

Heat Tolerance in Alloxan Diabetes

During the past twenty-five years many papers dealing with the relationship between blood sugar levels and body temperatures, as well as the influence of diabetes and insulin on body temperature have been written. The rather extensive literature concerning these subjects will be reviewed in a more detailed report to be published elsewhere. No data concerning heat tolerance in diabetes was found in the literature available to us.

In the present experiments adult rabbits weighing approximately 2,000 g were used. Diabetes was produced by intravenous injection of 100 mg/kg alloxan. The body weights, blood sugar levels and glycosuria were all recorded. The method used in measuring and comparing tolerances to heat was the same as that employed in previous experiments in similar studies on animals which were thyroidectomized<sup>1</sup>, fed with methylthiouracil<sup>2</sup> or castrated<sup>3</sup>. Animals having practically identical heat tolerances were selected and paired in preliminary experiments in which litter mates of the same age, sex and weight were overheated several times for 3½ hour periods in a thermostat at 34–35° C. The hyperthermic body temperature curves were plotted on a graph. The areas between the curves and the abscissas were measured in square millimetres and called time-temperature areas. Their values—dependent upon the degree and duration of hyperthermia—form a reliable basis for measuring and comparing tolerances to heat. Should large numbers of preliminary experiments be carried out on many litter mates pairs are always found which, in several overheating experiments on various days have nearly the same time-temperature area values and, therefore, practically identical heat tolerances<sup>4</sup>.

<sup>1</sup> B. BERDE, Schweiz. med. Wschr. 77, 1367 (1947).  
<sup>2</sup> B. BERDE, Hungarica acta physiol. 1, 62 (1947).  
<sup>3</sup> B. BERDE and L. TAKÁCS, Z. Vitamin-Hormon-Ferment-Forschg. 1, 480 (1947/48); 2, 23 (1948/49).  
<sup>4</sup> A. LINDER, Statistische Methoden (Verlag Birkhäuser, Basel 1945).

One animal from each of fifteen such pairs selected in this manner was injected with alloxan and, after a significant rise in the blood sugar level and glycosuria were obtained, was subjected to repeated overheating together with its control mate. Six of the animals died shortly after alloxan treatment, thus leaving only nine pairs of rabbits on which comparative overheating experiments were able to be carried out. These nine pairs were overheated four to nine times during the five to twelve days following injection of alloxan. Eight of the nine alloxanic animals developed diabetes. One showed no change, but seven of the diabetic rabbits always had a pronounced rise in body temperature over its non-diabetic mate in each of the various overheating periods. This indicates that diabetes lowered the animals' tolerance to heat.

The Table cites details of one of our experiments. The relationship of the time-temperature areas—similar when heat tolerances are identical and larger when tolerance to heat is lessened due to alloxan diabetes—is easily seen in the Table. As mentioned above, seven of eight diabetic rabbits showed reduced tolerances to overheating. In one rabbit the lack of tolerance toward heat was so marked that the usual 3½ hour periods of overheating in the thermostat had to be reduced by one hour or more due to hyperpyrexia and other extreme symptoms.

These experiments show that tolerance to heat is lessened in rabbits suffering from alloxan diabetes. The mechanism involved in this phenomenon needs further elucidation.

B. BERDE, L. TAKÁCS, and A. FEKETE

Institute of Physiology, University of Budapest, June 1, 1949.

Zusammenfassung

In Überwärmungsversuchen (Thermostat von 34–35° C) wurden Kaninchenpaare von gleicher Wärmetoleranz ausgelesen. Bei je einem Tier dieser Paare wurde mit 100 mg/kg Alloxan i. v. ein Diabetes hervorgerufen. Bei der Wiederholung der Wärmebelastungsversuche zeigten 7 von 8 Tieren eine herabgesetzte Wärmetoleranz.

Date in June 1948	Rabbit No. 3a				Rabbit No. 3b			
	Body weight in grams	Blood sugar in mg%	Glycosuria	Time-temperature areas in square millimetres		Glycosuria	Blood sugar in mg%	Body weight in grams
11th	1,750			2,279	2,210			1,830
12th				2,284	2,143			
14th				2,318	2,346			
15th				2,084	2,193			
16th				2,346	2,191			
17th				2,030	2,041			
				Mean: 2,226 2,184				
				P > 0,05				
21st	1,900	110	∅	100 mg/kg alloxan i. v.		∅	102	1,900
22nd	1,800	>340	+++	3,067	2,547	∅	105	1,880
23rd			+++	3,159	2,325	∅		
24th			+++	2,387	1,597	∅		
25th			+++	3,016	2,391	∅		
26th	1,800	340	+++	2,848	2,054	∅	102	2,000
30th			+++	3,252	2,454	∅		
				Mean: 2,955 2,228				
				P < 0,01				