Egypt. J. Anim. Prod. 25, No. 2, pp. 165-172 (1985)

Effect of Heat Stress on Body Fluids and Heat Tolerance Coefficient of White Giza and Bouscat Buck Rabbits

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TO FIND OUT the effect of heat stress on body fluids and heat tolerance coefficient a group of 6 white Giza bucks and a similar group of 6 bouscat bucks were subjected to increase ambient temperature from 16°C with 65% R.H. to 35°C with 65% R.H. B.W., T.B.W. and W.T.R. increased while T.B.S. and biological half life of the tritiated water (T 1/2) decreased under heat stress. Heat tolerance coefficient was higher for the native white Giza (76.56%) than for bouscat (67.53%) bucks rabbits.

Rabbits production is affected by the strong challenge of aridity, intense heat load and water loss. Water loss is influenced by the accumulated heat which must be dissipated to keep the animal within the thermoneutral zone. Determination of water exchange between an animal and its environment became available with tritum as reported by Pace *et al.* (1947) and Richmond *et al.* (1962). Daily water turnover rate (WT.R.) may reflect the range of the metabolic adaptation and may be used as an index for an estimation of daily water requirement. The present work was planned to study the effect of high ambient temperature as a stress factor on body fluids and heat tolerance coefficient of native white Giza and bouscat bucks rabbits.

Material and Methods

Animals and management

Two groups of 6 bucks each aged about 4 months were used, one group was white Giza rabbits and the other group was bouscat strain purchased from a private farm, Sharkia governorate, Egypt. In one room all the rabbits were housed separately in cages

for an adaptation period of 7 days. Clean water was provided and the rabbits were fed ad libitum on a well balanced ration (18.1% protein and 15% crude fibres). The rabbits received light dark cycles of 14 hr light followed by 10 hr dark throughout the experimental period. The two groups were treated under the same managerial and hygienic conditions.

Treatments

The rabbits were subjected to two successive treatments, the first was mild heat exposure where ambient temperature was kept constant at 16°C and 65% relative humidity for 8 hr daily. Animals were allowed 3 days to adapt to this treatment. The rabbits were fasted 18 hr weighed and one blood sample was withdrawn from each buck as a background. Tritiated water was injected with a TOH dose of 1 ml containing 0.1 m Ci per Kg live body weight. Further blood samples were withdrawn at 1.48 and 96 hr respectively. The second treatment was high temperature exposure (heat stress treatment) where ambient temperature was raised to reach 35°C with 65% relative humidity for 8 hr daily. After 3 days, as adjustment period, the rabbits were fasted 18 hr and were weighed thereafter. A dose rate of 0.2 m Ci/Kg live body weight was injected in each buck and blood samples were performed as the same system of the first treatment. Blood samples were centrifuged within 30 minutes at 1000 g. for 30 min and the plasma were separated and were kept under 20°C until counting in beta counter. The turnover of body water was measured by the disappearance rate of TOH from the blood.

$$\text{Total body water (ml.) (virtual tritium space) (T.B.W.)} = \frac{\text{Std. activity, ml} \times \text{Std. dil. Factor} \times \text{Dose volume/ml}}{\text{Activity in ml at zero time}}$$

$$\text{T.B.W.\%} = \frac{\text{T.B.W.} \times 100}{\text{Live body weight (L.B.W.)}}$$

Total body solids (T.B.S.) = Live body weight (L.B.W). — T.B.W. Biological half life time (T $\frac{1}{2}$) of TOH tritiated water, is the time needed to (count C.P. m/ml half the activity of the zero time dosing) remove $\frac{1}{2}$ total exchangeable body water pool.

Heat index (Heat tolerance coefficient) = 100 — T.B.W. increase % in high temperature, (Yousef, 1973 and Habib, 1981).

Statistical analysis

Analysis of variance was carried out according to Steel and Torrie (1960) to find out effects due to rabbit strain ; temperature and interaction on L.B.W., T.B.S., T.B.W., W.T.R. and T $\frac{1}{2}$.

Results

Table 1 shows that means of L.B.W.; T.B.W. (ml. or %) and W.T.R. increased when rabbits were exposed to high ambient temperature. On the other hand T.B.S. decreased when rabbits were maintained under high ambient temperature. T $\frac{1}{2}$ of the tritiated water became shorter under heat stress. Table 2 indicates that neither rabbits nor temperature had significant effect on L.B.W. or T.B.S. The effect of heat stress on T.B.W., W.R.T. and I $\frac{1}{2}$ was highly significant ($p \leqslant 0.01$). It is clear from Table 3 that T.B.W. increased percent during high ambient temperature as heat tolerance coefficient was higher for white Giza than for bouscat rabbits.

Discussion

The increase in T.B.W. of rabbits in the present work with the exposure to high ambient temperature agrees with the findings of Kamal and Seif (1969) ; Macfarlane and Howard (1970) ; Kamal and Johnson (1971) ; Kamal *et al.* (1978) and Habib (1981) on ruminant animals.

Heat stress, in the present work, induced increases in water turnover rate and shortage the biological half life time of tritiated water. Similar results were noticed with different species (Macfarlane and Howard, 1970; Kamal and Johnoson, 1971; Kamal, *et al.* 1972, Youssef, 1973; and Habib, 1981). The increase in W.T.R. may be due to an increase in water intake and water loss which occurs frequently under high environmental temperature (Thompson *et al.*, 1949; Kamal *et al.* 1962; Black, *et al.* 1964; Biance

Table (1): Effect (mean ± s.e., n = 6) of exposure to high ambient temperature on live body weight (LBW gm); total body water (TBW ml or %), total body solids (TBS); water turnover rate (WTR ml) and biological half life of tritiated water ($T_{1/2}$ hrs) in white Giza and bouscat bucks rabbits.

	White Giza Bucks												Bouscat Bucks											
	Ambient temperature												Ambient temperature											
	Mild (16°C)						Hot (35°C)						Mild (16°C)						Hot (35°C)					
	LBW gm	TBS gm	T B W% ml	%	WTR ml	$T_{1/2}$ hrs	LBW gm	TBS gm	T B W ml	%	WTR ml	$T_{1/2}$ hrs	LBW gm	TBS gm	T B W ml	%	WTR ml	$T_{1/2}$ hrs	LBW gm	TBS gm	T B W ml	%	WTR ml	$T_{1/2}$ hrs
X	957.5	459.31	498.19	52.19	48.53	173.33	1021.7	411.4	610.27	59.99	68.99	116	937.5	422.6	514.9	54.8	52.9	170	1005	322.5	682.5	67.5	92.8	118
±s.e	225.83	113.29	109.44	1.61	12.64	25.51	213.18	103.6	116.17	2.67	7.03	19.27	189.15	77.6	112.53	1.33	18.11	34.5	200.8	62.6	173.5	5.3	18.7	12.07

X = mean

s.e. = standard error

et al., 1965; Allen *et al.* 1966; Argenzio *et al.*, 1968 and Anderson 1971). The exposure of the rabbits as non-sweating animals to heat stress accelerated respiration rate (Abo-elezz *et al.*, 1982 Shafie *et al.*, 1982) and facilitates heat dissepation by water vaporization (Brody, 1945). The increase in W.T.R. of the present work may arose from the need for additional evaporative cooling.

Table (2): Analysis of variance of effect of heat stress on live body weight total body solids, total body water(ml & %)water turnover rate and T_2 of white Giza and bouscat rabbits.

Trait	S.O.V.	D.F	SS	M.S.	F
Live Body Weight	Breed	1	2016.67	2016.67	0.047
	Temperature	1	26004.17	26004.17	0.6107
	Interaction	1	16.66	16.66	0.0039
	Error	20	851558.34	42577.917	
Total Body Solids	Breed	1	23671.55	23671.55	2.8326
	Temperature	1	32865.473	32865.473	3.9327(+)
	Interaction	1	4086.527	4086.527	0.4890
	Error	20	167138.432	8356.9216	
Total Body Water (ml.)	Breed	1	11869.934	11869.934	0.6957
	Temperature	1	117336.948	117336.948	6.8770(+)(+)
	Interaction	1	4625.368	4625.368	0.2711
	Error	20	341244.743	17062.2372	
Total Body Water (%)	Breed	1	152.3088	152.3088	15.5840(+)(+)
	Temperature	1	632.4267	632.4267	64.7090(+)(+)
	Interaction	1	36.6054	36.6054	3.7454
	Error	20	195.4671	9.7734	
Water Turnover Rate	Breed	1	329.3005	329.3005	1.487
	Temperature	1	8154.9067	8154.9067	36.8301(+)(+)
	Interaction	1	56.304	56.304	0.254
	Error	20	4428.3965	221.4198	
TOH Biological Half life ($T_{\frac{1}{2}}$)	Breed	1	2.6667	2.6667	0.0045
	Temperature	1	17930.6667	17930.6667	30.4391(+)(+)
	Interaction	1	43.6667	43.6667	0.074
	Error	20	11781.3334	-589.0667	

(+): P≤10%.
(+)(+): P≤1%.

Table (3): Total body water (T.B.W.) (mean ± S.E. n=6) increase percent during heat stress as a heat tolerance coefficient in white Giza and bouscat buck rabbits.

Rabbits	Item	Ambient temperature			T.B.W. increase % during heat stress	Heat index (Heat tolerance coefficient (100-TBW increase %)
		Mild (16°C)	Hot (35°C)	Difference (Hot - Mild) 35 - 16 = 19°C		
White Giza	X̄	498.19	610.27	112.08	23.44	76.56
	±S.E.	109.44	116.17	37.18	8.10	8.10
Bouscat	X̄	514.90	682.48	167.58	32.47	67.53
	±S.E.	112.53	173.54	88.30	13.36	13.36

X̄ = means.
S.E. = Standard Error.

L.B.W. includes two variables namely T.B.W. and T.B.S. which do not necessary vary in the same direction This finding agrees with results of Kamal and Seif (1969) on large ruminant animals. The decrease in T.B.S. of rabbits of the present work coincides with results of Kamal and Johnson (1971) on cattle. The decrease in T.B.S. under heat stress may be due to physiological and biological changes which may include glucocorticoides, catecholamine and insulin secretion and consequently tissue catabolism.

Heat tolerance coefficient of white Giza rabbits is higher (76.56) than that of bouscat rabbits (67.5). The difference may be due to that bouscat rabbits genetically evolved under moderate latitude while the native white Giza rabbits evolved under the semi-arid condition. The ecological differences of the rabbits may be in part expressed in differences in reabsorption and secretion by the kidney and the intestinal tract which reflected in higher withstanding and tolerance to dehydration in white Giza rabbits than in bouscat.

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Acknowledgement. — Thanks are due to S.N.M. Habib, Abdel Shafy and K. El Masry (Biochimatology Unit. Radiobiology Department. Atomic Energy Establishment. Cairo. Egypt) for their help.

تأثير العباء الحرارى على سوائل الجسم والتحمل الحرارى لذكور أرانب الجيزة الأبيض والبوسكات

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اجرى هذا البحث لمعرفة تأثير العباء الحرارى على ماء الجسم ومدى التحمل الحرارى لارانب الجيزة الأبيض والبوسكات باستعمال التريتيوم . عرضت مجموعة من ٦ ذكور أرانب جيزة أبيض وكذا مجموعة متماثلة من أرانب البوسكات لارتفاع حرارة الجو المحيط من ١٦°م الى ٣٥°م .

نتيجة للتعرض للحرارة العالية لوحظ الآتى :

١ – زيادة وزن الجسم .

٢ – زيادة ماء الجسم (كمية ونسبة) .

٣ – قلة نسبة المواد الصلبة .

٤ – قصر فترة نصف العمر البيولوجية للتريتيم .

٥ – ارتفاع معامل التحمل الحرارى لارانب الجيزة الابيض عن ارانب البوسكات .