Influence of Dietary Potassium on Potassium-42, Rubidium-86 and Cesium-134 Retention in the Rat.* (23518)

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MacLeod and Snell(1) reported that cesium, potassium and rubidium behaved similarly in the nutrition of lactic acid bacteria. These elements are known to enter the solute complex, participating in ion antagonism, osmosis, permeability regulation, maintenance of the colloidal state and similar physiological phenomena(2). Mraz *et al.*(3) observed an increase in excretion of cesium-134 by the rat when dietary potassium was increased. Mraz and Patrick(4) demonstrated that the absence of dietary potassium in a casein-cornstarch diet decreased urinary and fecal excretion of cesium-134, potassium-42 and rubidium-86. Miller(5,6) observed that the minimum potassium requirement for rats lies somewhere between 0.55 and 1.44 g per kilo of diet. This study was initiated to ascertain the feasibility of utilizing potassium-42, rubidium-86 and cesium-134 as indicators of potassium requirement in the rat.

Methods and materials. The basal diet used in these studies is the casein-cornstarch diet of Mraz and Patrick(7) minus the potassium chloride. Potassium in the chloride form was substituted for part of the cornstarch in the basal diet. Four albino rats (Rockland strain) were used per diet in each of the experiments. The rats in the potassium-42 trial were fed their respective diets for 14 days and those in the rubidium-86 and cesium-134 trials for 7 days before administration of the radionuclides. Five microcuries of cesium-134 or 35 microcuries of rubidium-86 were administered in the cesium or rubidium trials and a 72-hour balance trial made. The short half-life of potassium-42, 12.5 hr as compared to 2.3 years for cesium-134 and 18.6 days for rubidium-86, necessitated the use of 200 microcuries of the nuclide and only a 48-hour balance trial. The rats were sacrificed at the end of the balance trials. All nuclides were subcutaneously administered in the chloride form. Cesium-134 was used at tracer levels, while the potassium-42 and rubidium-86 dosages contained 26 mg potassium and 8.2 mg rubidium, respectively. Feces and urine samples were collected every 24 hours after administration of the nuclides. Excreta were digested with nitric acid and aliquots counted in a scintillation well-type counter. In the interest of ease of recording and reading, all data have been reported utilizing a maximum of three significant figures and are not indicative of sensitivity of the experiments. Least significant differences at the 5% level of confidence were determined and used as criteria for reporting significance between tissues and excreta as attributable to treatments.

In each experiment 8 groups of rats were fed either 0, 0.5, 0.075, 0.1, 0.15, 0.2, 0.3 or 0.4% potassium. At initiation of the trials, average weights of the rats were 100, 80, and 60 g for the potassium-42, rubidium-86 and cesium-134 trials, respectively.

Results. It may be noted (Table I) that rats fed diets containing 0.15 or more per cent potassium retained significantly less potas-

TABLE I. Potassium-42 Content of Tissues and Excreta as Influenced by Varying Levels of Potassium.

Dietary K (%)	Wt gain (14 day) (g)	Tissue* (%/g)			Excretion* (48 hr)
		Muscle	Kidney	Liver	
.00	−2	1.34	1.10	1.38	.8
.05	18	1.15	.89	1.06	.6
.075	24	1.21	.86	1.05	3.4
.10	32	1.02	.81	.89	5.1
.15	56	.75	.53	.70	8.0
.20	55	.79	.59	.69	10.7
.30	58	.73	.54	.65	10.1
.40	39	.84	.63	.75	15.2
L.S.D.†		.24	.23	.23	6.0

* Expressed as % of subcut. administered dose.
† Least significant difference between means at 5% level of confidence.

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sium-42 in their tissue than did those fed diets containing 0.075 or less per cent potassium. Significantly more potassium-42 was excreted by rats fed diets containing at least 0.15% potassium than by those fed diets containing 0.05 or less per cent potassium.

Significant differences in rubidium-86 uptake by tissues were observed (Table II) but the level of potassium at which significance was found varied between tissues. The rats fed 0.15% potassium excreted significantly more rubidium-86 than did those fed lower levels. Each increment of dietary potassium fed beyond 0.15% induced a significant increase in rubidium-86 excretion.

Tissue uptake of cesium-134 (Table III) proved to be quite variable with no sharp trends being apparent. Excretion of cesium-134, however, showed more uniform trends with the first significant difference in cesium-134 excretion occurring at 0.15% potassium and the next at 0.20% after which it levels off.

Growth rate in all 3 experiments began to plateau at 0.15% potassium. The tissue uptake of radionuclides on the various potassium levels is believed to be partially a reflection of body weight of the rats at time of dosing. Since the rats fed potassium deficient diets did not grow as well as those on potassium adequate diets, their body weights were lower at the end of the feeding period. The smaller the rat, therefore, the higher the concentration of radionuclides per gram of tissue, even if excretion of the nuclides remained constant.

TABLE II. Rubidium-86 Content of Tissues and Excreta as Influenced by Varying Levels of Potassium.

Dietary K (%)	Wt gain (7 day) (g)	Tissue* (%/g)			Excretion* (72 hr)
		Muscle	Kidney	Liver	
.00	3	1.66	2.15	2.42	1.2
.05	15	1.66	1.80	2.06	1.7
.075	17	1.47	1.55	2.13	1.6
.10	22	1.42	1.58	1.67	2.1
.15	26	1.32	1.45	1.74	3.6
.20	29	1.18	1.00	1.39	4.8
.30	27	1.24	1.37	1.50	6.9
.40	31	1.18	1.37	1.37	9.8
L.S.D.†		.35	.35	.41	1.2

* Expressed as % of subcut. administered dose.
† Least significant difference between means at 5% level of confidence.

TABLE III. Cesium-134 Content of Tissues and Excreta as Influenced by Varying Levels of Potassium.

Dietary K (%)	Wt gain (7 day) (g)	Tissue* (%/g)			Excretion* (72 hr)
		Muscle	Kidney	Liver	
.00	2	2.79	3.27	1.18	4.1
.05	8	2.53	3.64	1.26	7.0
.075	15	2.90	3.10	1.40	7.9
.10	19	2.32	3.47	1.11	8.1
.15	26	2.09	2.24	1.03	14.3
.20	27	1.93	2.38	.93	19.0
.30	21	1.88	2.21	.97	21.1
.40	27	1.71	1.85	.84	21.1
L.S.D.†		N.S.	1.18	N.S.	4.8

* Expressed as % of subcut. administered dose.
† Least significant difference between means at 5% level of confidence.

Soft tissue-seeking radionuclides such as cesium-134, potassium-42 and rubidium-86 show promise as indicators of dietary potassium deficiency in rats. If one postulates that these radionuclides partially substitute for potassium in a deficient animal, the results may be interpreted to indicate that the dietary requirement lies between 0.075 and 0.15% potassium, probably between 0.1 and 0.15%. Of course, impaired metabolism due to potassium deficiency may be the factor influencing excretion of these radionuclides, but the interpretation of data would still be valid. The growth data would also tend to support this supposition. More investigations will have to be conducted, however, before the radionuclide method can be quantitatively used for determination of animal requirements.

Summary. An increase in dietary potassium has been shown to increase excretion of cesium-134, potassium-42 and rubidium-86. Interpretation of the first significant increase in excretion of these radionuclides as being the point at which dietary potassium is adequate would place the potassium requirement of the rat between 0.075 and 0.15%, probably between 0.1 and 0.15%. This is supported by the growth data.

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Concurrent Concentrations of Human Salivary Buffer Components in Serum and Saliva.* (23519)

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The buffer systems in human saliva constitute a major natural defense mechanism against dental decay. Quantitatively, the buffer concentration of saliva varies with glandular activity, stimulated saliva having an appreciably higher buffer level than unstimulated saliva(1).

Numerous investigators have shown that the salivary buffer capacity of caries-resistant persons exceeds that of caries-active individuals(2,3,4,5). In a given subject under physiologic conditions, the buffer concentration of saliva varies only slightly from hour to hour and from time to time. It has been stated that the buffering power of saliva is directly dependent upon that of blood(6). Experiments in this laboratory have shown that metabolic acidosis depresses the salivary buffer capacity and that a similar reaction follows the administration of 2-acetylamino-1,3,4-thiadiazole-5-sulfonamide (Diamox) a carbonic anhydrase inhibitor(7).

Materials and methods. Specimens of venous blood and paraffin stimulated saliva were obtained simultaneously from 34 patients of the Nutrition Clinic, Hillman Hospital. The samples were collected in sterile tubes under paraffin oil in the morning before breakfast and before brushing the teeth. The serum was drawn off after centrifugation and saved for analysis under paraffin oil. Neither the paraffin blocks which served as secretory stimulants nor the paraffin oil contained detectable amounts of any of the constituents tested. The buffer capacities of samples of serum and saliva through the pH range 7 to 6 were determined by the method of Dreizen, Mann, Cline and Spies(8) using 0.1 N lactic acid for the development of the titration curves. The sodium and potassium content of each sample was assayed with a Perkin-Elmer Model 52-A flame photometer by the procedure of Bills, McDonald, Niedermeier and Schwartz applying the internal standard technic(9). The serum and saliva concentrations of bicarbonate, phosphate and protein were measured by the methods of Van Slyke and Neill(10), Fiske and SubbaRow(11) and Wolfson, Cohn, Calvary and Ichiba(12) respectively. The values for each constituent were converted into milliequivalents per liter using the factors described in a previous publication(1). The data were then subjected to statistical analysis.

Results. The ranges and mean concentrations of the anionic and cationic constituents of the buffer systems measured in the serum and saliva of the 34 patients are shown in Table I. The ranges in saliva exceeded those in serum for each ion except protein. Sodium had the widest range in saliva and bicarbonate in serum. The mean levels in milliequivalents/liter were: Na^+, 32.80 in saliva and 145.72 in serum; K^+, 20.40 in saliva and 5.10 in serum; HCO_3^-, 15.60 in saliva and 27.04 in

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