

Effects of hot environments on bone growth in rats

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The physio-chemistry and endocrinology of bone growth was studied in rats housed under different temperature conditions. Bone lengths did not change significantly but bone widths and densities became significantly smaller in rats kept at 34°C. The depression of bone alkaline phosphatase activity indicated the disturbance of bone organic matrix formation in a hot environment. Levels of TSH, T₄ and insulin were also influenced by a hot environment.

Die fisio-chemie en endokrinologie van beengroei is bestudeer in rotte wat onder verskillende temperatuurtoestande gehuisves is. Beenlengte het nie betekenisvol verander nie, maar beenwydtes en digtheid was betekenisvol kleiner in rotte wat by 34°C gehou is. Die daling in been alkaliese fosfatase aktiwiteit is 'n aanduiding van die versteuring van beenorganiese matrysvorming in 'n warm omgewing. Vlakke van TSK, T₄ en insulien is ook beïnvloed deur 'n warm omgewing.

Keywords: Bone growth, hot environment, rats, alkaline phosphatase, acid phosphatase, hormones

Introduction

Very poor performance in cattle is often found in tropical and sub-tropical areas of the world (MacDowell, 1972). Cattle often fail to reach 300 kg body mass several years after birth. One of the causes is the hot environment. It is well known that high temperature induces a loss of appetite and consequently retards body growth of ruminants. However, physiological effects of high temperature on body growth are not well defined. The present experiment was designed to study bone growth in rats

housed under different temperature levels with respect to physio-chemistry and endocrinology.

Table 1 Body mass of rats subjected to hot environments

	Lot		
	1 (24°C; <i>ad lib.</i>)	2 (34°C; <i>ad lib.</i>)	3 (24°C; restricted)
Initial	142 ± 5	137 ± 7	139 ± 7
Final	342 ± 16 ^a	206 ± 31 ^b	170 ± 8 ^b
Increase	200 ± 13 ^a	67 ± 31 ^b	31 ± 13 ^b

Mean ± SD. a,b: $p < 0,01$.

Table 2 Measurements of bone growth and enzyme activities in rats subjected to hot environments

Measurements	Lot		
	1 (24°C; <i>ad lib.</i>)	2 (34°C; <i>ad lib.</i>)	3 (24°C; restricted)
Femur			
Dry mass (mg)	370 ± 26 ^a	205 ± 36 ^b	263 ± 11 ^c
Length (mm)	32,2 ± 0,9 ^a	28,5 ± 1,2 ^b	28,3 ± 0,6 ^b
Width (cm)	3,63 ± 0,16 ^a	2,78 ± 0,19 ^b	3,16 ± 0,12 ^c
Volume (cm ³)	0,39 ± 0,03 ^a	0,24 ± 0,03 ^b	0,29 ± 0,01 ^c
Density mg (cm ³)	947 ± 29 ^{ac}	833 ± 86 ^{bf}	912 ± 26 ^{abg}
Mineral weight (mg)	239 ± 16 ^a	127 ± 25 ^b	160 ± 6 ^c
Enzyme activities (units/mg protein)			
Alkaline phosphatase	132 ± 16 ^a	83 ± 15 ^b	79 ± 11 ^b
Acid phosphatase	37 ± 6 ^a	23 ± 3 ^b	29 ± 4 ^c

Mean ± SD: a, b, c: $p < 0,01$; e, f, g: $p < 0,05$.

Table 3 Hormone levels in serum of rats subjected to hot environments

Hormone	Lot		
	1 24°C; <i>ad lib.</i>	2 34°C; <i>ad lib.</i>	3 24°C; restricted
TSH (μU/ml)	1,54 ^b	2,92 ^a	0,37 ^c
T ₄ (μg/100 ml)	3,97 ^{ae}	1,86 ^{bf}	2,98 ^{bg}
HGH (ng/ml)	0,25	0,30	0,40
Insulin (μU/ml)	45,1 ^a	33,2 ^a	19,0 ^b
PTH (IU/ml)	0,75	1,23	0,77

a, b, c: $p < 0,01$; e, f, g: $p < 0,05$.

Materials and Methods

Twentyfour Wistar strain rats weighing about 90 g were fed for a preliminary period of 1 week and then, divided into 3 lots as follows: (1) 24°C, fed *ad libitum*, (2) 34°C, fed *ad libitum* (3) 24°C, restricted feeding, the amount being the same as for lot (2). All animals were kept in a

temperature controlled room for 5 weeks. The following parameters were measured; mass and bone growth, diet and water intake, bone and serum mineral contents using an atomic absorption spectrophotometer, bone remodelling enzymes using a spectrophotometer and some hormone concentrations in serum using radio-immuno assay methods.

Results and Discussion

Body mass, bone mass, bone length, alkaline phosphatase (Alp-ase) and acid phosphatase (Acp-ase) activities were increased in rats of lot (1). Although body mass, bone lengths and Alp-ase activities did not differ between lot (2) and lot (3), bone mass, bone densities, bone mineral contents and Acp-ase activities were lower in lot (2) than

in lot (3) (Table 1 and 2).

TSH concentrations in serum appeared to be higher in rats housed at the higher temperature than at the lower temperature (Yousef, 1982). Insulin concentrations in serum tended to be higher in lot (1) than in either lot (2) or (3), with rats in lot (2) showing higher concentrations than those in lot (3). There seemed to be no difference in growth hormone concentrations among the 3 lots of rats (Table 3).

In conclusion, bone lengths did not change significantly but bone widths and bone densities became significantly smaller in rats housed in high temperatures. The depression of bone Acp-ase activity indicated the disturbance of bone organic matrix formation in a hot environment.

References

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