Iodine (I)

Food:

	µg/100g
Cod fillet fried/simmered	243
Egg boiled	36
Bread wholemeal	58
Milk semi-skimmed	15
Cheese Camembert 30+	20
Mussels boiled	125
Brown rice boiled	5

(Dutch Food Composition Database, NEVO)

Main functions:

- Used by the thyroid gland to produce and release thyroid hormones
- Important component of healthy fetal development during pregnancy
- Supports the growth and cognitive development of infants and young children
- Plays a vital role in the health and wellbeing of adults

For scientific sources, please contact **info.nutritionscience@dsm.com.**

Iodine (I)

Iodine is an essential micronutrient that is used by the thyroid gland to produce thyroid hormones that regulate metabolism and carry out many other important functions in the body. It is particularly important during pregnancy, when sufficient maternal intake is vital for healthy fetal and infant development. Iodine deficiency is considered the most common cause of preventable intellectual disability in the world.

Functions

Iodine is used by the thyroid gland to produce and release two thyroid hormones that are used by nearly every cell in the body; thyroxine (T4) and triiodothyronine (T3). These hormones regulate metabolic activity in adults and help the brain, heart, liver, muscles and other organs function properly throughout life.

Iodine intake is also vital during pregnancy, as the corresponding production of thyroid hormones not only regulates many processes in the mother's body but also supports the healthy development of the baby and infant. Adequate availability of iodine during this critical period is essential for the early growth and development of most organs – particularly the brain.

The **European Food Safety Authority (EFSA)**, which provides scientific advice to assist policy makers, has confirmed that clear health benefits have been established for the dietary intake of iodine in contributing to:

- Normal cognitive function
- Normal energy-yielding metabolism
- Normal functioning of the nervous system
- Maintenance of normal skin
- Normal production of thyroid hormones and normal thyroid function

Dietary sources

The best sources of iodine include seafood, such as fish, shellfish, molluscs, and seaweed, as well as their derivatives and iodized salt. However, iodine levels within each category are variable, particularly in milk and eggs due to differences in feeding and hygiene practices during production.

Absorption and body stores

Dietary iodine is converted into the iodide ion before being rapidly and nearly completely absorbed in the stomach and upper small intestine. When iodide enters circulation, the thyroid gland uses the required amount for thyroid hormone synthesis, while the rest is mainly excreted by the kidney. The body of a healthy adult contains up to 20 mg of iodine, of which 70-80% is found in the thyroid gland, and the rest is generally stored in bodily tissues such as blood, ovaries and muscles.

Measurement

Iodine status is typically assessed using a urine test, as more than 90% of dietary iodine is excreted. If more detailed information is needed, then evidence of abnormal hormonal levels would be required, such as elevated thyroid-stimulating hormone (TSH). In this case, the thyroid function would be assessed as a first step and only then would iodine status be investigated.

Physiological interactions

- Iodine metabolism can be impaired by a dietary deficiency in one or more of the following; vitamin A, selenium, zinc, copper or iron
- Adequate selenium status may provide protection against a high intake of foods that disrupt the production of thyroid hormones by interfering with iodine uptake in the thyroid gland, such as cabbage, broccoli, soy and cassava – known as 'goitrogens'. It can also counter the negative effects of habitually low levels of dietary iodine
- Thyroid hormones and steroid hormones seem to have overlapping or interacting actions in different cells. These effects involve heart and brain cells as well as cancer cells. Both families of hormones may have proliferative actions (i.e. rapidly growing and increasing number of cells) on cancer cells. These findings have potential clinical implications

Deficiency

Under normal circumstances, when blood levels of TSH rise, the thyroid uses iodine to make thyroid hormones. When iodine levels are low, however, it can't make enough of them and this can adversely affect the health of adults.

One of the most common symptoms is an abnormal enlargement of the thyroid gland (goiter), which causes the neck to swell and is a reflection of the body's attempt to work harder to produce thyroid hormones. Iodine deficiency can also trigger a condition known as 'hypothyroidism', which is characterized by a range of symptoms including unexpected weight gain, fatigue and weakness, hair loss, elevated cholesterol levels, poor memory, and dry skin.

If iodine deficiency is severe enough to affect thyroid hormone synthesis during pregnancy and early infancy, it can lead to irreversible mental and physical retardation, as well as impaired cognitive development. This is because most of the growth and development of the brain occurs during the fetal period and first two to three years of post-natal life, so a lack of dietary iodine can have serious clinical consequences.

Although global iodine nutrition has been improving over the last decade, it was estimated that nearly one-third of the population still had insufficient iodine intakes in 2011. A vegetarian and particularly vegan diet may be of concern for possible shortage of iodine as animal-derived foods are the richest sources of this micronutrient.

Possible reduction of disease risk factors

Pregnancy complications

Moderate-to-severe iodine deficiency during pregnancy increases rates of miscarriage, reduces birth weight and increases infant mortality. Infants born to deficient mothers are at higher risk of cognitive disability, with 'cretinism' (physical and neurological abnormalities) the most severe outcome from chronic iodine deficiency. Mild-to-moderate maternal iodine deficiency has been associated with an increased risk of hyperactivity disorder in children. The World Health Organization (WHO), United Nations Children's Fund (UNICEF), and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) recommend pregnant women increase iodine intake to 250 µg/day, compared to the 150 µg/day guideline for adult women.

Impaired development in children

Moderate-to-severe iodine deficiency during childhood can reduce physical growth and development. The use of dietary iodine sources and/or supplementation in primary school children has been shown to improve cognitive and motor function.

Thyroid cancer

Chronic iodine deficiency may be associated with an increased risk of the follicular form of thyroid cancer. As this is not conclusive, further research is needed – particularly the assessment of iodine status biomarkers and total iodine exposure in large cohorts.

Agricultural deficiencies

Crops grown in iodine deficient soils have low iodine levels, which means that people living in these regions are more likely to have a dietary deficiency. Mountainous areas, such as the Himalayas, Alps, and Andes regions, as well as river valleys prone to flooding in South and Southeast Asia are among the most iodine deficient regions in the world. Consuming iodized salts or foods produced outside the iodine-deficient area can be an effective counter measure.

Prevention of deficiencies in high-risk categories

Certain dietary patterns can increase the likelihood of iodine deficiency. People who are vegan, have certain food allergies or are lactose intolerant, may not obtain sufficient amounts. Goitrogens are substances found in certain foods, such as cabbage, broccoli, soy and cassava. When consumed in excess, they can interfere with the function of the thyroid gland and inhibit iodine uptake. In this context, the use of iodine fortification (e.g. salt) or iodine supplements may be considered as a means to control iodine deficiency.

Recommended Daily Intake (RDI)

The recommended daily dietary intake of iodine is 150 µg/day for adult men and women, with lower levels set for infants and children. The requirement is slightly higher for pregnant and lactating women (220-290 µg/day) due to changes in hormone synthesis and production.

Recommended daily intakes (RDI)

Group	Life stage	Dose/day*
Infants	<6 months	110 µg**
Infants	7-12 months	130 µg**
Children	1-8 years	90 µg
Children	9-13 years	120 µg
Children	14-18 years	150 µg
Adults	>19 years	150 µg
Pregnancy	>14 years	220 µg
Breastfeeding	>14 years	290 µg

** Institute of Medicine (2001)*
*** Adequate intake (AI)*
If not otherwise specified, this table presents RDIs.

Safety

High intakes of iodine can cause some of the same symptoms as iodine deficiency, including goiter, elevated thyroid-stimulating hormone (also known as TSH) levels and hypothyroidism. This is because excess iodine in susceptible individuals inhibits thyroid hormone synthesis and thereby increases TSH stimulation. In most people, iodine intakes from foods are unlikely to exceed these high intake levels.

U.S. health authorities have established a safe upper intake level of 1,100 µg/day for adults, as well as pregnant and breast-feeding women. For children, this upper intake level is lower and depends on age. This limit does not apply to individuals receiving iodine for medical treatment.

Supplements and food fortification

Although a number of measures can be used to tackle iodine deficiency, the overwhelming intervention of choice is salt iodization; the fortification of salt with iodine by salt manufacturers. Iodine fortification is implemented in many countries; 121 countries have mandatory and 16 voluntary standards for iodine fortification. Various staples can be fortified with iodine, but most frequently salt is fortified, and iodized salt is often used in bouillon cubes or bread.

In terms of supplementation, iodine is often present as potassium iodide or sodium iodide, although products containing kelp (a seaweed that contains iodine) are also available. Individuals following strict vegan diets or who have a limited intake of iodine-rich foods, such as fish, dairy and eggs, may consider taking an iodine supplement, but should always seek advice from a healthcare professional.