Selenium is an essential trace mineral required by the body in very small amounts. The Daily Value for adults is 70 mcg/day.

Selenium can be found in several different foods. Good sources include fish, pork, beef, seeds, and whole grains, with the most-concentrated source being brazil nuts (about 540 mcg/oz). Selenium occurs naturally in foods almost exclusively in the form of organic compounds—primarily selenomethionine and selenocysteine. These organic compounds represent selenium analogues of the sulfur-containing amino acids methionine and cysteine.

Inorganic selenium is commonly used to supplement animal feed, and less often, to provide a source of selenium for vitamin-mineral supplements. The most commonly used inorganic selenium is sodium selenite, with sodium selenate becoming increasingly popular, as it is less likely to oxidize other components in the diet because of its lack of a free electron.

**Absorption and Bioavailability**

Approximately 80% of dietary selenium is absorbed, although this depends on the type of food consumed. Overall absorption of all forms of selenium is relatively high (70 to 95%), but varies according to the source and the individual’s selenium status.

Several studies have shown that selenium bioavailability in meat is high because selenium forms in foods of animal origin are mostly selenocysteine and selenomethionine.(1) Although selenium content in fish is high, fish is sometimes a poor source of bioavailable selenium, due in part to the content of mercury and other heavy metals that bind to selenium, forming insoluble inorganic complexes.(2) Although this may reduce selenium absorption, this mechanism protects the body against heavy-metal toxicity.(3)

Selenium-enriched yeast and garlic are two natural products containing selenium, mostly as highly bioavailable selenomethionine or gamma-glutamyl-Se-methylselenocysteine.(4)

Selenium bioavailability is strongly influenced by its chemical form. Organic compounds of Se are more bioavailable than inorganic forms.(5)

**Biological Functions**

**Antioxidant**

Selenium is incorporated into proteins to make selenoproteins, some of which are important antioxidant enzymes. The antioxidant properties of selenoproteins help protect the body against oxidative stress caused by free radicals. Free radicals are by-products of oxygen metabolism that have been shown to contribute to the development of chronic diseases such as cancer and heart disease.(6-9)

Glutathione peroxidase (GPX) and thioredoxin reductase (TrxR) contain selenocysteine, and the presence of this amino acid is essential for catalytic activity.(10-12) Several glutathione peroxidase (GPX 1-4) enzymes have been characterized, and each catalyzes the same basic reaction, but in different tissues. Glutathione peroxidase catalyzes the removal from tissues of hydrogen peroxide (H2O2) and hydroperoxides, including lipid peroxides that would otherwise damage cell membranes and other cellular components. Thioredoxin reductase is involved in oxidation-reduction roles and also helps modulate intracellular signaling cascades, inhibit apoptosis, and regulate cell growth.(13-14)

**Thyroid Function**

The thyroid gland contains the highest selenium concentrations per unit weight among all body tissues. Selenium is considered to have substantial structural and functional roles in the thyroid selenoproteins.

Thyroid function requires the support of several selenium-dependent enzymes that are critical for
thyroid hormone metabolism (deiodinases). Abundant amounts of glutathione peroxidase are present in thyroid tissue to help protect the thyroid against oxidative damage caused by the presence of excess hydrogen peroxide, a by-product of thyroid hormone production.(14-16) Selenium plays a major role as a cofactor for the iodothyronine deiodinases (IDIs). Of particular interest is the fact that these enzymes contain the unusual amino acid selenocysteine at their active site. This amino acid is similar to cysteine, except the sulfur is substituted by selenium. These enzymes, found within the thyroid gland, help to both activate and inactivate thyroid hormone during thyroid hormone metabolism. Chronic autoimmune (Hashimoto's) thyroiditis (HT) is the most common thyroid disorder in iodine-sufficient areas. HT is characterized by the presence of elevated thyroid peroxidase autoantibodies (TPOab). Along with several genetic and environmental factors, selenium deficiency has been implicated in its pathogenesis.(17-19)

Research Review

Selenium has received a lot of attention both in the media and in the scientific community. Much of this surfaced when the SELECT (Selenium and Vitamin E Cancer Prevention) trial was prematurely stopped in 2008.(20) When it was announced the trial had been stopped, most media reports assumed that it was evidence that selenium is ineffective against prostate cancer. This statement is considered by many selenium researchers to be misleading, because the SELECT data only relate to the effects of L-selenomethionine supplementation in a selenium-replete population. The results of the SELECT trial should have come as no surprise, given the fact that they are consistent with previous animal studies.

Dr. David McCormick at the Experimental Toxicology and Carcinogenesis Division, IIT Research Institute in Chicago, found no effects with selenomethionine supplementation on the prevention of prostate cancer in rats.(21) The negative findings using selenomethionine have not been observed when using other forms of selenium.

David Waters, PhD, DVM, and colleagues found a high-selenium yeast to be more effective than selenomethionine in reducing DNA damage in canine prostate cells.(22) In addition, a study published in the Journal of the American Medical Association, the Nutritional Prevention of Cancer trial (NPC trial), showed that regular use of 200 μg/day of selenium in the form of high-selenium yeast reduced the incidences of colon, lung, and prostate cancers by 50 to 63%.(23) Finally, Karam El-Bayoumy, PhD, and colleagues at the Penn State University Cancer Institute found that supplementation with high-selenium yeast reduced serum prostate-specific antigen (PSA) levels, an established risk indicator for prostate cancer.24

Another critically important factor to consider is the selenium status of study subjects. In the SELECT trial, study subjects in both the treatment and placebo groups were shown to have selenium levels above 120 ng/ml, where any additional selenium given via supplementation would have no added benefit.20 In the NPC trial, selenium supplementation was effective in the group of subjects with a baseline of plasma selenium below 120 ng/ml.

So, not only is the form of selenium important, but it is well documented that selenium status is equally important if one is to expect to see benefits related to cancer from selenium supplementation. Those individuals who benefit the most from selenium supplementation are those with low baseline selenium levels.(23, 25)

If one is to biopsy the literature on the relationship between selenium and cancer risk, one may conclude that the form of selenium used is of critical importance. High-selenium yeast contains, in addition to selenomethionine, a wide variety of organically bound selenium compounds (e.g., methylselenocysteine), which have demonstrated greater anticarcinogenic activity. Selenomethionine provides selenium for selenoprotein synthesis, but it can also be diverted from that pathway into general protein synthesis due to its sulfur-analog methionine. This differentiates selenomethionine from other selenium compounds which, rather than being diverted, are converted into methylselenol, a known antitumorogenic compound.(26)

Dr. Alan Kristal, epidemiologist, Fred Hutchinson Cancer Center, and one of the researchers involved in the SELECT trial, stated in an editorial that “the decisions of SELECT on supplement dose and formulation were wrong.”(27) The conclusions from both the NPC and SELECT trials should be that daily selenium supplementation will not benefit all persons. Cancer risk reduction with selenium could be expected mostly in men who have low baseline selenium levels prior to beginning supplementation, and high-selenium yeast may be the ideal form of selenium to be used in such studies.
What Can We Learn from SELECT?

Similar to many studies on individual nutrients, the SELECT trial attempted to demonstrate that a single agent administered at the same dose to all participants will provide a benefit to the overall population.(28) We have seen this with vitamin E, calcium, and many other nutrients, which have typically been studied in a similar way as a drug would, expecting the same outcome. Researchers have to spend more time individualizing these therapies by selecting study participants who would be more likely to benefit from a particular nutrient. This can only be accomplished by investigating various genes associated with a particular condition, and how a particular nutrient may or may not impact the expression of such genes. In addition, spending more time evaluating an individual’s nutrient status and using animal and cell culture studies to determine the ideal dosage and form(s) of a nutrient would provide the greatest benefit. These are only some of the ways we can achieve the greatest benefit from nutritional research.

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