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Selenium: Another window to reality

When I emerged from Penn Station, Madison Square Garden's billboard caught my eye: "Zeromania."

Was this an apt characterization of our society—the clamor for having the risks of our world reduced to ZERO, chiefly by others (e.g., government)? You know, there's a popular illusion that risks can, in fact, be reduced to zero.

I stepped out on Eighth Avenue to the sound of a police siren, and ventured an unnerving taxi ride to my hotel. Then I went to the restaurant and ordered lobster. The service was slow. I drank a glass of water. I found paper and began to scribble. (I had been reading about toxicity (*1*, *2*).)

Let's see, if the water I had drunk contained the average level of trace elements of natural fresh waters in the U.S. (0.02 ppm) (*3*), then I ingested some 30 quadrillion atoms of selenium, about 2 μg, and "everybody knows that selenium is toxic." (Actually, the standards for drinking water set by man are less than 0.01 ppm), so I probably took in only 10 quadrillion atoms.)

Now, I have drunk this planet's water all my life. I am a member of a species that evolved through millions of years of adaptation to this earth's environment, including its natural waters. Common sense dictates that something is wrong with poorly qualified statements about toxicity—or any other "evil" property—of a natural substance that has been consumed by people for eons. The story of selenium research, with its periods of darkness, brightness, confusion, and surprise, provides an excellent insight into that common-sense thesis.

Selenium is ubiquitous. Bread contains typically 0.4–0.5 ppm (*4*), garlic 0.9 ppm (*5*), one of the finest edible mushrooms, *Boletus edulis*, about 17.8 ppm (*1*). Yet selenium was labeled as a cancer hazard more rapidly than it could be proven to be one.

The initial reports of carcinogenicity were followed by efforts by many researchers, and contradictory findings followed. Then, in 1976, the NAS reported that "Despite an initial report of selenium as a carcinogen, chronic experimental exposure of rats and mice to selenium salts over a period of 12 years has not induced neoplasia" (*6*).

Meanwhile, a number of reports appeared that demonstrated in animal experiments that selenium had *anti*-carcinogenic activity, including correlations showing lower human cancer incidence the greater the selenium content in local vegetation, and therefore presumably in the diet for specific population groups (*7*, *8*).

Whilst these winds were changing in cancer research, other significant developments arose in nutritional research. It was known that excessive intake of selenium by animals grazing on certain selenium-enriching plant species could lead to selenosis, diseases known as blind staggers, and alkali disease (*9*). But in the period from 1956 to 1963, it was shown that selenium not only had useful metabolic functions, it is a necessary trace element in nutrition.

While most people benefit from dietary intake of 60 to 300 μg/day of selenium, amounts below that magnitude can have serious consequences (*10*). For example, in China's Szechuan Province a juvenile heart deficiency called Keshan's disease is associated with the exceptionally low selenium intake in that locality (*11*).

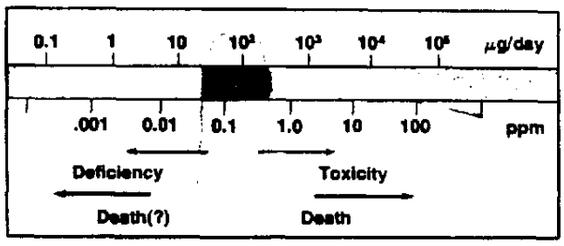

Figure 1. **The window of selenium intake. Upper scale: Total daily intake by man. Lower scale: Average selenium content of food taken by other mammals.**

The story of selenium demonstrates the fallacy of seeking a "zero" in the exposure to a chemical or physical parameter. Intake of selenium appears undesirable, if not unacceptable, below as well as above certain finite values. Figure 1 pictures the selenium window of our real world.

The National Research Council's "safe and adequate" intake of selenium, 50–200 μg per day (*12*), lies in the range of typical exposure on earth (*13*). That makes good sense, as I had guessed from my evolutionary heritage.

Before I knew it my lobster dinner had arrived, and though I enjoyed it I realized that I'd just consumed about 50 mg of arsenic (*14*). But I like crustaceans. Besides, I found that "In rats, 5 ppm arsenic in the drinking water completely prevents signs of selenosis" (*15*).

Postscript: I called the promoter of "Zeromania." "What's Zeromania?" I asked. It's a pop group of singers and dancers whose leader is Renato Zero, I learned.

References

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