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9 **Molybdenum**

10 **Introduction**

11 Molybdenum has a number of valences and functions in oxidation-reduction reactions
 12 in plants and lower organisms. In humans only three molybdenum-containing enzymes
 13 are known: sulphite oxidase, xanthine oxidase and aldehyde oxidase. The enzymes are
 14 involved in catabolism of sulphur amino acids and heterocyclic compounds, including
 15 purines and pyridines.

16

17 **Dietary sources and intake**

18 Molybdenum is ubiquitous in food and water as soluble molybdates, although the
 19 content of molybdenum in plants varies widely with soil concentration and pH. Good
 20 food sources are grains, legumes, nuts, offal, milk and milk products and eggs, while
 21 fruits, root vegetables and muscle meat are poor sources (Scientific Committee for
 22 Food 1993). High concentrations have been found in shellfish. Molybdenum levels in
 23 drinking water are mostly low, typically less than 0.01mg/L. However, in areas near
 24 mining sites, molybdenum concentrations up to 0.2 mg/L have been reported (WHO
 25 2004).

26

27 There are few published data on the dietary intake of molybdenum in the Nordic
 28 countries. Typical intakes according to supermarket baskets or dietary surveys are in
 29 the range 100-150 µg/day (Räsänen et al 1985, Bro et al 1990, Becker and
 30 Kumpulainen 1987). Many multivitamin-mineral supplements contain molybdenum
 31 and must be taken into consideration when estimating total dietary intake.

32

33 **Physiology and metabolism**

34 Molybdenum absorption from the diet is efficient (> 80 %). The body content is
 35 primarily regulated via the kidneys.

36

37 There is only one recorded case of apparent molybdenum deficiency, which occurred
 38 in a subject receiving total parenteral nutrition (50 µg Mo/day) for 18 months due to
 39 Crohn's disease (Abumrad et al 1981, Mullee et al 2012). Unconsciousness, heart
 40 disturbances and night blindness were observed; the symptoms disappeared after
 41 supplementation with 160 µg Mo/day.

42

43 Stable isotopes have been used to investigate molybdenum metabolism in healthy men
 44 aged 22-33 years (Turnlund et al 1995 a; b, Turnlund and Keyes 2004, Novotny and
 45 Turnlund 2007). Molybdenum absorption was efficient (about 90 %) when subjects
 46 ingested diets containing five levels of the metal (ranging from 22 to 1490 µg/day) for
 47 24 days each. Excess molybdenum was rapidly excreted in urine, although whole-body
 48 retention was increased when the dietary level was low.

49 Molybdenum status is difficult to determine as low plasma levels are tightly
50 maintained by up-regulated urinary excretion after increased intakes (Mullee et al.
51 2012).

52

53 **Requirement and recommended intake**

54 Adult men fed a diet with only 22 µg/day molybdenum for 102 days did not develop
55 any symptoms of molybdenum deficiency, leading Turnlund and co-workers (1995b)
56 to suggest that the minimum daily requirement for this trace element is about 25 µg.
57 Based on the findings of Turnlund and co-workers (1995b), the U.S. Food and
58 Nutrition Board (2001) has set a Recommended Dietary Allowance (RDA) for adult
59 men and women to 45 µg/day. The average dietary intake of molybdenum in US men
60 and women is more than twice this level.

61

62 The Nordic Recommendations of 2004 did not include recommendations for
63 molybdenum intake. The evidence regarding molybdenum in relation to setting dietary
64 reference values is still limited (Mullee et al 2012) and not considered sufficient to
65 establish requirements. Accordingly, recommendations are not given for any age
66 group.

67

68 **Upper intake levels and toxicity**

69 The absence of toxicity symptoms in men fed 1490 µg molybdenum per day for 24
70 days (Turnlund et al 1995a) provides a working upper boundary for further studies.

71

72 The US Food and Nutrition Board (2001) set a Tolerable Upper Intake Level (UL) of 2
73 mg/day based on impaired reproduction and growth in animals. A British expert group
74 concluded that there are insufficient data from animal and human studies to establish a
75 Safe Upper Level for molybdenum (FSA 2003). The Scientific Committee on Food
76 (SCF) set the UL at 0.6 mg/day for adults and between 0.1 and 0.5 mg/day for children
77 aged 1-17 years (SCF, 2006).

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