Antioxidants: Confirming a heart-y role

In cigarette smokers, vitamin C supplements reduce signs of chemical reactions believed to play a pivotal role in the development of artery-clogging plaque, a new study finds. A second study reports that vitamin C can restore normal functioning to impaired blood vessel walls in otherwise healthy smokers. Together, the reports refine the picture of how antioxidant vitamins combat heart disease.

A wealth of accumulating evidence now implicates free radicals and other oxidants—short-lived, biologically damaging molecular fragments—in aging and a host of chronic diseases (SN: 5/18/96, p. 331; 8/1/92, p. 76). "Because of their very evanescence, [these oxidants] are extraordinarily difficult to measure in the body," notes Garret A. FitzGerald of the University of Pennsylvania Medical Center in Philadelphia.

In 1990, however, a team of researchers led by Jason D. Morrow and L. Jackson Roberts II at Vanderbilt University in Nashville discovered a novel class of chemicals—termed F_2-isoprostanes—produced by the oxidation of fats in the body. In the May 4, 1995 NEW ENGLAND JOURNAL OF MEDICINE, the scientists showed that smokers produce far higher concentrations of these compounds than nonsmokers do.

That was not surprising, since cigarette smoke can flood the body with copious quantities of oxidants. Moreover, smokers tend to exhaust the body's stores of vitamin C—a premier oxidant quencher—more quickly than nonsmokers. The study's real benefit, Roberts says, was to establish that isoprostanes are stable, highly quantifiable markers of internal oxidation that can be tested outside the body.

FitzGerald's team focused on urinary excretion of one isoprostane, known as 8-epi, to explore how a series of treatments altered internal oxidation among 24 smokers in Dublin. They describe their findings in the July 1 CIRCULATION.

During the 3 weeks that six of the volunteers swapped their heavy cigarette habits for nicotine patches, 8-epi concentrations fell about 23 percent; even so, they were about 75 percent higher than concentrations in 24 nonsmokers. The Penn team observed a comparable 8-epi drop in the five heavy smokers who took 2 grams of vitamin C daily for 5 days and in the four who consumed both the vitamin C and 800 international units of vitamin E daily.

In follow-up studies, FitzGerald says he's found that "if you give more E for a longer time, you also get an effect." Nor is this benefit available only to smokers. In recently completed experiments, Balz Frei of Boston University's Whitaker Cardiovascular Institute observed a similar drop in the production of isoprostanes by nonsmokers taking large supplements of vitamin E.

In a second study reported this week in CIRCULATION, Thomas Münzel of the University of Freiburg in Germany and his coworkers injected 10 male smokers with drugs that should make blood vessel walls relax and widen, increasing blood flow. Initially, these men did not respond to the drugs as well as nonsmokers did. However, when Münzel's team infused high concentrations of vitamin C (18 milligrams per minute) into the men's arteries, the smokers largely regained their responsiveness to the drugs.

The finding mirrors one that Frei and his colleagues reported in a March CIRCULATION study of 42 people with established coronary artery disease. Two hours after administering vitamin C orally, Frei's team also observed an improvement in an artery's responsiveness to vessel-dilating drugs.

The use of isoprostanes will result in better studies, FitzGerald predicts. "For the first time, we can develop a rational basis for attributing a role for free radicals in those diseases, for establishing antioxidant doses," and for evaluating antioxidants in disease treatment. —*J. Raloff*

Pressuring potassium to react with nickel

Under immense pressures, chemical elements can adopt new identities, displaying characteristics that differ radically from those seen at normal atmospheric pressure.

Researchers have already found that high pressure can force alkali metals, such as potassium, rubidium, and cesium, into behaving more like transition metals, such as iron, cobalt, and nickel. Now, a team of chemists has used a high-pressure apparatus to induce the formation of various nickel-potassium compounds.

Alkali metals and transition metals normally do not react, says chemist John V. Badding of Pennsylvania State University in University Park. Badding and his coworkers Laura J. Parker and Toshiyuki Atou report their achievement in the July 5 SCIENCE.

These results not only pioneer a new type of high-pressure chemistry but also have implications for geophysics. They suggest that Earth's core, made up largely of iron or an iron-nickel mixture, could also contain potassium.

The researchers used an apparatus called a diamond anvil cell, which consists of a pair of gem-quality diamonds separated by a metal gasket with a small hole that serves as a sample chamber (see diagram). Applying a force to the diamonds squeezes the sample.

Badding and his coworkers compressed a mixture of potassium and nickel powder to 310,000 times atmospheric pressure. They then used an infrared laser to heat the sample to a temperature of about 2,500 kelvins.

The high pressure forced potassium atoms to collapse to roughly one-fifth their usual volume, packing the electrons of each atom more closely together. The pressure also forced the outermost electron of each atom into a type of energy level characteristic of transition metals. Nickel, on the other hand, changed much less under the same pressure, retaining its transition-metal electronic structure.

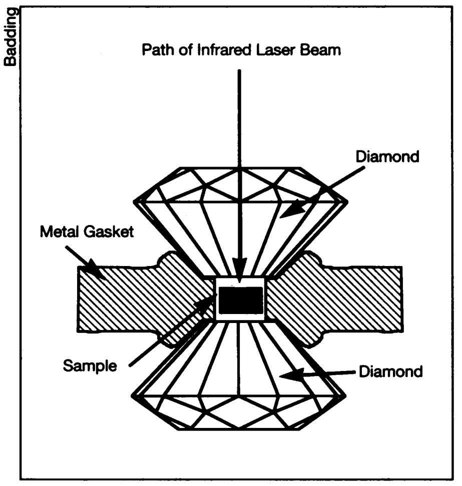
Measurements of the angles at which the resulting material deflected X rays revealed the emergence of a new pattern of deflections, indicating the formation of a compound or alloy after the sample was heated.

"Potassium and nickel are chemically reacting," Badding says. "Some sort of bond formation is taking place."

The observation that potassium can combine with nickel at pressures comparable to those deep within Earth suggests that potassium is a constituent of Earth's core. Seismological measurements indicate that the core is less dense than would be expected for pure iron or an iron-nickel combination, and researchers have postulated that the presence of lighter elements, such as potassium, hydrogen, or carbon, would account for the discrepancy.

The researchers are now preparing to do the same experiment with potassium and iron, as well as trying to characterize the types of nickel-potassium compounds created under high pressure. —*I. Peterson*

Badding



In a diamond anvil cell, two diamonds squeeze a tiny sample to high pressures, while an infrared laser heats it.