Fungi: California's answer to selenium?

In 1985, California's Kesterson National Wildlife Refuge was shut down to limit its further contamination with selenium-tainted irrigation-drainage water (SN: 3/30/85, p.206). The toxic selenium pollution has been held responsible for the poisoning of numerous waterfowl and other animals there. Phased-in measures to clean up the refuge and bury its selenium wastes were due to begin this year at an estimated cost of up to $50 million. But last week soil scientists at the University of California at Riverside unveiled a far less costly alternative — helping fungi convert the pollutant to a nontoxic, gaseous compound that will float away.

William T. Frankenberger Jr. and Ulrich Karlson were not out to solve Kesterson's problem when they began looking for selenium-detoxifying microbes. Says Frankenberger, "We were simply trying to solve an important agricultural problem that is getting more serious all over" — leaching of the toxic mineral out of soils and into drainage water. In the process, however, the scientists identified three aerobic fungi abundant in crop soils — *Penicillium citrium, Acremonium falciforme* and *Ulocladium tuberculatum* — which will convert selenite (SeO_3^{2-}) or selenate (SeO_4^{2-}) salts into harmless volatile compounds through "methylation" (addition of CH_3 groups).

In laboratory tests with Kesterson soil, the scientists got a 300 percent increase in selenium detoxification, or methylation, through the addition of pectin, an inexpensive vegetative carbon source. (Lemon peels, for example, are 75 percent pectin.) Addition of zinc, nickel or cobalt improved methylation three-fold more. In fact, Frankenberger's data indicate "that with further modification we can accelerate this process up to 10-fold." In so doing, their laboratory data suggest, the new process might restore Kesterson to a healthy refuge within a year at almost no cost — something the state's plan would not have achieved. Frankenberger will be proposing to field test his enhanced fungi treatment at Kesterson to both federal and state officials.

Helping spuds defend themselves

Each year, managing insect predation costs potato producers an estimated $120 million, according to the U.S. Department of Agriculture (USDA). And because of growing insect resistance to them, these chemicals are becoming increasingly less effective. Now plant breeders are helping potatoes fight back naturally — with an indigenous pesticide and a bug-catching glue.

At Cornell University in Ithaca, N.Y., scientists are crossing a wild Bolivian potato known as *Solanum berthaultii* with its cultivated North American kin. Explains entomologist Ward M. Tingey, the Bolivian plant bears glandular hairs on its leaves that, when triggered by touch, release a clear chemical. Upon exposure to air, this chemical quickly begins darkening and turning sticky, owing to the presence of the enzyme polyphenoloxidase. Tingey and his colleagues have shown that this chemical system, acting much like flypaper, traps or otherwise seriously glues up the pests that feed on potatoes.

Their data indicate that this defense system works with differing degrees of success not only against the Colorado potato beetle — the most serious U.S. potato pest — but also against many other of the plant's foes. And after seven years of crossbreeding *S. berthaultii* stock, Cornell's Robert Plaisted has armed a number of hybrids with the glandular-hair trait.

Compared to conventional U.S. potatoes, the more successful hybrids suffer 80 percent less from aphids, 90 percent less from leafhoppers and 60 to 80 percent less from flea beetles. Ironically, Tingey notes, although the potato's glue isn't sticky enough to actually entrap the Colorado potato beetle, it does lead them to feed less and rest more — contributing to a reduction in their growth, delay in their maturation and decrease in their reproductive capacity. In fact, he told SCIENCE NEWS, this sticky-chemical system appears to provide some hybrids with about the same protection from Colorado potato beetles as do three or four insecticide applications.

However, while the nontoxic glue works, the hybrids in which it appears are far from commercially acceptable, according to Plaisted: They set their tubers (potatoes) too far from the plant roots and do it too late in the growing season to produce an acceptable yield. While he's optimistic these traits can be corrected, he suspects it may take almost another two decades before an insect-gluing potato makes its commercial debut.

Crossing U.S. cultivars with another wild species, this one from Argentina and Peru, results in a potato that produces its own repellent against Colorado potato beetles — and probably against leafhoppers too. Researchers at USDA's Beltsville (Md.) Agricultural Research Center (BARC) found that *S. chacoense*, an Andean potato, produces the glycoalkaloid leptine in its leaves. Unlike a potato's most common glycoalkaloids — solanine and choconine — this one is acetylated (contains an extra CH_3COOH group on its molecule). The result, explains BARC's Stephen Sinden, is that this chemical is a 10-times more potent inhibitor of insect feeding than the usual glycoalkaloids. Though hybrids are undergoing field tests to quantify the effect of their leaves' unpalatable taste on insect dining (this glycoalkaloid does not appear in the edible tubers), Sinden says that "we're not looking to release this variety." Lacking many attributes demanded by commercial growers, it will instead be used for breeding.

Warning: Peel potatoes before cooking

Potatoes are good food. "In fact," says Cornell University food scientist Nell Mondy, "a diet of only milk and potatoes can supply the human body with all the nutrients it needs." But what part of the potato you eat can make a difference. Toxic glycoalkaloids — solanine and choconine (not leptine) — found in the plant's edible tubers have, in large doses, caused human poisoning. Normally these compounds are concentrated almostly exclusively in the vegetable's skin. But at the June 18 Institute of Food Technologists' annual meeting in Las Vegas, Cornell graduate student Barry Gosselin presented data showing that cooking potatoes in their skins causes these toxic compounds to migrate from the skin into a potato's flesh.

Since a potato produces glycoalkaloids in response to quite variable conditions — including stress (such as drought), improper storage (under a grocer's lights in or warm temperatures), rough handling (bruising) and sprouting — there's no way of predicting the levels in any individual potato, Gosselin says. Depending on their storage and handling, for example, one potato may have negligible levels, while another from the same plant may have levels high enough to cause headaches, nausea and diarrhea in susceptible people. But because about 90 percent of glycoalkaloids start in the skin, most can be removed by peeling.

However, there has been a growing trend, especially in many New York restaurants, according to the researchers, to serve potatoes — particularly new potatoes and other small ones — that were boiled in their skins. Gosselin's studies now show that doing so, even if the potatoes are then peeled before eating, can transfer 10 percent of the skin's glycoalkaloids into the adjacent flesh, a situation he says "could pose a health hazard." Worse still, he believes, is the growing trend to eat these potatoes unpeeled. But his research also points to a more aesthetic reason for peeling potatoes before cooking: It lowers the potato's phenol content, causing less grey-black discoloration after cooking (from a binding with iron).