Selenium (Se)

Food:

	µg/100g
Tuna prepared	108
Brown rice boiled	9
Beef steak prepared	14
Brazil nuts	1917
Tilapia prepared	54
Cheese 45+	12
Red lentils boiled	11

(Dutch Food Composition Database, NEVO)

Main functions:

- Plays an important role in thyroid hormone synthesis and metabolism
- Provides protection against oxidative damage and infection
- Contributes to DNA synthesis
- Supports reproductive health

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

Selenium (Se)

Selenium is an essential trace mineral that the body needs to stay healthy. It is important for reproduction, thyroid gland function, DNA production, and protecting the body from damage caused by free radicals and infection. The richest sources of selenium are animal derived foods such as meat, poultry, eggs, and dairy products, although some plant-based foods also contain selenium. Selenium status can vary significantly due to low selenium soil and animal feed in certain regions around the world. Furthermore, people who have a predominantly plant-based diet can be at risk of inadequate selenium intake.

Functions

Selenium is a trace element required for a range of cellular functions. It is widely used for the biosynthesis of the unique amino acid selenocysteine, which is a structural element of selenoproteins. As such, selenium is involved with antioxidant effects, the immune function, thyroid hormone metabolism, selenium homeostasis and transport, as well as skeletal and cardiac muscle metabolism.

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 selenium in contributing to:

- Maintenance of the normal function of the immune system
- Maintenance of normal hair
- Maintenance of normal nails
- Normal thyroid function
- Normal spermatogenesis
- Protection of cells from oxidative stress

Dietary sources

Selenium is found naturally in a variety of foods, mostly in combination with amino acids in an organic form known as 'selenomethionine', which is readily absorbed by the human body. There are also inorganic forms (selenate and selenite) that plants accumulate and convert to organic forms.

The most important sources of selenium are meat, poultry, eggs, and dairy products, although some plant-based foods also contain selenium. In all cases, the selenium content can vary significantly. Differences in the dietary feed used to produce livestock, as well as the available selenium content of the soil and water where crops are grown can all have an impact. In China, for example, the selenium content of corn, rice and soy beans can range from 0.005 to 45 µg/kg. While in New Zealand, where intakes were previously low, levels have improved following greater imports of high-selenium Australian wheat.

Absorption and body stores

The selenium found in plant and animal sources is incorporated into various proteins and enzymes in the body (selenoproteins). Most selenium is stored in skeletal muscle tissue, which accounts for around 28-46% of the total selenium pool, although the thyroid holds the highest concentration. Based on available data, EFSA estimates the absorption efficiency of selenium from the average diet to be 70%.

Measurement

Dietary assessment methods are considered an imprecise way to measure selenium intake, largely due to the considerable variability in the selenium content of food. Instead, plasma or serum selenium are commonly used as status biomarkers. The analysis of selenium in hair and toenails is also useful as a long-term biomarker.

Physiological interactions

- Selenium and iodine play critical roles in thyroid hormone metabolism. One of the enzymes in this metabolism is composed of two selenium atoms and catalyses the conversion of thyroid hormones.
- Complicated pregnancies are characterized by increased oxidative stress (imbalance between free radicals and antioxidants in the body, which can be harmful) in the placenta. Selenium and iodine potentially work together to impact oxidative stress in the placental cells. Therefore, there may be an interaction of selenium and iodine on placental and child health.

Deficiency

Adverse health effects are associated with selenium deficiency, including poorer immune function, problematic fertility/reproduction in men and women, fatigue, muscle weakness, and cognitive decline. Worldwide, 1 billion people have been estimated to have low dietary selenium intake. Suboptimal selenium status was reported to be widespread throughout Europe, the United Kingdom and the Middle East, and these results agreed with previous reports highlighting the problem. As animal-based foods are very rich in selenium, people who have a predominantly plant-based diet can be at risk of inadequate selenium intake. In addition, it is predicted that the concentration of selenium in soil will decrease in the future as a consequence of climate change. These losses could increase the global prevalence of selenium deficiency.

Possible reduction of disease risk factors

Cardiovascular disease

Selenoproteins help prevent the oxidative modification of lipids, reducing inflammation and preventing platelets from clustering (aggregating). Recent studies found that selenium supplementation could significantly decrease serum levels of total cholesterol and triglycerides. Furthermore, a positive effect on reducing oxidative stress and inflammation in coronary heart disease patients is also suggested.

Thyroid disease

Epidemiological evidence suggests a relationship between selenium levels and thyroid gland function in women. However, randomized, controlled trials of selenium supplementation in patients with thyroid disease have had various results. Additional research is needed to determine whether selenium supplements can help to prevent or treat thyroid disease.

Effects on the brain

Low selenium status has been associated with increased risk of cognitive decline, while selenium deficiency can cause irreversible brain injury. Evidence also suggests a correlation between low selenium status and the occurrence of seizures, Parkinson's disease, poor co-ordination, and cognitive decline. In addition, selenium supplementation has been shown to reduce intractable childhood seizures in a few, small studies.

Cancer

Prospective studies have generally shown some benefit of adequate selenium status, compared to low selenium status, on the risk of prostate, lung, colorectal, and bladder cancers. However, findings from trials have been mixed. More research is needed to confirm the relationship between selenium concentrations and cancer risk in order to determine whether selenium supplements can prevent any form of cancer.

Immune system

Low selenium levels are associated with poor immune function. A growing body of evidence suggests that increasing selenium status will enhance the immune function, in particular the ability to respond to viral infection. However, the mechanisms underlying these effects are not fully understood and more research is needed.

Recommended Daily Intake (RDI)

In the U.S., the daily intake recommendation for adults is 55 µg/day, while for women who are pregnant or breastfeeding the values are slightly higher of 60 µg/day and 70 µg/day respectively. Values also vary according to age for children under the age of 18 years. European health authorities have set an adequate intake (AI) for selenium of 70 µg/day for adult men and women, while values for children range from 15 µg/day to 70 µg/day, depending on age.

Recommended daily intakes (RDI)

Group	Life stage	Dose/day*
Infants	<6 months	15 µg**
Infants	7-12 months	20 µg**
Children	1-3 years	20 µg
Children	4-8 years	30 µg
Children	9-13 years	40 µg
Children	14-18 years	55 µg
Adults	19-50 years	55 µg
Adults	>51 years	55 µg
Pregnancy	>14 years	60 µg
Breastfeeding	>14 years	70 µg

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

Safety

Although selenium is essential for health, too much can lead to health problems. Early indicators of excess selenium intake include a garlic odor in the breath and a metallic taste in the mouth. The most common clinical signs of chronically high selenium intake (selenosis) are hair and nail loss or brittleness.

The U.S. Food and Nutrition Board (FNB) has established upper intake limits (UL) from food and supplements of 400 µg/day for adult, with values reducing according to age. In Europe, EFSA has defined a safe upper intake level for selenium as 300 µg/day for adults, including pregnant and lactating women. The UL values for children range from 60 µg/day (1-3 years) to 250 µg/day (15-17 years).

Due to the potential for interactions, individuals on regular medication should discuss their selenium status with their healthcare provider.

Supplements and food fortification

Selenium is available in a multivitamin/multimineral supplement, as well as a stand-alone option. The most common forms used in supplements are selenomethionine or selenium-enriched yeast (grown in high-selenium mediums), as well as sodium selenite or sodium selenate. Each form offers different bioavailability. For example, more than 90% of selenomethionine is absorbed by the body, compared to around 50% of selenium from selenite. This distinction is important as it determines how much of this essential trace mineral is actually taken up to support important bodily functions. Currently, selenium fortification is limited. It is added to some breakfast cereals, sports drinks, salt, and infant foods.