Selenium and Human Health

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Selenium (Se), along with iron, zinc, and iodine, is one of a number of essential micronutrients that must be consumed in sufficient amounts in order to maintain human health. Selenium is part of a number of proteins within the human body that play an important role in protecting our bodies from infections. There is evidence for links between the Se status of individuals and the progression of HIV/AIDS in their bodies. Populations consuming insufficient amounts of selenium may be more at risk of dying from HIV infections; early studies suggest that increased consumption of Se slows the progression of HIV to AIDS and results in fewer secondary infections. On the other hand, if over-consumed, Se can be toxic to humans and other animals, although this happens infrequently and is usually a result of contamination by industrial processes. This article will summarize how we are exposed to Se, and where people are at risk of consuming too little Se. It will also suggest strategies for increasing Se consumption.

How do we get selenium?

Selenium is naturally present in very low concentrations in soil, and the concentration varies from region to region. Sometimes levels of Se in soil can vary over relatively short distances. Plants accumulate Se from the soil in which they are grown. Selenium is then consumed by the people (or farm animals) eating the plants. Eating animals (or animal products, such as milk or eggs) that have eaten plants also results in consumption of Se. Many factors influence the amount of Se in foodstuffs, including the concentration of Se in soil; soil conditions such as pH, soil texture (clay vs sand), percent organic matter; and the type of plant grown. Different kinds of plants growing in the same soil can vary widely in the amount of Se they take up and store in their tissues. Selenium can also be taken as a supplement; it is sometimes present in multivitamin supplements containing minerals. Overall, the total amount of Se consumed is determined by the concentration of Se in each food consumed and the amount of each food that is consumed.

How much selenium should we consume? Under what conditions might consumption of selenium be too low?

Recommendations vary somewhat for what is considered a healthy range of Se consumption. According to the Food and Nutrition Board of the Institute of Medicine of the National Academies, the recommended daily allowance for Se for adults is 55 μg/day. Women who are pregnant or lactating are recommended to take in 60 and 70 μg/day, respectively (NIH, 2013). The World Health Organization has set approximately 26-34 μg of Se per day for adults as the minimum recommended level of consumption (FAO/WHO Expert Consultancy, 2002). Consuming less than this increases the risk of adverse health effects. The safe upper limit of Se consumption is around 450 μg/day. Actual consumption of Se varies from country to country (and between regions within countries), with lowest consumption in areas where:

- **Soil concentrations of Se are low and diets are made up of locally-grown foods**. In parts of China known to have low-Se soils, Se consumption was in the range of 2.6 – 11 μg/day, but was higher in other regions. Those living in a low-selenium area of New Zealand consumed 11 μg Se/day. In Finland, Se consumption increased from 26 to 56 μg/day after 1985, when trace amounts of Se were added to chemical fertilizers. In the United States and Canada (where wheat is grown in regions with naturally high levels of Se in soil) daily consumption of Se was found to be 80 to 224 μg/day (EUFIC, 2008).
- **Predominately vegan diets are consumed**. A study from India suggested that daily consumption of Se was 48 μg/day for those consuming conventional diets, but 27 μg/day for a lower income population consuming a vegan diet. Similarly, in Sweden, those consuming a vegan diet consumed 10 μg Se/day, while others consuming a conventional diet consumed 40 μg Se per day (FAO/WHO Expert Consultancy, 2002). A study of Se uptake in Malawi, where commonly consumed vegetables are low in Se, concluded that intake of 20 to 30 μg/day was widespread (Chilimba *et al.*, 2011).

Some have estimated that 0.5 to 1 billion people globally are severely Se-deficient, while even more may consume Se at less-than-optimal amounts. These people may be at increased risk of certain cancers and infectious diseases (Coombs, 2001).

What are some human health issues arising from insufficient consumption of selenium?

More research needs to be done in this area, and definitive conclusions have not been reached. However, there is intriguing evidence of a number of links between low Se and human health.

Keshan and Kaschin-beck Disease: The earliest link between Se deficiency and human health was the discovery that lack of Se can cause Keshan disease. Keshan disease occurred in people living in a region in China known to have extremely low concentrations of Se in soil. Symptoms included fatigue after mild exercise and cardiac problems such as arrhythmia and palpitations and even congestive heart failure (FAO/WHO Expert Consultancy, 2002). Another disease called Kaschin-beck disease was also observed in children in this region of China, and is characterized by stunted growth (shortened fingers, leg and arm bones). The incidence of these diseases in China has dropped since the 1970s due to improvements in nutrition.

Cancer: Adequate Se appears to offer protection from certain types of cancer, including prostate, lung, and colon cancers (Brown and Arthur, 2001).

Immune Function: Ongoing research suggests links between Se and infectious diseases; lack of Se appears to increase the likelihood of submitting to certain viral infections. Researchers are still studying the link between HIV and Se, but HIV clearly causes a decrease in levels of Se in the blood, which is in turn related to the rate at which HIV progresses to AIDS and related to mortality (FAO/WHO Expert Consultancy, 2002).

How can selenium consumption be increased?

There are several ways to increase consumption of Se within a population. But be careful - whatever the method, remember that Se can be toxic when exposures are too high. There is only about a ten-fold window between not enough Se (less than 60 to 70 μg/day) and too much Se (more than 450 μg/day).

Selenium Supplements: One option is to supply supplements to those suspected of having a low Se diet. This is not a great long-term solution, and does not help people in the early stages of certain diseases, but if you are working with people who are HIV positive, it would not hurt to supply Se supplements.

Food Processing: In many parts of the world, certain minerals are added to foods during processing to ensure an adequate supply of these elements in the human diet. For example, sometimes iodine is added to salt, and iron to wheat flour. If you live and work in a region where Se is in low supply, and if there is a food staple that is centrally processed (e.g. flour?), consider whether or not adding trace amounts of Se is possible. In parts of North America and Europe, animal feeds are supplemented with trace amounts of Se both for animals' health and to increase the amount of Se in animal products such as eggs or milk (Melse-Boonstra *et al*., 2007). Like humans, livestock can also suffer negative effects from insufficient Se.

Agricultural Practices: Techniques can be employed to increase the amount of Se in soil, and to increase its bioavailability to plants. In some regions (e.g. Finland), Se is added to chemical fertilizers in order to increase the amount of Se in foods. Selenium is present in compost and animal manures, so maintaining high levels of soil organic matter can help increase Se supply. Soil pH is also important; somewhat similar to phosphate, if soils are acidic, the Se that is present in soil is less easily taken up by plants. Organic matter can buffer against changes in pH, and adding lime can increase soil pH.

Diet: Plants growing in the same plot of ground can differ in the amount of Se they accumulate and store in their tissue. Many fruits and vegetables contain low concentrations of Se. However, plants of the Brassica (e.g. cabbage) and Allium (garlic and onion) genera, certain legumes, and nuts (especially Brazil nuts) tend to accumulate greater amounts of Se. Mushrooms can contain higher amounts of Se as well. Fish and meat (especially organ meat) also tend to be richer in Se. In a survey of staple foods of Malawi and Mauritius, most vegetables contained less than 1 µg Se/ 100 g of the vegetable. The highest concentrations of Se were measured in black chickpea (Cicer arietinum; 138 µg Se/100 g), Kabuli gram (Canjanus cajan; 93 µg Se/100 g), soybean (Glycine max; 78 µg Se/100 g), and Lima bean (Phaseolus lunatus; 53 µg Se/100 g). The Se concentration of animal products ranged from ~ 10 to 70 µg Se/100 g. (Melse-Boonstra *et al.*, 2007). In the same study, the Se content of cereals were studied. Corn flour and rice contained 2.5 and 2.4 µg Se/100 g, respectively, while flours made from millet or sorghum contained 8.0 and 9.3 µg Se/100 g, respectively. As with other crops, while different species can accumulate Se with different efficiencies, the amount of bioavailable Se in soil will have a significant impact on the amount of Se in grain crops. A recent decline in Se consumption by Europeans is believed to be caused by a switch to consumption of grains grown in Europe and away from consumption of grains grown in North America, where they are grown in Se-rich soils (Haug *et al.*, 2007).

Conclusion

Consuming sufficient amounts of Se is very important for maintaining health. Selenium concentrations in soil, and the bioavailability of Se, vary. Plants also vary in their ability to accumulate Se within their tissues. These factors make generalized recommendations difficult to make. If your location and the typical diet in your area suggest less-than-optimal Se consumption, strategies mentioned in this article may work to increase Se in the diet. Readers who suspect they may be in a low-Se region and would like further input can consult the references below, and may also contact ECHO to be put in touch with the author, Edward Berkelaar.

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