Food-restriction polydipsia in hamsters

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Adult golden hamsters restricted to 1 g of food per day developed polydipsia and polyuria. Unlike the rabbit, the hamster did not show cessation of polydipsia when given additional NaCl and did not show how high urinary loss of Na⁺. From three to 10 days were required for the development of a vigorous polydipsia on this schedule.

Although food restriction produces adipisia in guinea pigs and hypodipsia in rats, it produces polydipsia in gerbils and hamsters (Kutsch, in press). Cizek (1961) reported that total food restriction in rabbits produces polydipsia, polyuria, and a high rate of Na⁺ loss from the kidney resulting in Na⁺ deficiency. Substitution of 0.85% NaCl for drinking water abolished the polydipsia. The following experiments were done to see if NaCl supplements during food restriction would abolish polydipsia in hamsters and to determine urine output during polydipsia in order to eliminate the possibility that the hamsters were merely spilling water and not actually drinking it.

Method. Subjects were 20 naive, adult, male golden hamsters *Mesocricetus auratus* which were obtained from a local dealer. Mean body weight was 138.0 g at the beginning of the experiment. Hamsters were maintained on Purina chow mash and tap water throughout the experiment.

Ten hamsters were placed in individual 9½ x 5 x 7 in. aluminum cages with hardware cloth floors and Plexiglas tops. After hamsters were allowed three days of adaptation to the cages, water intake and urine outputs were measured at 30 min intervals for 24 h (food available ad lib). Voided urine samples were allowed to fall onto a clean polyethylene sheet (placed beneath the cages) from which they were removed immediately with a syringe and needle and deposited into graduated centrifuge tubes for determination of volume. Water intakes were measured with inverted eudiometer tubes (graduated in 0.2 ml units) fitted with steel drinking tips.

Ten other hamsters were placed in individual 10 x 12 x 9 in. cages of steel and hardware cloth in which water was always available. After 14 days of ad lib food intake, they were given 1 g of food per day for five days. Five hamsters were given normal chow, and five were given chow with NaCl added (0.14 g of NaCl per 1.0 g of chow) in sufficient quantity to maintain normal salt intake on the diet of 1 g of food per day. Mean ad lib food intake was 12.7 g per day. After a five week recovery period, the food restriction was repeated for five days. Hamsters previously given salted chow were now given normal chow and vice versa. Daily water intakes were measured.

Fig. 1. Mean daily water intakes for five days of unrestricted food intake (ad lib) and for five days of food restriction (1 g/day). Food offered during the food-restriction period was either "normal" chow (N) or "salted" (S).

Fig. 2. Individual daily water intakes for three hamsters for (a) five days of unrestricted food intake (ad lib) followed by (b) food-restriction (1 g of normal chow per day). Drinking curve for hamster No. 1 was typical of most animals tested. No. 7 was the first to develop polydipsia in the group of nine hamsters and No. 2 was the last.

Results and Discussion. Since in both groups, the same animals were tested under both of the experimental conditions, all data comparisons were made with t tests for related data. The probability values cited are for two-tailed tests.

The first group of 10 hamsters showed both polydipsia and polyuria when exposed to the food-restriction schedule for five days. Mean daily water intakes rose significantly ($p < .05$) from 10.5 ml on the ad lib test day to 20.4 ml on the fifth day of food restriction. Urine output increased from 5.4 ml to 18.5 ml ($p < .01$). Any water spilled from the drinking tubes was easily distinguished from urine and thus could not contaminate the measurements. Urine Na⁺ concentration decreased significantly ($p < .01$) from 217 mEq/L on the ad lib test day to 15 mEq/L on the fifth day of food restriction. Clearly, the hamsters were ingesting (and excreting) abnormally large amounts of water and were not merely spilling it. Unlike the rabbit (Cizek, 1961), the hamsters were also showing a considerable amount of Na⁺ conservation and were excreting extremely dilute urine. The mean urinary Na⁺ loss (0.28 mEq) only slightly exceeded the intake (0.20 mEq) on the severely reduced food intake in spite of the polyuria condition.

In the second group of 10 hamsters, one animal was discarded because of ill health before the deprivation began. The following data is from nine animals. Mean daily water intakes under salted and normal chow conditions are shown in Fig. 1. The addition of NaCl to the 1 g of food per day (thus preventing Na⁺ deficiency) did not prevent the development of polydipsia, but enhanced it. Under the salted chow condition, mean water intake on the fifth day of food restriction (25.5 ml) significantly exceeded ($p < .01$) intake on the last ad lib day (13.9 ml). Intake on the fifth day of food restriction was significantly higher ($p < .01$) for the salted chow condition (25.5 ml) than for the normal chow condition (15.9 ml). It was puzzling that the normal chow condition did not

produce polydipsia at all within five days although polydipsia was noted in the hamsters used to measure urine output. Three weeks following the end of food restriction, the second group of hamsters was again placed on food restriction (1 g/day) until polydipsia developed. Every animal showed a vigorous polydipsia although some animals required 10 days to develop it (Fig. 2). Peak water intakes ranged from 40.0 to 114.5 ml (mean intake on the last ad lib day = 17.1 ml). Failure to observe polydipsia under the normal chow condition (Fig. 1) was apparently due to restricting observations to five days of food restriction.

Food-restriction polydipsia in hamsters seems to be different from food-restriction polydipsia in rabbits (Cizek, 1961) since hamster polydipsia does not seem to be related to alteration in Na⁺ metabolism. Further experiments are needed to establish the

source of hamster polydipsia and to show why polydipsia occurs with food restriction in some animals (hamsters, gerbils, and rabbits) and not in others (rats and guinea pigs). The possibility of kidney dysfunction resulting from fasting needs to be investigated. Unpublished studies by the authors show that the polydipsic gerbil can excrete hypertonic urine and conserve water as well as normal gerbils when stressed with water deprivation and hypertonic salt injection, thus indicating no renal dysfunction. Such experiments need to be done in hamsters.

REFERENCES

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