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Selenium: Atomic Number 34, Mass Number 78.96

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Abstract

Selenium, a trace element, is an antioxidant and is an essential component for normal functioning of the immune system and thyroid gland. It is a micronutrient. Normal daily needs, sources, effects of deficiency and excess of selenium are mentioned. Some current issues and controversies concerning selenium are discussed. These include thyroid function, cancer, heart disease, arthritis, HIV / AIDS, and selenosis.

Keywords*: antioxidant, arthritis, beefed-up broccoli, cancer, heart disease, HIV / AIDS, immune system, micronutrient, selenium, selenium deficiency, selenosis, thyroid function, trace element*

Introduction

Selenium with Atomic Number Z = 34 and Mass Number A = 78.96 is in group VIA and period 4 of the periodic table of the elements.[#] It has sulfur on top and arsenic next to it. Both sulfur and arsenic have some healing properties, and since neighbors in the periodic table have similar properties, it is not surprising that selenium seems to influence human health.

Its chemical symbol is Se, and is most commonly found in nature as sodium selenite, its inorganic form. Selenomethionine, found in foods, is an organic form.

Over the past two decades an intense controversy over the role of selenium in human nutrition and other therapeutic applications has been prominent. Benefits and toxic aspects are not yet fully understood. Selenium was thought to be toxic and not necessary to human health. But recently it was reclassified as an essential micronutrient, required in a balanced human diet. The National Research Council established the first recommended daily allowance (RDA) in 1989 (Frey 2002).

The human body needs some elements in small amounts. These elements are called trace elements or trace minerals, or micro-nutrients. Selenium is such an element (US National Research Council, Food and Nutrition Board. 1989). It is essential for keeping the immune system humming and free radicals* under control.

Free radicals are produced during normal oxygen metabolism. They harm the body by letting oxygen combine with body tissues, literally burning up the body. Chemically, such reactions are called oxidation. High levels of free radicals can damage cells and contribute to the development of some chronic diseases (Combs and Gray 1998).

Compounds that prevent these adverse oxidation effects are called antioxidants. They are one of the body's defenses used to control free radical levels. Selenium is an important part of antioxidant enzymes. Selenium is also essential for normal functioning of the immune system and thyroid gland (Arthur 1991; Corvilain *et al.* 1993; and Levander 1997).

The average selenium content of the human body is less than 1 mg and is concentrated in the liver, kidneys, and pancreas. It is also found in the testes and seminal vesicles in males. Recent studies suggest that selenium reduces incidences of cancer when taken in high doses.

This news has prompted increased use of selenium supplements. Sales rose from $60 to $66 million, a 10% increase between 1996 and 1997, according to most recent statistics from

* A chemistry table that groups elements of similar properties together.

the Nutrition Business Journal published in San Diego, California. But supplementation benefits have not been sufficiently proven (Mcbride 2000).

Thus, selenium is essential for a healthy body, and it is needed only in small amounts. What are the sources of selenium, how much is needed, and what are the common effects of selenium deficiency? Can excess selenium be harmful? Is selenium an alternative medicine?

Facts on Selenium (US NIH 2002)

Sources of Selenium

In most countries the major dietary sources of selenium are foods of plant origin. The soil selenium content, which varies by region, determines the amount of selenium in plant foods. For example, in the U.S. the high plains of northern Nebraska and the Dakotas are very high in selenium, whereas some regions of China and Russia are very low in selenium (Longnecker *et al.* 1991).

Some meat and seafood contain selenium. Animals that consume selenium-rich plant foods have higher levels of selenium in their muscle. Meat and bread are common sources of dietary selenium Some nuts are very good sources of selenium, particularly Brazil nuts and Walnuts (Pennington and Young 1991; and Pennington and Schoen 1996).

How Much is Needed?

The RDA (Recommended Dietary Allowance) is defined as the average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97-98%) individuals in each stage of life and gender group (IMFNB 2000). As shown in Table 1, adult (19 over) men and women require 55 µg daily, whereas, pregnant and lactating women rise to 60 µg and 70 µg, respectively.

When Can Selenium Deficiency Occur?

Obviously low selenium intake will cause selenium deficiency. Keshan Disease, resulting in an enlarged heart and poor heart function (Levander and Beck 1997) has been observed in low-selenium areas of China, where the dietary intake is less than 19 µg per day for men and less than 13 µg per day for women (Levander 1991).

Selenium deficiency has been seen in people who rely solely on total parenteral nutrition (TPN) for nutrition (Itokawa 1996; Abrams *et al.* 1992). TPN is a method of feeding nutrients through an intravenous (IV) line to people with digestive dysfunction. Selenium supplementation has become routine during TPN administration (Gramm *et al.* 1995).

Selenium depletion or deficiency may also be caused by severe gastrointestinal disorders, such as Crohn's disease, that reduces the absorption of selenium (Rannem *et al.* 1998). Most selenium depletion or deficiency cases are associated with severe gastrointestinal problems, such as in individuals who have had over half of their small intestines surgically removed (Rannem *et al.* 1992; Bjerre *et al.* 1989).

Some Current Issues and Controversies Concerning Selenium

Selenium and Thyroid Function: Selenium is essential for the synthesis of active thyroid hormones, hence, selenium deficiency can affect thyroid function (Arthur 1991). Adequate selenium nutritional status may help protect against some of the neurological effects of iodine deficiency (Corvilain *et al.* 1993).

Selenium and Cancer: Some studies (Russo *et al.* 1997; Patterson and Levander 1997; Knekt *et al.* 1998; Fleet 1997; Shamberger 1985; Young and Lee 1999; and Burguera *et al.* 1990) suggest that people with high selenium blood levels or intake, have less mortality rates (deaths) from cancer, including lung, colorectal, and prostate cancers.

In the U.S., non-melanoma skin cancer incidences are significantly higher in areas with low soil selenium levels (Fleet 1997). From 1983 through the early 1990s, the effect of selenium supplementation on the recurrence of these types of skin cancers was studied in

seven dermatology clinics in the U.S. A 200 µg selenium daily supplementation did not affect recurrence of skin cancer. But it significantly reduced total mortality. In addition, incidences of prostate cancer, colorectal cancer, and lung cancer were lower in the group given selenium supplements (Combs *et al.* 1997).

However, some studies do not show such a relationship between selenium status and cancer. In 1982, over 60,000 participants of the U.S. Nurses Health Study with no history of cancer submitted toenail clippings for selenium analysis. Toenail analysis shows selenium status over the previous year. After three years, researchers compared the toenail selenium levels of nurses with and without cancer. They did not find any apparent benefit of higher selenium levels (Garland *et al.* 1995).

These conflicting results emphasize the need for additional research on the relationship between selenium and chronic diseases such as cancer. France has started a study called the Supplementation en Vitamines et Mineraux AntiXydants, or SU.VI.MAX. It is a prevention trial. Doses of antioxidant vitamins and minerals that are up to three times higher than recommended intakes, including a daily supplement of 100 µg selenium, are given. It is an eight-year study that involves more than 12,000 men and women, and is designed to determine the selenium supplementation effect on the incidence of chronic disease, such as cancers and cardiovascular disease (Hercberg *et al.* 1998).

Different foods package selenium in different biochemical forms. And the body uses these forms differently. Garlic, broccoli, and Brussel sprouts stores selenium in a form that appears to be most active against cancer: selenium methyl seleno-cysteine, or SeMSC. The body simply snips the end off this amino acid to produce the anticancer agent called methyl selenol.

Selenium metabolism affects the risk of colon cancer. Both selenate and selenite salts of selenium can prevent the first of several steps that can lead to cancer, but selenomethionine, the grain form, is ineffective (Mcbride 2000).

Beefed-up broccoli with high selenium content may be the best source of SeMSC. Some commercial California broccoli has up to 50 times more selenium than normal. Selenium enriched by hydroponics can yield broccoli with 100 to 200 times more selenium than the California heads (Finely and Davis 2000).

Selenium and Heart Disease: Some population surveys have indicated that a lower antioxidant intake contributes to a greater incidence of heart disease (Gey 1998). Additional evidence suggests that oxidative stress from free radicals may promote heart disease (Ozer *et al.* 1995). For example, the oxidized form of low-density lipoproteins, LDL, or 'bad' cholesterol promotes plaque build-up in coronary arteries (Lapenna *et al.* 1998). Antioxidants like selenium may help limit the oxidation of LDL cholesterol and thereby help to prevent coronary artery disease (Ozer *et al.* 1995; and Neve 1996). Evidence is still insufficient to recommend selenium supplements for the prevention of coronary heart disease.

Selenium and Arthritis: Patients with rheumatoid arthritis, a chronic disease that causes pain, stiffness, and swelling in joints, have reduced selenium levels in their blood (Kose *et al.* 1996; and Heliovaara *et al.* 1994). Arthritis in some people may be due to low selenium intake (Stone *et al.* 1997).

Free radicals triggered by the body's immune system destroy invading organisms and damaged tissue, but they can also harm healthy tissue (Grimble 1994). Being an antioxidant, selenium may help control free radical levels and help to relieve arthritis symptoms (Aaseth *et al.* 1998). However, further research is necessary.

Selenium and HIV: HIV / AIDS related mal-absorption can deplete many nutrients. Selenium deficiency is commonly associated with HIV / AIDS, and has been associated with a high risk of death from this disease (Patrick 1999; and Baum *et al.* 1997). A five-year observation of 24 children with HIV showed that those with low selenium levels died at a younger age, indicating faster disease progression (Campa *et al.* 1999). A similar study of 125 HIV positive men and women also associated selenium deficiency with mortality (Baum *et al.* 1997).

Selenium may be important because of its role in the immune system and as an antioxidant. Selenium may also be needed for HIV virus replication. This could deplete host levels of selenium (Patrick 1999). The role of selenium in HIV / AIDS is actively being investigated, and clinical trials that evaluate the effects of selenium supplementation on HIV disease progression are being conducted **(**Baum and Shor-Posner 1998).

Excess Selenium and Selenosis: Excess selenium has a moderate to high health risk. High blood levels of selenium (Koller and Exon 1986) can cause selenosis. Gastrointestinal upsets, hair loss, white blotchy nails, and mild nerve damage are symptoms of selenosis. Selenium toxicity is rare in the United States and the few reported cases have been associated with industrial accidents and a manufacturing error that led to an excessively high dose of selenium in a supplement (Raisbeck *et al.* 1993; Hathcock 1997). "Tolerable upper intake levels refer to the maximum intake of a nutrient that is likely to pose no risk of adverse health effects in almost all individuals in the general population". The U.S. Institute of Medicine has set a tolerable upper intake level for selenium at 400 µg per day for adults to prevent the risk of developing selenosis (IM 2000).

Alternative Medicine

Naturopaths use selenium supplements to treat asthma, acne, tendinitis and infertility problems in men, and post-menopausal disorders in women. Because of its role in tissue repair and maintaining youthful skin elasticity, selenium is an important component in naturopathic life extension (longevity) diets.

Since the 1960s, selenium has been used in dandruff shampoos and topical medications for such skin disorders as folliculitis ('hot tub' syndrome) and tinea versicolor, a mild infection of the skin caused by the yeast-like fungus *Pityrosporum orbiculare*.

Selenium combines with sulfur to form selenium sulfide, which has antibiotic and antifungal properties. It is easily absorbed by the epithelium, the outermost layer of skin cells.

Inside the cells, the selenium sulfide splits into selenium and sulfide ions. The enzymes that are responsible for producing new epithelial cells are counteracted by selenium ions. This lowers the turnover of surface skin cells whereby itching and flaking of the skin associated with dandruff and tinea versicolor is reduced (Frey 2002).

Conclusion

Selenium with Atomic Number Z = 34 and Mass Number A = 78.96 has apparent healing properties. It seems to have the potential to cure chronic diseases, or at least lower the mortality rate. However, the necessity for selenium supplementation, has not yet been proven. But the consummation of foods that contain significant amounts of selenium is advisable, and the potential benefits exist. See Table 2 and note that the daily value for selenium is 70. If you need plenty of selenium then, *"Eat Brazil nuts – you squirrel"*. But be on the look out for selenosis!

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Table 1. 2000 RDAs for selenium for adults [1/]

Life-Stage	Men	Women	Pregnancy	Lactation
Ages 19 +	55 µg	55 µg		
All ages			60 µg	70 µg
Results of the Total Diet Study, a national survey conducted by the U.S. Food and Drug Administration (1982-86), indicated that the diets of most adult men and women provide recommended amounts of selenium (Pennington 1996).				

[1/] *(IM 2000)*

Table 2: Mean selenium content of foods [2/]

Food	Micrograms	% DV*
Brazil nuts, dried, unblanched, 1 oz	840	1200
Tuna, canned in oil, drained, 3 1/2 oz	78	111
Beef / calf liver, 3 oz	48	69
Cod, cooked, dry heat, 3 oz	40	57
Noodles, enriched, boiled, 1 c	35	50
Macaroni and cheese (box mix), 1 c	32	46
Turkey, breast, oven roasted, 3 1/2 oz	31	44
Macaroni, elbow, enriched, boiled, 1 c	30	43
Spaghetti w/ meat sauce, 1 c	25	36
Chicken, meat only, 1/2 breast	24	34
Beef chuck roast, lean only, oven roasted, 3 oz	23	33
Bread, enriched, whole wheat, 2 slices	20	29
Oatmeal, 1 c cooked	16	23
Egg, raw, whole, 1 large	15	21
Bread, enriched, white, 2 slices	14	20
Rice, enriched, long grain, cooked, 1 c	14	20
Cottage cheese, low fat 2%, 1/2 c	11	16
Walnuts, black, dried, 1 oz	5	7
Cheddar cheese, 1 oz	4	6
* DV = Daily Value. DVs are reference numbers based on the Recommended Dietary Allowance (RDA). They were developed to help consumers determine if a food contains very much of a specific nutrient. The DV for selenium is 70 micrograms (µg). The percent DV (%DV) listed on the nutrition facts panel of food labels tells adults what percentage of the DV is provided by one serving. Even foods that provide lower percentages of the DV will contribute to a healthful diet.		

[2/] *Total Diet Study (Pennington et. al. 1986) and USDA data bank (USDA 1998).*