Importance of Dietary Intake of Potassium in Renal Failure

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This study, supported by PPI/PPIC, established a model for relating dietary potassium (K) deficiency to different biochemical aspects, using rats as the test animal.

Potassium is essential for all animals as well as plants. In human beings, K helps in the maintenance of normal physiological functions. Potassium plays a particularly important role in specific renal functions relating to heart and muscle control, or with afflicted people, in cardiac ailments and muscular weakness. In addition, erythrocyte function and chemical composition are significantly affected by dietary K intake.

Materials and Methods

Treatments consisted of three groups of rats (Winstar strain). A deficient group was artificially prepared by supplying rats with a K deficient diet (Table 1) and double distilled water while kept in metabolic cages. After the induction of K deficiency, a sub-group of rats was rehabilitated with a K salt mixture (Table 1) for four weeks, while another sub-group was maintained on a K-deficient diet. A normal diet group of rats was kept as the control. Renal functions were assessed by measuring different biochemical parameters, including blood urea, creatinine, plasma electrolyte, and the lipid profile.

Table 1. Compositions of low K diet and salt mixture.

Low potassium diet	Percent composition/100 g
Starch	60.5
Casein	30.0
Groundnut oil	3.5
Salt mixture (without K)	6.0
Vitamins (multi-vitamin tablet)	one tablet
Salt mixture	
Calcium carbonate	20.94
Calcium phosphate	41.00
Cobalt chloride	0.02
Cupric chloride	0.15
Ferric phosphate	3.20
Magnesium sulfate	19.70
Manganese sulfate	0.40
Sodium iodide	0.014
Sodium phosphate	14.80
Zinc sulfate	0.116

Note: Normal diet contained the salt mixture with 16 percent potassium chloride (KCl) and supplemented diet with 24 percent KCl.

Results

Plasma K in deficient rats was significantly lower as compared to rats fed normal or rehabilitation diets (Table 2). However, there was no significant change in plasma sodium (Na) levels in all study groups. Plasma urea and creatinine levels were significantly elevated in K deficient rats. Subsequent K rehabilitation successfully returned serum urea and creatinine to levels equivalent to the control group.

Plasma calcium (Ca) and magnesium (Mg) levels were significantly lower in K deficient rats as compared to the control group (Table 3). Potassium supplementation raised plasma Ca and Mg to levels equaling the control. Erythrocyte Mg level was significantly reduced in K deficient rats, but this Mg deficiency was successfully corrected in the rehabilitated group. These results reflect the important role of dietary K in the homeostasis of Ca and Mg levels in the bodies of rats.

Table 2. Plasma biochemical parameters in the different groups of rats.

Group	Sodium (Na^+) meq/l	Potassium (K^+) meq/l	Urea mg/dl	Creatine mg/dl
Potassium deficient	142.0 ± 4	2.9 ± 1	58.0 ± 6	2.0 ± 0.5
Control	142.0 ± 3	4.0 ± 1	50.0 ± 6	1.5 ± 0.5
Rehabilitated	142.0 ± 3	4.3 ± 1	52.0 ± 5	1.6 ± 0.7

Values expressed as a mean ± standard deviation of 10 rats in each group.

Total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very low-density lipoprotein (VLDL) were also compared among the treatment groups (Table 4). Serum cholesterol, LDL and VLDL levels were approximately two times higher in the K deficient group as compared to the control or rehabilitated group. Interestingly, the LDL/HDL ratio in the K deficient group was significantly higher than either the control or rehabilitated group. The consequence of this relatively high LDL/HDL ratio would likely be diagnosed as a precursor to coronary artery disease or atherosclerosis. Potassium supplementation, however, was able to return lipid profiles to a normal range.

Table 3. Plasma calcium and magnesium and erythrocyte in different groups of rats.

Group	Plasma Ca^{2+} meq/l	Plasma Mg^{2+} meq/l	Erythrocyte Mg^{2+} meq/l
Potassium deficient	1.85 ± 0.10	0.70 ± 0.10	4.0 ± 0.60
Control	2.35 ± 0.09	1.20 ± 0.20	4.4 ± 0.80
Rehabilitated	2.40 ± 0.08	1.25 ± 0.21	4.8 ± 0.70

Values expressed as a mean ± standard deviation of 10 rats in each group.

This study shows that low dietary K intake has major deleterious effects on animal plasma, Ca, and Mg contents as well as lipid metabolism. Calcium and Mg play important roles in signal transduction, muscular activity, and integrity of the cellular membranes as well as in activities of the many enzymes that participate in normal cellular metabolism. It is noteworthy that K supplementation in a salt mixture normalized renal function, Ca, and Mg levels and the lipid profile. Due to recent clinical attention being given to mineral nutrition in body functions and particularly the importance K and Mg, the major intracellular cations, this study has identified their association with cardiac rhythm, general muscle function and the body's response to K rehabilitation. BCI

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Table 4. Total serum cholesterol, low-density lipoprotein, high-density lipoprotein, and very low-density lipoprotein in the different groups of rats.

Group	Total cholesterol mg/dl	LDL mg/dl	HDL mg/dl	VLDL mg/dl
Potassium deficient	200.0 ± 10	130.0 ± 5.0	30.0 ± 1.5	40.0 ± 2.0
Control	130.0 ± 7	60.0 ± 3.0	60.0 ± 2.5	20.0 ± 1.5
Rehabilitated	137.0 ± 8	70.0 ± 4.0	55.0 ± 2.8	25.0 ± 2.0

Values expressed as a mean ± standard deviation of 10 rats in each group.