in bull and ram and serum testosterone level in bull only.

The correlation coefficient (r) values (Table 4) between TDI and each of libido, wave motion, motility, sperm con-

centration and conception rate were positive ( $P < 0.01$ ) in both bull and ram and with acrosomal reaction at 0 and 10 hr in bull and ram and with serum testosterone in ram only. However, the correlation coefficient between TDI and dead sper-

Table 3. Libido, semen quality, serum testosterone level and fertility in the ram and bull related to categories to Tunica dartos index (TDI)

Variable	TDI					
	0.91		0.81-0.89		0.79	
	Ram	Bull	Ram	Bull	Ram	Bull
No. of ejaculates	10	10	10	10	10	10
Libido (second)	45.3 <sup>a</sup> ±1.8	52.1 <sup>A</sup> ±3.1	65.7 <sup>b</sup> ±2.8	61.6 <sup>B</sup> ±5.2	122.3 <sup>c</sup> ±18.1	88.7 <sup>c</sup> ±7.8
Semen quality						
Ejaculate (ml)	1.2±0.45	4.6±1.3	1.3±0.35	4.7±1.8	1.4±0.56	5.2±1.4
Wave motion (1-5)	4.3 <sup>a</sup> ±0.18	4.2 <sup>A</sup> ±0.03	2.2 <sup>b</sup> ±0.96	2.3 <sup>B</sup> ±1.0	0.8 <sup>c</sup> ±0.04	1.4 <sup>c</sup> ±0.1
Motility (%)	80.6 <sup>a</sup> ±3.2	81.6 <sup>A</sup> ±3.3	57.3 <sup>b</sup> ±9.8	55.3 <sup>B</sup> ±9.7	3.7 <sup>c</sup> ±6.8	37.7 <sup>c</sup> ±10.2
Dead spermatozoa (%)	10.3 <sup>a</sup> ±2.1	10.6 <sup>A</sup> ±0.8	27.6 <sup>b</sup> ±1.3	31.2 <sup>B</sup> ±3.2	32.7 <sup>b</sup> ±4.1	35.2 <sup>B</sup> ±2.6
Total abnormal spermatozoa (%)	7.3 <sup>a</sup> ±0.6	8.3 <sup>A</sup> ±1.0	22.8 <sup>b</sup> ±3.1	25.6 <sup>B</sup> ±2.8	28.6 <sup>b</sup> ±4.2	38.9 <sup>c</sup> ±2.9
Coiled tail (%)	7.3 <sup>a</sup> ±0.6	7.2 <sup>A</sup> ±0.6	3.7 <sup>b</sup> ±1.6	2.1 <sup>B</sup> ±0.6	4.2 <sup>b</sup> ±1.2	2.3 <sup>B</sup> ±0.01
Pyriform cells (%)	0.0	1.1 <sup>A</sup> ±0.4	7.1±2.0	6.9 <sup>B</sup> ±1.0	8.6 <sup>b</sup> ±1.8	18.2 <sup>c</sup> ±1.3
Midpiece abnormality (%)	0.0	0.0 <sup>A</sup>	8.0±1.3	6.3 <sup>B</sup> ±1.1	10.8 <sup>b</sup> ±2.4	8.3 <sup>B</sup> ±2.0
Acrosomal abnormality (%)	0.0	0.0 <sup>A</sup>	4.0±1.2	10.3 <sup>B</sup> ±1.7	9.0 <sup>b</sup> ±2.4	10.0 <sup>c</sup> ±0.3
Sperm concentration ( $\times 10^9$ ml <sup>-1</sup> )	1.326 <sup>a</sup> ±0.002	0.916 <sup>A</sup> ±0.016	0.068 <sup>b</sup> ±0.006	0.517 <sup>B</sup> ±0.019	0.036 <sup>c</sup> ±0.008	0.096 <sup>c</sup> ±1.3
Acrosome reaction						
at 0 hr	5.9 <sup>a</sup> ±1.0	8.3±1.3	7.8 <sup>b</sup> ±0.6	8.2±1.2	4.1 <sup>c</sup> ±1.8	8.1±1.8
at 10 hr	8.6 <sup>a</sup> ±3.2	12.1 <sup>A</sup> ±1.8	6.4 <sup>b</sup> ±1.6	7.1 <sup>B</sup> ±2.1	5.1 <sup>c</sup> ±1.3	6.3 <sup>B</sup> ±1.7
Serum testosterone level (ng/ml)	27.8 <sup>a</sup> ±1.7	28.3±1.6	20.8 <sup>b</sup> ±2.1	26.5±2.9	19.6 <sup>b</sup> ±2.1	25.0±2.4
Conception rate	93.3 <sup>a</sup> ±6.1	83.5 <sup>A</sup> ±2.4	57.7 <sup>b</sup> ±3.1	60.6 <sup>B</sup> ±2.4	33.1 <sup>c</sup> ±2.6	46.5 <sup>c</sup> ±3.3
Calving / lambing %	86.7	82.4	46.2	52.8	27.8	36.2

Means in the same row having the same letter did not differ significantly, otherwise they differ ( $P < 0.01$ ).

Table 4. Correlation coefficients between *Tunica dartos* index (TDI) and each of libido, semen quality, serum testosterone level and conception rate in bull and ram

Variable	TDI	
	Bull	Ram
Libido	0.72** ±0.06	0.75** ±0.02
Semen quality		
Ejaculate volume	0.03±0.01	0.08±0.02
Wave motion	0.88** ±0.12	0.83** ±0.05
Motility	0.60** ±0.04	90.91** ±0.08
Dead spermatozoa	-0.67** ±0.06	-0.71** ±0.03
Total abnormal spermatozoa	-0.69** ±0.2	-0.83** ±0.06
Coiled tail	-0.06±0.003	0.09±0.004
Pyriform cells	-0.63** ±0.08	-0.83** ±0.09
Midpiece abnormality	-0.73** ±0.09	-0.82** ±0.08
Acrosomal abnormality	-0.81** ±0.16	-0.88** ±0.02
Sperm concentration	0.83** ±0.03	0.91** ±0.08
Acrosomal reaction		
at 0 hr	0.16±0.02	0.71** ±0.03
at 10 hr	0.23±0.03	0.69** ±0.06
Serum testosterone level	0.22±0.18	0.73** ±0.02
Conception rate	0.79** ±0.11	0.86** ±0.09

\*\*P <0.01; ±S.E.

matozoa, total abnormal spermatozoa, pyriform cells midpiece and acrosomal abnormality were negative (P<0.01).

#### DISCUSSION

These results clearly illustrate importance of *Tunica dartos* thermoregulatory mechanism and relation to semen quality and reproductive performance.

The ultimate value of temperature selection either relaxation or contraction for scrotum based on value of standard deviation equal zero. Which was related to suitable relaxed and smooth or contracted and puckered. When the *Tunica dartos* contracts, the testes are drawn closer to the abdominal wall.

The great variation among bulls or rams in testicles length might be due to differences in size and probably age.

In TDI the individual variation might be due to differences in thermal receptors of scrotal skin and/ or action of

muscle. In rams and probably bulls, thermal receptors initiating *Tunica dartos* responses are probably located in scrotal skin (Curtis 1983).

Bull and ram, having TDI more than 0.90, had a larger libido, wave motion motility, spermatozoa concentration, sperm capacity especially in rams and conception rate and calving or lambing, and lower dead spermatozoa %, total abnormal spermatozoa %, pyriform cell %, acrosomal and midpiece abnormality. When the testicles cannot thermoregulate sufficiently, the formation of sperm is impeded and a temporary condition of lowered fertility results (Taylor and Bogart 1988). The significant correlation coefficient between TDI and semen quality and fertility in the present study agrees with those relationships. In conclusion, significant relationships were found between the TDI and various parameters measured. In addition to, it may indicate that bull and ram with large TDI produced semen of high quality and fertility.

#### REFERENCES

- Chenoweth P G. 1981. Libido and mating behaviour in bulls, boars and rams. A review. *Theriogenology* 16 : 155-77.
- Curtis S E. 1983. *Environmental Management in Animal Agriculture*. Iowa State University Press, Ames, USA.
- Duncan D E. 1955. Multiple Range and Multiple F-test. *Biometrics* 11 : 1-42.
- Fleiss J L. 1981. *Statistical Methods for Rates and Proportion*. John Wiley and Sons, Pub., New York-Toronto-Singapore.
- Lenz R W, Ball G D, Lohse J K, First N L and Ax R L. 1983. Chondroitin sulphate facilitates and acrosome reaction in having spermatozoa as evidenced by light microscopy, electron microscopy and *in vitro* fertilization. *Biology of Reproduction* 683-90.
- NRC National Research Council. 1985. *Nutrient Requirements of Domestic Animals*. 5th edn. National Academic Science, Washington D C.
- Roberts S J. 1971. *Veterinary Obstetrics and Genital Diseases*. 2nd edn. Ithaca, New York.
- Snedecor G W and Cochran W G. 1982. *Statistical Methods*. 7th edn. Iowa University Press, Ames, USA.
- Smyth P and Gordon I. 1967. Seasonal and breed variations in the semen characteristics of rodents in Ireland. *Ireland Veterinary Journal* 21 : 222-33.
- Taylor R E and Bogart R. 1988. *Scientific Farm Animal Production*. Macmillan Publishing Company. New York, USA.