Enhancement of Cesium^{137} Excretion by Rats Fed Potassium-Supplemented Diets.*‡ (27071)

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Enhancement of radiocesium excretion is of importance to man, as Cs^{137} is a high yield product of uranium and plutonium fission and ranks high on the list of potentially hazardous by-products of peaceful applications of nuclear energy. Published studies regarding enhancement of Cs^{137} excretion through increased potassium intake are still somewhat inconclusive. Mraz *et al.*(1) found that acutely administered Cs^{137} was lost more rapidly from rats when dietary potassium levels were increased. Similar findings were reported for other species(2,3). Ogawa *et al.*(4) found that ingested potassium chloride had little, if any, effect on retention of acutely administered Cs^{137}. Wasserman and Comar(5) found no beneficial effect of increased dietary potassium on retention of chronically administered Cs^{137} by rats.

Some experimental results are questionable because potassium-deficient semisynthetic diets were fed to control animals. Feeding of diets deficient in a specific element is known to cause pronounced deviations from the metabolic pattern normally obtained for that element. In addition, potassium-deficient diets are often deficient in other elements, such as magnesium, and can cause renal damage(6,7). Results of this study, obtained by whole body counting techniques, represent another contribution towards the solution of this problem.

Materials and methods. Thirty male Sprague-Dawley rats, 84 days old (average weight, 317.5 g), were divided into 5 equal groups. One group was fed ground Purina Lab Chow (basal diet); another was fed a commercially supplied potassium-deficient diet; and the remaining 3 groups were fed basal diet supplemented with varying amounts of potassium added as chloride. Potassium concentration was about 1% for the basal diet (8), and 5, 8, and 11% for the supplemented diets. A Patterson-Kelley twin-shell laboratory blender was used to facilitate mixture of basal diet with the potassium supplements. All animals were fed basal diet for about 1 week for acclimation to pulverized food and special feeders.

Immediately after intraperitoneal injection of 0.65 μc carrier-free Cs^{137} per animal, each group was placed on its specific dietary regimen. Animals were radioassayed individually at 30 minutes following injection and at suitable intervals therafter in a 4π whole body liquid scintillation counter(9). Biological retention of Cs^{137} at each time of measurement was calculated by the following expression: Biological Retention = (Animal Count Rate/Standard Count Rate)$_t$/(Animal Count Rate/Standard Count Rate)$_o$ in which subscripts t and o refer to time after Cs^{137} injection. This expression corrects for minor day-to-day fluctuations in the counting system.

Approximately 80 days after injection, the 3 surviving animals maintained on the potassium-deficient diet were placed on basal diet for the remainder of experiment.

Results and Discussion. Mean whole body retention values as a function of time are given for each group in Fig. 1. The time-course of Cs^{137} retention for control animals is similar

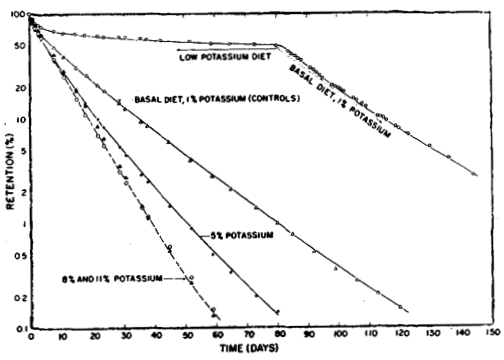

FIG. 1. Effect of dietary potassium on retention of Cs^{137} administered intraperitoneally to rats.

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TABLE I. Parameters of Cesium^{137} Retention Functions for Normal Male Sprague-Dawley Rats.

	No. of Rats	Component	a* (%)	k* (fraction/day)	T_b† (days)
This Study	6	1	17.26	.84110	.82
		2	28.15	.10869	6.38
		3	54.47	.05014	13.82
Previous Study(10)	6	1	17.34	.75918	.91
		2	32.38	.10094	6.87
		3	50.19	.05181	13.38

* From $R_t = \sum^{n} (a_i e^{-k_i t})$, where R_t is retention at any day t, and a_i and k_i are intercept and rate constants, respectively.

† $T_b = \frac{0.693.}{k}$

to that previously observed for normal rats at this Laboratory(10).

Table I compares retention parameters obtained for control animals in this experiment with those previously obtained for normal rats. In both cases, retention parameters were obtained by computer analyses based on iterative least square calculations. Details of this curve-fitting procedure have appeared elsewhere(10). Values in Table I indicate how precisely the time-course of retention can be measured and described by whole body counting and computer curve-fitting techniques. Further, by integrating the retention functions (Table I) between o and ∞ time, we find the total areas agree to within $\pm 2\%$.

It is apparent from Fig. 1 that the potassium-deficient diet caused increased retention of Cs^{137} and, therefore, does not serve as an adequate base line or control for studies designed to assess effects of dietary potassium on Cs^{137} excretion. It is also apparent that when these animals were returned to the basal diet, the retention pattern approximated that of control animals on an adequate potassium diet.

All groups receiving supplementary dietary potassium lost Cs^{137} more rapidly than the control group. Increased Cs^{137} excretion was not linearly related to potassium content of the diet, as no further increase was observed when dietary potassium was increased above 8%.

Fig. 1 shows that the initial Cs^{137} burden of animals on the 5% potassium diet decreased by a factor of 100 in 50 days, whereas the time required for a similar reduction in the initial body burden of animals fed basal diet containing 1% potassium was 80 days. At 20 days after injection, the Cs^{137} burden of animals maintained on the 5% potassium diet was half that of animals fed basal diet. This experiment simulates conditions of accidental Cs^{137} contamination and suggests the order of effect that may be expected from immediate therapeutic measures based on increased dietary potassium. In view of possible practical applications of such therapy, similar experiments will be repeated on larger mammalian species.

Summary. Normal rat diet supplemented with potassium at concentrations of 5, 8, or 11% increased the excretion of a single intraperitioneal dose of Cs^{137} from rats as compared with control rats ingesting normal rat diet without added potassium. Twenty days after injection, the Cs^{137} burden of rats maintained on 5% potassium diet was half that of animals fed basal diet. Animals fed a semisynthetic low potassium diet retained Cs^{137} more tenaciously than animals on the normal diet.

Increasing dietary potassium intake simultaneously with exposure to Cs^{137} does have the beneficial effect of enhancing Cs^{137} excretion in the rat.

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