

Selenium

Selenium, an essential trace mineral, functions largely through its association with proteins, known as selenoproteins. Several selenoproteins defend against oxidative stress. The selenium content of food depends upon the selenium content of the soil in which the plant or animal food source was grown or raised.

Mushrooms accumulate selenium based on the soil content, with levels highest in those grown in the Midwest (Beelman). Mushrooms provide more selenium than other foods in the produce category and can be a source of this essential mineral for vegetarians. According to the Mushroom Council's Nutrition Labeling Toolkit for Mushrooms (2002), white, brown and Portabella mushrooms are a "good" source of selenium, providing 10 percent of the Daily Value (70 micrograms) per serving (84-85 g). The Institute of Medicine's Food and Nutrition Board in 2000 set the selenium Recommended Dietary Allowance (RDA) at 55 micrograms (mcg) day for both men and women. A serving of mushrooms has the potential to contribute significantly to the 55 mcg RDA for selenium although 70 mcg remains the Daily Value for labeling purposes. According to the National Health and Examination Survey, 1999-2000 for the U.S. population, the mean dietary intake of selenium for all ages and both genders is estimated to be 103 mcg – almost twice the RDA (Ervin).

Consumer awareness

The Council conducted market research to determine selenium awareness among consumers and whether information about selenium's benefits motivates consumers to purchase mushrooms. According to research conducted by telephone in 2000 (Herrmann), a majority – 55 percent – claimed to have heard of selenium prior to the survey. Of these "selenium aware" respondents, 43 percent considered selenium to be nutritionally important. Consumers who were both aware of selenium and considered it important represented less than one-quarter of the survey respondents. The report suggested focusing on the selenium aware group. Although a niche market, the selenium-aware group had identifiable demographics, which could make them easier to reach.

Consumer research in 2004 determined the impact selenium claims on product labels might have to motivate consumers to buy fresh mushrooms (Stanton). In the overall sample, 37 percent of the respondents claimed some knowledge of selenium, which is lower than their awareness of some other less common nutrients (43 percent awareness of lycopene) and considerably lower than awareness of more common nutrients such as vitamin C (97 percent awareness level). However, of those that claim to be somewhat or very nutritionally aware, 84 percent claimed to be aware of selenium.

For the approximately one-third of the overall sample claiming knowledge of selenium, several sample product claims on selenium's benefits had broad appeal. However, the population in general appears not interested in selenium. According to this purchase trigger research, inclusion of a selenium claim on a product may in fact be unfavorable for the general population, although such claims could be effective in targeted stores where selenium aware shoppers frequent.

Anticancer Activity

Selenium has received increasing attention as a possible cancer preventive trace mineral possibly through antioxidant protection and/or increased immune function. The anticancer activity of selenium has been shown in laboratory animals and cell lines. There is evidence from human studies to suggest that selenium may reduce the incidence of cancer when taken in

higher doses than most diets provide – 200 micrograms a day usually as selenium yeast supplements.

Epidemiological studies suggest an inverse relationship between selenium intake and the incidence of certain cancers. Blood or plasma levels of selenium often are lower in patients with cancer than those without, but results of research based on toenail selenium values and the incidence of cancer have been inconsistent (Whanger). Nail clippings are thought to reflect nutritional status for up to a year prior to clipping and thus be an indication of long-term selenium intake compared to blood levels.

An update on the relationship of selenium to cancer (Whanger) and a thorough review of current literature on selenium and prostate cancer describing ongoing clinical trials and preclinical mechanistic studies of different forms of selenium have been published (Meuillet).

Prostate Cancer

A statistically significant inverse association between pre-diagnostic plasma selenium levels and subsequent risk of advanced prostate cancer was observed among men enrolled in the Physician's Health Study (Li). Among men with increased PSA levels at baseline, higher levels of plasma selenium were associated with a reduced risk of all prostate cancer. This research suggests that selenium may affect tumor growth rather than premalignancy development (Taylor).

The Netherlands Cohort Study observed an inverse association between toenail selenium level and prostate cancer risk (van den Brandt). However, in a case-controlled study among British men, fingernail selenium concentration was not significantly associated with prostate cancer risk. Selenium concentration was not associated with localized or advanced disease although men in the highest quartile of selenium nail concentration had a non-significant reduced risk of developing advanced prostate cancer compared to men in the lowest selenium quartile (Allen). Another study compared toenail selenium levels of Austrian men with prostate cancer with that of controls and found that selenium levels did not differ significantly (Lipsky). The nail selenium concentration in both British and Austrian men is lower than that of typical North American populations. Lipsky observes that body selenium levels may not influence prostate cancer incidence noting that toenail selenium levels in North America are twice as high in the Austrian study, yet prostate cancer incidence in North America is greater than in Europe.

Given these and other important findings on selenium and prostate cancer risk, the National Cancer Institute has launched a randomized, double-blind, placebo-controlled prevention trial involving 32,000 men at 400 sites to compare the effect of selenium and vitamin E (SELECT, the Selenium and Vitamin E Cancer Prevention Trial) administered alone versus in combination on the clinical incidence of prostate cancer. The results of the SELECT Trial are years away (2013); recruitment began in 2001 and each man's participation in the trial will last from 7 to 12 years.

Colorectal Cancer

Limited epidemiology published on the association between selenium and colorectal cancer has been mixed, inconclusive and based on small studies (Duffield-Lillico). However, by pooling study populations of large trials, researchers are able to analyze the effect of selenium on specific cancer endpoints with greater accuracy than in individual studies by themselves. A combined analysis of data from three completed clinical trials which tested the effects of various nutritional interventions (wheat bran fiber, low-fat, high-fiber diet or supplementation of vitamin C, E or beta-carotene) on the prevention of recurrence of colorectal cancer, found that the risk of recurrence of a new cancer was lower among those with high blood selenium levels. None of the dietary interventions in the pooled studies involved selenium supplementation – the analysis

related blood levels of selenium to the recurrence of colorectal cancer (Jacobs et al). While each of the trials showed a lower risk of recurrence in subjects with the highest blood selenium level versus those with the lowest – and only one reached statistical significance – the pooled data did show a progressive decrease in the likelihood of colon cancer recurring with higher levels of selenium.

Summary

Since the causes of many types of cancer are largely unknown, it is usually not possible to recommend dietary changes aimed at prevention. However, nutrients such as selenium may offer a way to lower the risk of certain diseases or slow their progression. In different tumor models, different active forms of selenium may be more effective (Whanger) so information about the individual seleno-compound is important to assess potential health benefits. More research is needed to better understand the chemical species and metabolic activity of selenium in foods (Combs 2004). A minireview on the role of selenium in prostate cancer prevention suggested that the chemical form/s of selenium that can be metabolized to methylselenol are those that are thought to be most anticarcinogenically active (Combs 2004). Therefore, evaluating the results of studies on the effects of selenium on cancer and other health conditions requires information on the form of selenium used, the selenium status of the subjects, the biomarkers used such as nail clippings or blood levels and stage of the condition of the disease.

As a result of a contact made by President Minor at a selenium conference sponsored by the USDA ARS Human Nutrition Research Center in Grand Forks, ND, in November, research is underway to identify the specific form of selenium in mushrooms.

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