The Distribution and Half-Life for Retention of Vanadium in the Organs of Normal and Diabetic Rats Orally Fed Vanadium(IV) and Vanadium(V)

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ABSTRACT

The concentration of vanadium in organs of diabetic rats that had been fed vanadium, either as V(IV) or V(V), in their drinking water has been determined. The kidney was found to have the highest concentration, about 185 nmol/g wet tissue. This averages about three times higher than for the liver or spleen, for which concentrations were comparable. The lung, blood plasma, and blood cells tended to have the lowest accumulations of vanadium. A time-course study indicated that the half-life for elimination of vanadium from the bodies of vanadium-fed rats is about 12 d.

Index Entries: Vanadate; vanadyl; diabetic rats; 51V NMR; elimination half-life.

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INTRODUCTION

It has been known for many years that vanadium in either its V(IV) or its V(V) oxidation state has a significant effect on the function of a variety of enzymes and, in particular, can perform an insulin-like function in living systems (1-3). This has led to intensive investigations of the possibility of using vanadium in the treatment of diabetes.

It has been shown that long-term treatment with oral administrations of either vanadyl or vanadate produced lowering of blood glucose levels in diabetic rats (1,4). In addition, short-term treatment of a group of diabetic animals with vanadyl sulfate kept blood glucose levels low significantly beyond the treatment period (5). In view of the potential benefits of vanadium treatment we have made an effort to determine vanadium concentrations in some of the organs of rats that had been fed vanadium, either as vanadate(V[IV]) or vanadyl(V[IV]) for extended periods of time. In addition, a time-course study was undertaken in order to estimate the half-life for elimination of vanadium from the bodies of these animals.

METHODS

Treatment

Wistar rats were made diabetic with streptozotocin (STZ, 60 mg/kg, iv) and were treated for 6 wk with vanadate (0.60-0.80 mg/mL) or 10 wk with vanadyl (1.00 mg/mL) dissolved in their drinking water, as described elsewhere (1,5). Vanadium levels in the organs of animals which had been sacrificed 36 h after their last treatment with vanadium were determined. For the time-course study, nondiabetic rats were fed vanadyl sulfate trihydrate (0.75 mg/mL) in their drinking water for 3 wk. Treatment was then stopped and residual vanadium levels in the kidney were measured at 2-d intervals.

Analysis

One part by weight of diced organ tissue was combined with two parts by weight of 1.0N NaOH and were treated for 6 wk with vanadate (0.60-0.80 mg/mL) or 10 wk with vanadyl (1.00 mg/mL) dissolved in their drinking water, as described elsewhere (1,5). Vanadium levels in the organs of animals which had been sacrificed 36 h after their last treatment with vanadium were determined. For the time-course study, nondiabetic rats were fed vanadyl sulfate trihydrate (0.75 mg/mL) in their drinking water for 3 wk. Treatment was then stopped and residual vanadium levels in the kidney were measured at 2-d intervals.

$^{51}$V NMR spectra of the product solutions were obtained, and the signal intensities were compared to those of standard samples. Spectral widths of 10 kHz, 0.05-s acquisition times, and 50° pulse angles were