

Through the Eyes of a Potato

Scientists hunt a better-bred spud, while the earthy vegetable keeps on giving

By DIANE D. EDWARDS

Consider the potato . . . if only for the time it takes to microwave one into soft submission. Unpretentious and modestly dressed, this tuber is taken for granted and occasionally ma-

which contains more than 2,000 potato species and roughly 5,000 varieties. Potato kin include the poisonous nightshade and the more delicate tomato. Unlike true root vegetables, the edible

Potato fields are now green seas of science, with genetically improved spuds huddled underneath. Researchers today are using the latest in computer science, biotechnology and genetics to develop hardier varieties and improve storage methods — modern efforts to make an already important plant even better.

Potato breeding is no simple matter. Most potatoes grown in the United States have 48 chromosomes, while many wild species contain half that number. Different types of potatoes frequently are incompatible and will not accept pollen from one another. And the tiny seeds (60,000 to an ounce) that develop in the plant's aboveground seedballs do not necessarily produce offspring resembling the parent, or even resembling each other. This unpredictability explains why farmers normally plant potatoes not as seed, but as pieces of potato, in order to get a crop of quality-controlled clones.

Scientists at state-owned laboratories, commercial companies and the U.S. Department of Agriculture (USDA) are using a technique called cell fusion in attempts to improve frying quality, inside color, drought tolerance, disease resistance and other traits. Cells from potato leaves are treated with enzymes that dissolve their walls, leaving structures called protoplasts. When mixed in special solutions, protoplasts fuse to combine genetic material from two or more parents, and eventually grow into hybrid plants.

At the USDA's Agricultural Research Service (ARS) in Beltsville, Md., Stephen L. Sinden and his co-workers recently used cell fusion to develop the first hybrid potato with a built-in insect repellent. The fusion introduces a wild-potato gene for the chemical leptine, which stays in the leaves and has been shown thus far to repel Colorado potato beetles and leafhoppers. Sinden says the scientists currently are looking for wild types with even higher leptine levels to fuse with cells from commercial potatoes.

Growing in unexpected colors and shapes, the wild potatoes of South America produce smaller and fewer spuds than do established commercial varieties. But they are a plant breeder's treasure, a hideaway for genetic resistance against disease, drought and frost. For example, a Bolivian potato, blessed with hairy projections that ooze a sticky anti-insect liquid, has lent its genes to new pest-resistant hybrids. Extensive collections of potato genes in the United States, Peru and elsewhere offer endless genetic possibilities. But cross-breeding problems and different chromosome numbers force innovation, like that at the University of Wisconsin in Madison, where scientists have found wild-potato pollen containing



ARS/USDA

Demonstrating the potato's unpredictable genetics, these wild potatoes all come from the same variety. Along with other wild types, they are providing scientists with expanded gene pools for breeding.

ligned. Since humans began eating its wild ancestors more than 8,000 years ago, the domesticated potato has sustained the Inca civilization, attracted the wrath of Scottish clergy for being evil, and lent its name to "couch potatoes" who spend the day in a vegetative state.

Sometimes called aphrodisiac, other times poison, the South American native had to overcome a bad image in Europe and elsewhere. Royalty, including Catherine the Great and Marie Antoinette, helped promote potatoes as socially acceptable food for the upper classes. But no matter how bland or notorious the potato's image, its nutritional value and adaptability to various climates have attracted plant breeders for centuries. Scientists now maintain libraries of potato genes for enhancing the vegetable's already considerable contribution to the world's food supply. The ordinary-looking potato has become a focus of some extraordinary research efforts that range from pollination by hand to the latest biotechnology.

Potatoes belong to the genus *Solanum*,

portion of potato plants is actually a swollen stem, or tuber; commonly known potatoes belong to the species *S. tuberosum*. Only eight species are cultivated worldwide, with an annual global yield of more than 290 million tons — ranking the potato fourth in world agricultural sales behind rice, wheat and corn. Providing more calories per acre than the major cereal grains — and the highest produce-section return for the U.S. grocer — the potato is admired for the fiber, carbohydrates and vitamin C stored in its firm body. Fat-free and 80 percent water, the average potato — peeled and unbuttered — contains only 90 calories.

Would a potato by any other name be so giving? Probably so, since the name potato itself is a misnomer derived from *batata*, a Caribbean Indian word for the unrelated sweet potato. And its tough-sounding nickname, "spud," may come from the spade used to dig the tubers. Whether hailed as *pomme de terre* or (in Irish-English) *praties*, the potato has come a long way since Europeans thought it caused leprosy and syphilis.

a mutation that allows fertilization between wild and domestic potatoes.

Pollination by hand, rather than genetic engineering, is likely to remain the breeder's standard approach for years to come, says ARS scientist Raymon Webb. The painstaking process may require thousands of cross-pollinations and more than a decade before finding one superior specimen. Webb and his co-workers have introduced a dozen new commercial varieties, bred for specific processing methods or growing seasons. A 30-year veteran of potato research, Webb says programs to commercially produce potato seed have had mixed success.

Another USDA scientist found the first viroid ever identified by scientists when studying potato spindle tuber disease, which is transmitted in tubers and seed. (Much smaller than a virus, a viroid is a piece of RNA that infects cells.) With a new screening test that uses special DNA, scientists can now quickly identify contaminated seed potatoes and eliminate the disease from fields. Viral diseases of potatoes are primarily controlled by such careful cultivation practices as the use of certified seed potatoes.



Ward M. Tingey/Cornell

An example of "sticky fingers" at work, this leaf from a wild Bolivian potato species is covered with glandular trichomes, which exude an adhesive that has trapped a green peach aphid. Scientists predict that breeding plants with this trait will help control potato-destroying insects.

The most notorious potato disease is late blight, caused by the fungus *Phytophthora infestans*. When it destroyed European potato crops nearly 150 years ago, Ireland lost more than a million people to starvation and even more to emigration. In the United States, late blight primarily affects potatoes grown in Maine, says William E. Fry of Cornell University in Ithaca, N.Y. Chemicals stop late blight and another fungal disease called early blight, but Fry says the pathogens' resistance to those chemicals is increasing in foreign countries. He and his co-workers are developing computer simulation models to forecast fungal attacks and choose the best time for chemical use. Other researchers are using computers to find the best conditions for long-term potato storage.

Despite these scientific successes,

One potato, two potato . . . more potato lore

For those who have spent root-cellar days twisting sprouts from aging potatoes, the rough-and-ready spud is less than glamorous — despite memories of when Mr. Potato Head used real potatoes, Spud Guns were the rage and the Mashed Potato belonged on the dance floor, not on a plate. But a few facts, substantiated and otherwise, can transform the potato into something more than a humble side dish waiting for a topping.

- To escape from jail, desperado John Dillinger reportedly carved a gun from a potato and turned it black with iodine (he apparently remembered his science lessons).

- According to *Blue Corn & Square Tomatoes* (Rupp, 1987, Storey Communications Inc.), German Emperor Friedrich Wilhelm ordered all peasants to plant potatoes, or have their noses and ears cut off.

- The National Seed Storage Laboratory at Fort Collins, Colo., contains seeds for 5,630 potato varieties and 135 species, and the International Potato Center in Lima, Peru, maintains a comparable collection of living plants.

- Historical accounts suggest the potato first reached what is now the United

States in 1622 as a gift from Bermuda. Thomas Jefferson brought the french fry home from Paris in the late 1700s, and legend says that a century later a grumpy restaurant cook in upstate New York invented the potato chip for a customer angered by too-thick fried potatoes.

- Department of Agriculture sources say U.S. potato exports dropped from about 280 million pounds in 1981 to 87.4 million pounds in 1986, reflecting the general decrease in agricultural exports. Imports remained stable at 280 million pounds. Producers in the United States now are targeting the Far East as a major market for frozen potato products. The Soviet Union is the world's top potato producer, followed by China, Poland and Germany.

- Stems and leaves of the potato plant contain the alkaloids solanine and chaconine, making them unfit for human consumption.

- Describing the aftereffects of too much alcohol, Rudyard Kipling wrote, "I've a mouth like an old potato." Potatoes have been a principal ingredient in vodka, whiskey and wine. Philosopher Friedrich Nietzsche claimed eating piles of potatoes led to liquor use.

Webb thinks "this potato game" has neglected the matter of taste. "Most [potatoes] taste like a bar of soap," he says. "We're doing a good job as far as the processed product goes, but not on the edible, fresh-market qualities . . . like flavor or texture. I call it malleability — how it feels in your mouth."

Out of the laboratory and into the stores, newly bred potatoes join what might be called spud wars, the fight for potato sales and the \$1.7 billion annual U.S. potato crop. "Marketing has induced the public to select the Russett Burbank as a social item," Webb says. "Forty years of advertising moves you to that bin." Long and brown, the Burbank grows in the West and now controls a king's share of the market. Where Maine once ruled as top U.S. potato producer, Washington and Idaho now reign, with Idaho spuds accounting for 35 percent of those sold in the East from November to May.

Webb and others are breeding better potatoes specifically for Eastern growing seasons, while scientists west of the Mississippi are improving their own varieties. A recently developed ARS potato called the Atlantic absorbs less fat during frying than other varieties, and it is chipping away at the processed-potato market. The latest from the ARS program is the new Coastal Russet, a disease-

resistant baking potato that took 10 years to develop. According to ARS plant pathologist Robert W. Goth, this potato stays whiter inside when baked, matures more quickly than the Burbank and grows throughout the United States. It also is resistant to some poetic-sounding diseases: net necrosis, hollow heart and potato scab.

French courtiers once used potato starch to whiten their wigs, and there was a time when any decent picnic included a potato race. But most uses for the potato are more gustatory. Every person in the United States consumes, on the average, 128 pounds of spuds each year (based on the latest USDA figures, from 1986). Federal officials say our growing hunger for fast-food restaurants is fed in part by the 5 billion pounds of U.S. potatoes that become french fries each year. Now fewer than half of the potatoes we mash, boil, fry or bake are purchased fresh at the local market.

Fresh or frozen, chipped or flaked, the potato is firmly planted in the human diet. Despite the calories we pile on top and the tugs-of-war for market shares, the sober spud still offers good food in a quiet way. □

Former *SCIENCE NEWS* staff writer Diane D. Edwards is building a tepee near Big Sandy, Mont., where her father gives an annual refresher course on the right way to plant spuds.