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Effect of Water Deprivation in Winter on Certain Blood and Urinary Constituents in the Indian Gerbil, *Tatera indica indica*

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The effect of acute water deprivation for 30 days on body weight and on certain blood and urinary constituents in the Indian gerbil, *Tatera indica indica* was investigated. After an initial fall of about 15% by the 15th day of water deprivation, the body weights of the experimental animals started increasing till almost 90% of the initial body weight was regained. Feed consumption increased steadily as water deprivation proceeded. Faecal matter production, although inconsistent in the beginning, also increased after one month of water deprivation. Urine production was reduced to half of the normal production. Packed Cell Volume and blood and urinary urea concentrations increased as a result of water deprivation. While plasma sodium and potassium concentrations increased slightly, urinary sodium was reduced to less than half the normal value as a result of water deprivation. Potassium excretion increased in the water deprived animals. Water deprivation caused a reduction in total plasma protein concentration.

Key Words: Water deprivation, Indian gerbil, Blood and urinary electrolytes

Introduction

Although a bulk of information is available on the physiological and behavioural adaptational strategies of a variety of American (Schmidt-Nielsen & Haines 1964, MacMillen 1972 and MacMillen & Grubbs 1976), Australian (Haines et al. 1974) and Israeli (Horowitz & Borut 1970 and Horowitz et al. 1978) rodents to hot, arid environments, no detailed information in these lines is available on Indian desert rodents except for the reports of Ghosh et al. (1962) and Ghosh and Purohit (1964) on the Indian desert gerbil, *Meriones hurrianae*. Besides *M. hurrianae*, *T. indica indica* is an important component of the rodent biomass of Rajasthan's arid and semi-arid regions. Lack of quantitative information on this animal's physiological strategies to cope with the desert environment led to the present study. The studies have been mainly concerned with the changes in certain blood and urinary constituents of one-month water deprived *T. indica indica* with a view to examine their kidney function under the stressful conditions imposed.

Materials and Methods

Adult Indian gerbils, *Tatera indica indica* of both sexes were utilised in these studies. The animals, which ranged in body weight from 127 to 164 g, were collected from Bikaner town situated about 200 km to the north-west of Jodhpur. They were housed individually in wire mesh cages in the Institute's animal house at Jodhpur for about 10 days prior to experimentation. During this acclimatization period they were offered *bajra* grains *(Pennisetum typhoides)* and water *ad libitum.* Records of daily consumption of food and water were maintained, the drinking water being offered from graduated 'L' shaped glass tubes fitted to the cages. A similar tube filled with water and with the drinking end directed outwards was fitted to one of the cages to note the daily evaporation rate. The faecal matter collected from each cage was dried to a constant weight. On alternate days, the animals were transferred to round wire mesh cages placed over petri-dishes which had a layer of mineral oil for urine collection. No feed was offered during the 24 hr urine collection period. After the acclimatization period, the animals were divided into two groups of 6 each, one forming the experimental group receiving no water and the other, the control group, receiving water *ad libitum.* *Bajra* seeds comprised the sole feed of the animals. The feed intake and the amount of urine and faecal matter excretions by the animals during water deprivation were recorded at 5 day intervals.

On the 31st day of water deprivation, blood was collected from the lightly anaesthetised animals in heparinized test tubes by direct heart puncture. The kidney, adrenal, testis, epididymis and ovary were dissected out from the left side of each animal, cleared of extraneous tissue and weighed nearest to 0.1 mg on a Mettler semi-micro balance. Blood and urine from both groups of animals were processed for urea determinations by the diacetyl monoxyme method (Varley 1963). Packed cell volume (PCV) was determined in a micro-haematocrit centrifuge. Plasma was separated from the blood immediately after drawing. Both plasma and urine samples were diluted with distilled water for determinations of Na^+ and K^+ by flame photometry as described by Varley (1963). Plasma proteins were determined by the biuret method (Varley 1963).

Results

The ambient conditions prevailed at Jodhpur are represented in figure 1.

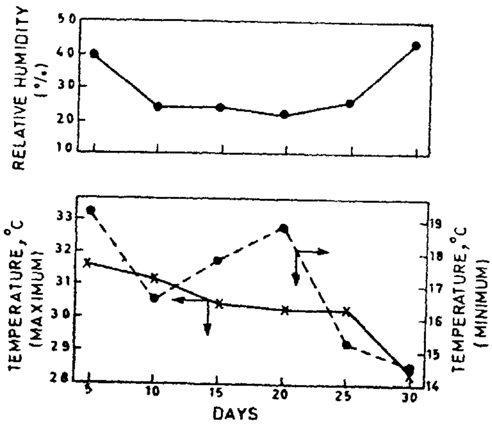

Figure 1 Ambient conditions at Jodhpur during the trial (values are averages of five daily observations)

Figure 2 represents the progressive changes in the body weights of the animals subjected to water deprivation for a month. The body weight of the water deprived animals which came down to about 85% of their initial body weight by the 15th day of water deprivation, subsequently recovered and recorded 90% of the initial weight by the end of the experimental water deprivation period of 30 days. The feed intake of the water-deprived animals at first showed a slow and steady increase, and then increased sharply after the 20th day of water deprivation (figure 2). Faecal matter production by the deprived animals, although inconsistent in the begining, showed a steady increase at later stages (figure 2). Urine volume was reduced almost to half after 10 days of water deprivation and remained as such till the end of the experimental period (figure 2).

From the weights of various internal organs of the two groups of animals given in table 1, it would appear that water restriction for one month does not affect the weights of the organs significantly.

Increased blood and urinary urea concentrations have been recorded after water restriction (figure 3). The concentrations of sodium and potassium in plasma also increased after water deprivation (figure 4). In the urine of the deprived animals, Na^+ concentration was reduced to less than half the normal value, while K^+ concentration recorded an increase.

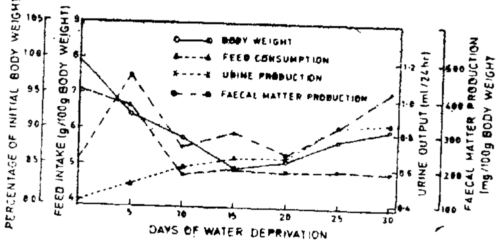

Figure 2 Effect of 30 days of water deprivation in *T. i. indica* (values are means of observations on 6 animals)

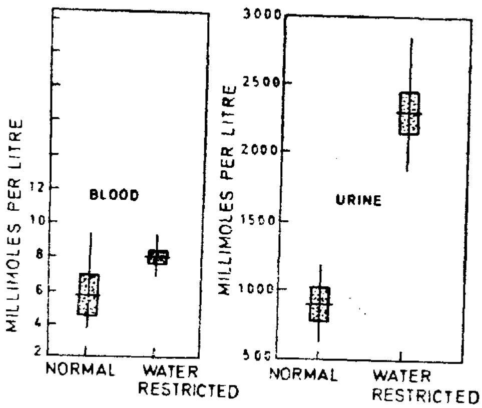

Figure 3 Blood and urinary urea concentrations in normal and 30 day water deprived *T. i. indica,* (values are means of observations on 6 animals. Horizontal lines indicate means; vertical lines indicate ranges; rectangles enclose the intervals ±S.E.)

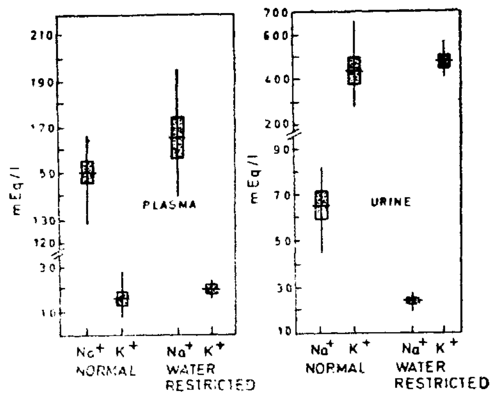

Figure 4 Plasma and urinary concentrations of electrolytes (Na^+ & K^+) in normal and 30 day water deprived *T. i. indica* (values are means of observations on 6 animals. Horizontal lines indicate means; vertical lines indicate ranges; rectangles enclose the intervals ±S.E.)

The total plasma proteins were reduced following water restriction, the albumen fraction contributing the major share to this reduction (table 2). The globulin fraction apparently remained unaffected by water deprivation.

Discussion

The observed initial decline in the body weight of the gerbils when water is withheld from them is similar to observations made by several workers on other species of rodents (Ghosh et al. 1962, Schmidt-Nielsen & Haines 1964, MacMillen et al. 1972 and Haines et al. 1978). This phenomenon may possibly be attributed to the process of acclimation which several workers believe to take place in water deprived rodents (Haines et al. 1973 and Horowitz et al. 1978). The increase in the feed intake of the water-restricted animals, as observed by us, may also form part of an acclimation syndrome. The faecal matter excretion of the water-deprived animals, though inconsistent in the beginning, runs almost parallel with their feed consumption at the later stages. As was expected, urine volume showed a sharp reduction in the beginning of the deprivation period, falling to almost half of the normal daily production by the 30th day of water deprivation.

The increase in packed cell volume (PCV) following water deprivation, as reported here, is in agreement with the report of Mogharabi and Haines (1973). This increase in PCV may be due partly to a shift of plasma water to other body

Table 1 *Effect of 30 days of water deprivation on certain body organ weights of the Indian gerbil,* Tatera indica indica

Treatment	Organ weights (mg/100 g B. wt.)*				
	Kidney	Adrenal	Testis	Ovary	Epididymis
Normal	279.94 ±20.53	21.63 ±1.85	470.17 ±81.06	7.65 ±1.17	124.78 ±16.98
Water restricted	313.73 ±19.86	27.08 ±3.10	411.63 ±163.69	7.75 ±1.45	149.66 ±38.80
	NS	NS	NS	NS	NS

*Mean ±SE of six observations
NS, Not significant

Table 2 *Effect of 30 days of water deprivation on packed cell volume and plasma proteins in the Indian gerbil,* Tatera indica indica

Treatment	Protein (g/100 ml)			
	Total proteins	Albumin	Globulin	PCV*
Normal	10.9±0.65	8.14±0.53	2.77±0.34	33.27±2.87
Water restricted	8.66±0.18†	5.44±0.47†	3.22±0.50	37.21±2.35

* Mean ± SE of six observations
† Significant at 5% level

water compartments in an attempt to achieve fluid homeostasis.

Though not fully independant of exogenous water, by virtue of their habitat selection, the relatively high renal concentrating capacity of *T. indica indica* are reflected in the substantial increase in their urinary urea concentration following water deprivation. MacMillen et al. (1972) working on the sandy inland mouse, *Leggadina hermannsburgensis*, have also reported a similar rise in urinary urea concentration when the animals were deprived of drinking water. However, *Leggadina hermannsburgensis* is fully independent of exogenous water, subsisting on dry seeds only.

Water deprivation was accompanied by slight increases in plasma Na^+ and K^+ concentrations in the gerbil. Similar plasma Na^+ responses have been recorded in water-deprived donkey, dog, man, camel, Merino sheep, and steer (Dill 1938, Elkinton & Taffel 1942, Adolph 1947, Schmidt-Nielsen 1964, Macfarlane et al. 1961 and Bianca et al. 1965). The increases in the plasma concentrations of Na^+ and K^+ in the gerbil also suggest a possible reduction of plasma volume after water deprivation in this species. The increase in plasma K^+ concentration after water deprivation, as observed in the present study, was not statistically significant.

Urinary Na^+ level decreased and K^+ level increased in the water-deprived gerbils. Similar observations have been made by Dicker (1949) on rats and by others in dogs and man (Elkinton & Taffel 1942 and Black et al. 1944). Mogharabi et al. (1973) working on squirrels have reported increased excretions of both Na^+ and K^+ following water deprivation.

Plasma protein concentration showed a decreasing trend in the water-deprived gerbils. Marriott (1923) reported that high concentrations of plasma proteins are usually associated with sudden dehydration. Since, in the present case, water deprivation was prolonged, decrease in the total plasma protein concentration of the animals was to be expected. This was mainly due to a drastic reduction in the albumin fraction (30%) which is accompanied by an increase of globulins by 16%—an important fraction involved in combating water stress conditions.

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