Iodine

Introduction

Iodine is an essential element for animals because it is a constituent of the thyroid hormones thyroxine (T4) and triiodothyronine (T3) (Stanbury 1996; Hetzel and Clugston 1999; Institute of Medicine [IOM] 2001; European Commission, Scientific Committee on Food [EC SCF] 2002). Both iodine deficiency and excess have adverse consequences for the thyroid gland. Iodine deficiency not only results in a syndrome known as iodine deficiency disorder (IDD) but can also, in extreme cases, ultimately result in goiter, the overt manifestation of thyroid gland enlargement stimulated by deficiency of the thyroid hormones. This hormone deficiency leads to many adverse effects in addition to gland enlargement, including congenital and developmental defects, poor growth, and mental retardation. Excess iodine—as well as iodine deficiency—can lead to thyroid dysfunction and elevated thyroid stimulating hormone (TSH) levels (Laurenberg et al. 1998).

Iodine occurs in the atmosphere—by evaporation of seawater and industrial sources (EC SCF 2002). Iodine levels in foods and total diets are dependent on geochemical, soil, and cultural conditions. The major natural food sources of iodine are marine fish, shellfish, marine algae, and sea salt. Milk and dairy products contain relatively high amounts derived from iodinated cattle feed supplements and iodine-containing sterilization products.

In mountainous tropical countries, iodine intakes are higher near the coast and lower in high regions where rain has leached much of the iodine from the soil (EC SCF 2002).

Safety Considerations

Except for rare instances of hypersensitivity to iodine, humans are remarkably tolerant of high intakes of iodine (Stanbury 1996; EC SCF 2002). Although toxic effects are not observed in humans until daily intakes have exceeded 10,000 µg, intakes of 2,000 µg should be regarded as

excessive and potentially harmful (Hetzel and Clugston 1999). Residents of coastal regions in some areas of Japan have chronic daily intakes of iodine as high as 50,000 to 80,000 µg. Persons who have not been conditioned by iodine deficiency can maintain normal thyroid size and function when they are consuming several milligrams of dietary iodine per day, but previous deficiency can cause hypersensitivity (Hetzel and Clugston 1999). In such situations, hyperthyroidism and iodine-induced thyroiditis may occur when intakes exceed approximately 200 to 300 µg per day. Healthy adults are much less sensitive to excess iodine.

Official Reviews

IOM (2001). The IOM concluded that elevated TSH levels associated with high levels of iodine intake constituted the critical indicator for adverse effects of excess iodine in a healthy adult population. For normal persons who have not been conditioned to iodine deficiency, the IOM identified an LOAEL of 1,700 µg per day. A UL of 1,100 µg of iodine from all sources was derived by applying a UF of 1.5 to the LOAEL. The IOM concluded that the adult iodine intake in the U.S. is usually 240 to 300 µg per day from foods plus another 140 µg from dietary supplements.

EC SCF (2002). The EC SCF utilized iodine intakes of 1,700 and 1,800 µg to establish a UL value, but selected a default UF of 3 to derive a UL of 600 µg per day. The report concluded that dietary intakes are unlikely to exceed 500 µg per day, since the 97.5 percentile intake in European men is 434 µg per day.

Expert Group on Vitamins and Minerals (EVM 2003). The UK's EVM, deciding that neither human nor animal data were sufficient to set a UL value, set a guidance level instead. From several clinical studies of supplemental iodine (Gardner et al. 1988; Paul et al. 1988; Chow et al. 1991), it was concluded that 500 µg of supplemental iodine "would not be expected to have any significant adverse effects in adults." The EVM identified 430 µg as the 97th percentile intake by adults. This led to establishment of guidance levels of 500 µg for supplemental iodine and 930 µg for total intake from all sources. Notably, the EVM did not cite the article by Laurenberg and coworkers (1998) that was relied upon by the IOM and the EC SCF in their calculations.

CRN Recommendations

CRN identifies its NOAEL for iodine as 500 μg per day for supplements and 1,000 μg for total intake. These values are based on the absence of adverse effects in healthy adults given 500 μg of supplement. Although the experimental subjects consumed diets of unknown composition (Gardner et al. 1988; Paul et al. 1988; Chow et al. 1991), their dietary intake of iodine almost certainly did not exceed 500 μg. The NOAEL for supplemental iodine is justified as the CRN UL because adverse effects occur only at 1,700 μg or higher total intake (the LOAEL identified by the IOM and EC SCF) and because dietary intakes almost certainly will not exceed 500 μg.

Quantitative Summary for Iodine

CRN UL, supplemental intake	500 μg/day
IOM UL, total intake	1,100 μg/day
EC SCF UL, total intake	600 μg/day
EC supplement maximum	Not determined
EVM, guidance level	500 μg/day supplemental; 930 μg/day total intake

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