30. Manganese

Physiology

Manganese is a component of arginase, pyruvate carboxylase and mitochondrial superoxide dismutase. It participates also in various hydrolase, kinase, decarboxylase, and phosphotransferase activities. The intestinal absorption of manganese occurs throughout the length of the small intestine. Mucosal uptake appears to be mediated by two types of mucosal binding, one which is saturable with a finite capacity and one which is non-saturable. The efficiency of manganese absorption in adults is low (approximately 10 %) but there is some evidence of improvement at low intakes. High levels of dietary calcium, phosphorus, and phytate impair the intestinal uptake of the element but are probably of limited significance because as yet no well documented case of human manganese deficiency has been reported.

Systemic homoeostasis of manganese is maintained principally by hepato-biliary excretion. Urinary manganese falls with reduced intake and rises with increased intake, suggesting a role of the kidney [1].

Deficiency and excess

Although it is difficult to characterise the precise biochemical mechanisms that have failed, manganese-deprived animals display numerous reproducible phenomena. These include growth retardation, impaired cartilage formation and defective endochondrial osteogenesis in fetuses leading to impaired development of the skeleton and otoliths (with resultant ataxia); impaired glucose tolerance and insulin secretion; reduced gluconeogenic response to glucagon and adrenaline; hypocholesterolaemia; hepatic and renal accumulation of lipids and ultra-structural abnormalities in cellular and sub-cellular membranes and convulsions [1].

Evidence of manganese deficiency in man is poor [2]. Interest in possible manganese deprivation in humans has been stimulated by reports of manganese-responsive carbohydrate intolerance, and reduced manganese concentration in the hair of some mothers whose babies had congenital abnormalities and in the blood or hair of children with skeletal abnormalities, osteoporosis, and non-traumatic epilepsy.

Men fed a low manganese diet (10 µg/d) developed an evanescent skin rash and hypocholesterolaemia; however neither feature responded unequivocally to manganese repletion [3].

Manganese toxicity of dietary origin has not been well documented. Mineworkers in Chile exposed to manganese ore dust developed, possibly as a result of inhalation rather than ingestion, 'Manganic Madness' manifested by psychosis, hallucinations, and extrapyramidal damage with features of Parkinsonism [1].

Requirements

Manganese is particularly abundant in vegetable-based diets and beverages such as tea and it would seem that current population intake is adequate [2]. Most intakes are around 2-3 mg/d, but some reach 8.3 mg/d [1,3]. No manganese-responsive problems were seen in young men on an intake of 0.1 mg [4] and a basal requirement of 0.74 mg daily has been derived from other balance studies [5]. Thus the finding of some negative balances on dietary intakes between 1.21 and 2.89 mg/d could represent homoeostasis [5]. In the absence of more information an LTI of 0.75 mg daily could perhaps be set, but it is considered preferable to give a safe and adequate range of 1-10 mg/d.

Summary

Acceptable Range of Intakes	1-10 mg/d

References

1. Hurley LS, Keen CL. (1987). Manganese. In Mertz W ed. *Trace Elements in Human and Animal Nutrition.* 5th ed.Vol 1. San Diego: Academic Press, 185-223.

2. Anonymous. (1988). Manganese deficiency in humans: fact or fiction? *Nutr Rev*, **46:** 348-352.

3. Friedman BJ, Freeland-Graves JH, Bales CW, Behmardi F, Shorey-Kutschke RL, Willis RA *et al.* (1987). Manganese balance and clinical observations in young men fed a manganese-deficient diet. *J Nutr*, **117:** 133-143.

4. Wenlock RW, Buss DH, Dixon E J. (1979). Trace nutrients. 2. Manganese in British Food. *Br J Nutr*, **41:** 253- 261.

5. Freeland-Graves JH, Behmardi F, Bales CW, Dougherty V, Lin P-H, Crosby JB, Trickett PC. (1988). Metabolic balance of manganese in young men consuming diets containing five levels of dietary manganese. *J Nutr*, **118:** 764-773.