Chemistry

Janet Raloff reports from Los Angeles at the American Chemical Society's 196th national meeting

Ap-peeling citrus chemistry

A large U.S. market exists for commercially peeled and sectioned citrus fruit, usually packaged in cans. However, because grapefruits and oranges can be difficult to peel, most of this work is done by hand — a process both time consuming and labor-intensive, and one that wastes up to 30 percent of the edible fruit. Two decades ago, 20 processing plants produced citrus sections in Florida; today there are only two. Labor costs have driven most of this industry overseas, says Robert A. Baker, a research chemist with the U.S. Department of Agriculture Citrus and Subtropical Products Laboratory in Winter Haven, Fla. But Baker believes a simple chemical process patented by his lab could bring much of that industry back home.

The sponge-like citrus peel is primarily air space. Baker's new process submerges fresh fruit in a water bath containing pectinase — an enzyme able to break down the intercellular cement that holds cells of the peel together. When a vacuum is applied, air bubbles out of the fruit's peel. Then the vacuum is released, driving the dilute pectinase solution into a peel's pores. Fifteen to 30 minutes later, the peel will slip off as cleanly as a tangerine's, Baker says. And because a little of the nontoxic, FDA-approved enzyme also attacks the pectin holding together sections of the fruit, they too separate as easily as the segments of a tangerine.

Because each sectioned piece retains its membrane covering, the fruit is firmer — holding open the prospect that mechanical processes might eventually do the peeling and separating. This process also offers producers 100 percent of the edible fruit. In fact, Baker suggests, fresh sectioned fruit might be sold without being immersed in juice or syrup — perhaps as a refrigerated snack food or a nonmushy offering at salad bars.

Radon: Is a little good for you?

Risks now associated with low-dose exposures to ionizing radiation have been extrapolated from effects seen in people exposed to high doses — generally atomic-bomb survivors, recipients of early X-rays, or workers in uranium mines. Because no one has established that there is a threshold to radiation effects — a level below which no hazard exists — policymakers have conservatively assumed that even tiny exposures present some risk. However, controversial new radon studies in humans now challenge the no-threshold view — and even go a step further. They hint, as a few animal studies have, that it's possible some radiation may actually be beneficial.

The studies, by Bernard Cohen at the University of Pittsburgh, compared U.S. data on average indoor-radon levels with average lung-cancer rates for the county in which each measurement was taken. According to the no-threshold theory, Cohen says, one would expect to find a trend toward higher lung-cancer rates for those counties with the highest indoor-radon averages. But to the contrary, he says, "we found there's a strong tendency for counties that have high radon levels to have low lung-cancer rates."

One study, representing data from 415 counties, was based on 39,000 measurements taken in the main living rooms (not basements, where readings are typically highest) of homes in which the residents had purchased their first radon test kit. Based on the radon average, a no-threshold estimate would have predicted female lung-cancer rates 25 percent higher than the national average. Instead, Cohen says, "the data show a 30 percent decrease." Comparisons for men and women in the 10 states for which there are data on 10 or more counties give similar "negative correlations in 80 percent of the cases. And in the states where there is a positive correlation," he adds, "it is very slight and not statistically significant." But this study was clearly nonrandom, since it involved only homes where the residents were worried enough to pay for radon measurements.

In a separate study, Cohen made similar comparisons for about 1,200 homes — this time selected at random — in 40 counties having the highest and lowest U.S. lung-cancer rates. Again, Cohen reports, in every case the radon level for low-lung-cancer counties was much lower than had been predicted, and the radon level in high-lung-cancer counties was much higher than predicted.

He reports similarly perplexing data from Scandinavia. For example, though Finland's average indoor-radon level is about 2.5 picocuries per liter (pCi/l) in air — about 2.5 times the world average — its female lung-cancer rate is only about 70 percent of the average for industrialized countries, he says. Cohen also cites five state-sponsored studies completed within the past year — in Florida, South Carolina, New Jersey and two in New York — that "showed the same trends."

These data do not suggest that people exposed to high radon levels have a low cancer risk, Cohen says, because a large body of data compellingly links high-radon exposures to lung cancer in underground miners. Rather, he says, it calls into question the no-threshold theory — because if there is no threshold, average county measurements should correlate directly with observed lung-cancer incidence. However, should further studies support the negative association found in these studies, Cohen says, scientists may soon be forced to ask the even more revolutionary question: Do small radiation exposures actually confer some sort of protection against lung cancer?

These data "certainly look counter to what you'd expect," says C. Richard Cothern, a radon-risk analyst and executive secretary of the Environmental Protection Agency's scientific advisory board committee on environmental health. But even if Cohen's interpretation is right, Cothern says, the Pittsburgh scientist can't prove it with these studies because "none of his data are truly random — they all have some kind of bias." Rather than prompting criticism of the study design, Cothern says, these biases should be recognized as inherent limitations in the available data.

Diluting radon's water risk

The Environmental Protection Agency ordinarily suggests homeowners consider taking corrective action when indoor radon levels exceed 4 pCi/l. Most of the radioactive gas, estimated to cause up to 20,000 U.S. lung-cancer deaths annually, seeps into homes from the soil. But where soil-radon levels are low or groundwater radon levels are exceptionally high, the offgassing of radon from residential water use can represent a family's major background-radiation threat.

That's the case in some Maine homes, where private well-water supplies carry up to 2 million pCi/l radon — the highest levels recorded in North America. C. Tom Hess at the University of Maine in Orono has just completed a study of water use, ventilation rates and home size to determine how high levels affect whole-house indoor radon concentrations. The results of his 100-home study show that under average conditions, groundwater-radon levels will be diluted 30,000-fold by indoor air.

What's average? A home with 2,000 square feet of floor space, 8-foot ceilings, 250 gallons of water use per day and a total venting of indoor air about once every 1.2 hours. If the house were much smaller, its water use much higher or its ventilation much lower, the dilution factor might be only 10,000 to 1. Under the opposite extremes, he found dilutions of 100,000 to 1 were possible.