Rubidium—A Possible Essential Trace Element

1. The Rubidium Content of Whole Blood of Healthy and Dietetically Treated Children

INGRID LOMBECK,1,* K. KASPEREK,2 L. E. FEINENDEGEN,2 AND H. J. BREMER1

1University Children’s Hospital C, University of Düsseldorf
Moorenstrasse 5, D-4000 Düsseldorf 1, Federal Republic of Germany,

and

2Medical Institute, Nuclear Research Centre of Jülich GmbH,
D-5170 Jülich, Federal Republic of Germany

Received March 3, 1980; Accepted April 16, 1980

Abstract

The rubidium content of whole blood was estimated by instrumental neutron activation analysis. In 46 healthy children it amounts to \( x = 11.47 \pm 2.88 \times 10^{-6} \text{g/g dry weight} \). There was no difference between the values found for infants, toddlers, and school children. In 29 dietetically treated patients with phenylketonuria and maple-syrup-urine disease the values were significantly lower than in healthy children. During the first three months of diet therapy the rubidium levels remained in the lower range of the normal values, decreasing to about 60% of the mean of normal values later on. With increasing length of diet therapy these values tended to decrease. It remains questionable whether these decreased levels reflect only an induced biochemical phenomenon without biological importance, or whether they are the first signs of a deficiency syndrome.

Index Entries: Rubidium, as a potential essential trace element; blood, rubidium content of; childhood, rubidium levels in blood during; normal values, of rubidium in blood; dietary treatment of rubidium deficiency.
Introduction

Rubidium, a heavier alkali element, has similar biochemical properties to those of potassium. Therefore, its radioisotope, rubidium-86, is often used to trace potassium metabolism. Rubidium substitutes potassium to some extent, but has certain effects on growth and longevity that preclude full interchangeability. Purified diets containing 0.02% or more rubidium decrease survival time of rats (4, 12). Mammals including monkeys first show irritability, hyperactivity, aggressiveness and convulsions. Purified diets containing 0.2% rubidium are not toxic (4). Contradictory information exists on the biological effects of trace amounts of rubidium. It is not clear whether rubidium levels of 0.01% or less are a dietary essential and stimulatory amount for animals or not (4, 11).

Previously published work neglected the biological functions of rubidium, while recent research postulates essentiality (4, 6, 15, 17).

One main feature of all essential trace elements is fulfilled by rubidium: It occurs in all tissues examined. The concentrations exhibit a low relative variance (1, 13, 14). The fact that significant differences in rubidium content occur not only in different organ systems (13, 24), but also in different inbred strains (17) strongly supports the notion of its essentiality and suggests that its concentration is genetically controlled. At the moment then, rubidium may be said to belong to those trace elements with suspected biological function, and is a possible essential trace element (16, 21).

The whole rubidium content of human adults is assumed to be \(0.36 \pm 0.09\) g (24). The main excretory route is through the urine, and the rate of clearance is slightly less than that of potassium (8). Following intravenous administration of rubidium-86, 39–134 days were required for one-half to be excreted in the urine and feces (2), while 30 min after intravenous administration less than 5% remained in the total circulatory blood (12). In humans, the red cells show a maximum uptake within 30 min, and maintain this content despite a rapidly decreasing plasma level. The blood uptake at 24 h, however, was lower than that of any other tissue examined except that of the brain (19). Rubidium treatment is said to enhance the turnover of brain norepinephrine (18), but its mechanism of action is not known. The intracellular distribution reveals the highest content in the supernatant fraction; mitochondrial and sarcotubular fractions have a reduced content compared to the heart as a whole (21). In brain tissue, the content was found to differ significantly between defined functional regions and to decrease with increasing age (5, 6). In general on a dry basis, soft tissues contain more rubidium than bone (4). The rubidium content of whole blood is mainly determined by the rubidium content of the erythrocytes (1, 20, 23).

Our studies were undertaken to estimate the normal values of rubidium in the whole blood of healthy children at various ages. These values were