Veggies REINVENTED

Breeding vegetables with more flavor and nutrients

No matter how you slice it, Americans just aren't eating their veggies. According to a recently published USDA study, less than half of 8,000 people surveyed in 1999 and 2000 got their recommended daily servings of fruits and vegetables.

To meet the federal government's MyPyramid dietary recommendations, individuals should munch on anywhere from 2 to 6-1/2 cups of fruits and vegetables each day, depending on their age, gender, and activity levels. For instance, a 50-year-old man who exercises 30 minutes a day should consume about 3 cups of veggies and 2 cups of fruit daily.

Are you making the cut?

If not, take comfort in knowing that Agricultural Research Service (ARS) researchers are on your side. They're working to make the nation's veggie-crunching goals more reachable. And they're taking more of a carrot—and less of a stick—approach.

You've Got To Dazzle 'Em

How do you get people to eat more brussels sprouts, cauliflower, and beets? You excite their senses. Surprise them, say, with unexpected color and explosive flavor. It's a worthwhile tack to take, says Philipp Simon, plant geneticist at the Vegetable Crops Research Unit in Madison, Wisconsin. And he should know.

Simon, who heads the ARS laboratory on the University of Wisconsin campus, helped elevate the humble carrot to its current prestigious position. Thanks to work he did with colleagues more than 25 years ago, the carrot is now an even better source of dietary vitamin A.

Using classical breeding methods, they helped boost the veggie's already abundant stores of beta-carotene by 75 percent. Beta-carotene is what our bodies use to make all-important vitamin A, which is crucial for good eye health and a strong immune system. It's also responsible for the carrot's orange hue.

Simon would like to sneak in other nutrients too. That's why, several years ago, he got to wondering: Why settle for just orange? After all, 700 years ago Western Europeans were feasting on carrots that ranged in color from lemon-yellow to burgundy to purple. We can have the same variety today—and the healthful antioxidants associated with those brightly colored pigments.

In addition to breeding yellow, red, deep-orange, purple, and even white carrots, Simon aims to create a "rainbow" carrot—a multi-pigmented root that naturally contains several antioxidants, such as lycopene, lutein, and anthocyanin.

Other ARS researchers at the Madison lab are just as innovative. Inspired by nature's genetic diversity, they're dreaming up all kinds of eye-catching and palette-tempting veggies.

STEPHEN AUSMUS (D726-33)

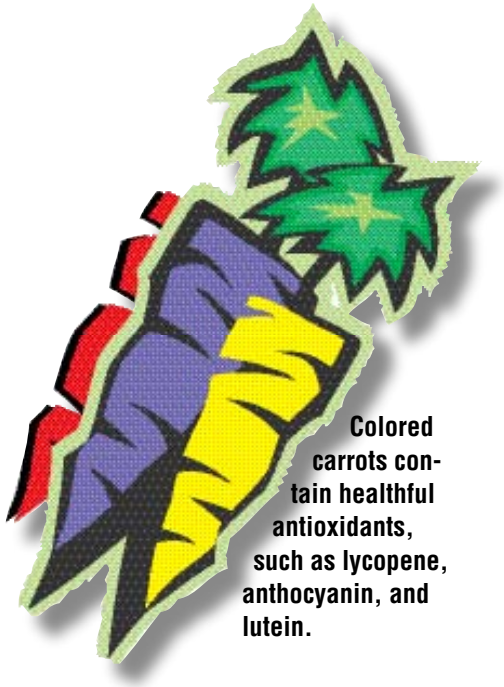
Geneticist Philipp Simon (left) and graduate student Mehtap Yildiz take measurements of garlic to evaluate flowering differences in diverse germplasm.

Potatoes: Mix Them Up!

Given its universal appeal and popularity (it's the most consumed veggie in America), the potato is one vegetable that's not being passed over in the pantry. But that doesn't mean it couldn't stand a little improvement.

STEPHEN AUSMUS (D724-36)

Inside a cage that keeps potential pollinating insects outside, geneticist Mike Havey collects onion seeds during studies to develop new inbred lines of onions. Flies are used as pollinators inside the cage.



Colored carrots contain healthful antioxidants, such as lycopene, anthocyanin, and lutein.

Just ask geneticist Shelley Jansky, who works in Simon's research unit. "Think of apples," she says. "We've got a staggering array of choices when it comes to this fruit. There's Red Delicious, Golden Delicious, Gala, Granny Smith, and so on." She thinks consumers deserve similar variety when it comes to potatoes.

Tapping genetic diversity as it exists in nature or in seed-preserving genebanks is one way to dress up the common potato. Taking advantage of environmental influences is another.

Exploring both routes, Jansky investigated how several factors, including potato variety, production site, and production method, influenced the sensory experiences of a group of volunteers eating baked potatoes.

"I was pretty surprised," says Jansky, "to see how dramatic the link was between flavor differences and the environment."

A Better Baker

Her study involved 13 potato varieties—some heralded as excellent bakers, some considered "so-so"—planted in four locations across Wisconsin. Some were grown in accordance with organic farming standards, others in a conventional manner. A panel of trained taste-testers evaluated the baked potatoes for texture, sweetness, flavor, and overall appeal.

"The panelists detected variations in texture among potatoes grown in different locations," says Jansky. "And some were able to group the organically raised potatoes together, based on taste or texture."

Jansky is repeating the sensory evaluation to see if she gets the same results. If so, she will begin the challenging task of linking desirable qualities with specific entities in the potato or its growing environment.

Even if the current sensory evaluations don't reveal consistent flavor differences among common varieties, Jansky is confident that she'll find fresh, new flavors and textures for pleasing potato enthusiasts. "In a new study, I've included some colorful potato selections with strong South American ties," she says, "and I can always add more."

Jansky's pie-in-the-sky goal? A baked potato that has all the taste of one that's "loaded," but requires little salt, pepper, or sour cream. Because potatoes have hundreds of aromatic compounds that can be subtlety plied and tweaked by expert breeders, she thinks it's altogether possible.

Tradition—With a Twist

But what if you've grown accustomed to classic white potatoes and want to keep them that way, without skimping on nutrition?

That happens to be a goal of ARS geneticist John Bamberg, who manages the agency's U.S. Potato Genebank in Sturgeon Bay, Wisconsin.

"There's a lot of exciting research going on with colored potatoes," he says. "But for many consumers, those might seem like a totally different food compared to the potatoes they're used to."

Just 12 potato varieties account for 90 percent of the spuds grown in the United States. This is in contrast to the 5,000 potato samples—representing nearly 140 species, from the southwestern United States to as far away as southern Chile—held in ARS's U.S. Potato Genebank.

Bamberg and collaborator Creighton Miller at Texas A&M University in College Station are trying to tap some of this wild character. The potatoes they're interested in have ordinary white flesh but are loaded with good-for-the-body antioxidants, including phenolic compounds such as chlorogenic and caffeic acid—and salicylic and p-coumaric acids, too.

"Like most wild species they have tubers the size of marbles," says Bamberg. "Their beneficial traits can eventually be bred into larger potatoes appropriate for a commercial crop."

Bamberg also has a passion when it comes to potatoes and potassium—a mineral that's been shown to lower blood pressure. Along with physiologist Jiwan

Palta at the University of Wisconsin's Department of Horticulture, he's screening the genebank's genetic diversity for stocks naturally higher in potassium.

"Potatoes are already high in potassium, and since we eat a lot of them, they account for a significant part of the average American's daily intake," he says. "So upping potatoes' potassium content, even just a bit, ought to be a practical way to increase the country's overall potassium intake without asking consumers to do anything different."

How Sweet It Is!

The onion has a reputation for being rather unpleasant or difficult. It's been associated with teary eyes, bad breath, flatulence, and indigestion.

That's a real shame, says Michael Havey, a geneticist in the Madison lab, because the onion is a nutritional knockout, containing three different groups of health-enhancing compounds: thiosulfinates, fructans, and flavonoids.

Thiosulfinates are what gives onions their pungent, sulfurlike taste and aroma. Despite their occasional sting and stench, these compounds are some of our bloodstream's best allies: They can bust up platelets that might otherwise form life-threatening troublesome plugs at sites of vascular damage.

Fructans, the most abundant soluble carbohydrate in onions, are a type of dietary fiber shown to reduce rates of colorectal cancers. And onions' flavonoids, such as quercetin, have proven antioxidant activities.

While this trio of impressive compounds is found in today's onions, you've got to be a fan of strong-tasting, ultra-firm varieties to access them. The onions that consumers generally find most pleasant, the so-called sweet onions, are heavily diluted with water and possess fewer health-enhancing compounds.

"And cooking or lightly sautéing onions to soften their bite can reduce thiosulfinates' effects too," says Havey. He aims to develop an onion that's mild in

STEPHEN AUSMUS (D725-6)

Geneticist Mike Havey juices onions to prepare for an analysis of flavor and health-enhancing fructans.

STEPHEN AUSMUS (D728-22)

Horticulturist Jack Staub (center) evaluates melon color with University of Wisconsin graduate research assistant Hugo Cuevas (right) and undergraduate Eric Wiesman. The color rating gives them a measure of relative carotene content and vitamin A content.

taste but still chock-full of heart-healthy nutrients. Before he can do this, though, he has to pinpoint the genetic differences between sweet onions and carbohydrate-dense ones.

Havey and colleagues are most keenly interested in fructans, which also happen to affect thiosulfinate concentrations. In other words, the more fiberlike fructans there are in an onion, the more platelet-busting thiosulfinates there'll be too.

In a recent paper published in the journal *Theoretical and Applied Genetics,* Havey and colleagues report a valuable gene that appears closely involved in fructan accumulation. They've identified its effect and mapped it, placing it on onion chromosome 8.

Havey's also discovered a gene that helps orchestrate sucrose concentrations in onion bulbs. This means it may be possible to boost their natural sweetness while increasing the carbohydrates linked to good health.

The major limiting factor for Havey? The onion's sluggish reproductive cycle. "It takes 2 whole years to get a new generation of onions after performing a cross between two plants," he says. But most consumers would probably agree that a sweet and healthful onion is definitely worth the long wait.—By **Erin Peabody,** ARS.

This research is part of Plant Genetic Resources, Genomics, and Genetic Improvement, an ARS National Program (#301) described on the World Wide Web at www.nps.ars.usda.gov.

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STEPHEN AUSMUS (D730-30)

Cucumbers: Encumbered by Lean Genes

Could the cucumber lose its cool? According to ARS geneticist Jack Staub, it just might.

He says this salad favorite suffers from an overly narrow genetic base. That means if disease strikes or severe drought settles in, it's possible that not just a few cucumber plants will suffer—they all could.

Staub is working to invigorate cucumbers' dismal DNA base with the help of wild relatives from southern Asia, the veggie's birthplace. "It hasn't been easy though," he says, "since domestic cucumbers don't cross easily with wild ones."

Twelve years ago, the Madison, Wisconsin-based researcher got lucky when an unusual wild cucumber species was discovered in China. Excited by its rarity and unlikely Chinese origins (the vegetable originated in India), Staub and a Chinese colleague tried crossing it with a domestic cultivar.

At first, they weren't able to recover any offspring. Then, with the help of a technique called "embryo rescue," some plants survived. And they were fertile, producing valuable seed for additional research.

Staub says that his advanced hybrids now "cross freely with domestic cucumbers." He's evaluating these hybrids for their horticultural potential in hopes of sharing the unique germplasm with breeders all over the world.

Now Staub faces a new obstacle: trying to cross the wild cucumber with its cousin, the melon. Why? Because untamed melons have a lot to offer domestic melons and cucumbers, including resistance to drought and pests. But Staub hasn't been able to achieve a successful cross, even though the plants should be compatible reproductively, since they share the same number of chromosomes.

One of only two public cucumber breeders in the country, Staub will continue trying to solve the mysteries of why the cucurbit cousins won't cross and how such a rare cucumber plant arose in China.

The future of crunchy dill pickles and refreshing cucumber slices could depend on it.—By **Erin Peabody,** ARS.

You Say Tomato . . .

Solanaceae (Soe-luh-NAY-see-ah). It's a mouthful, for sure, but this Latin-derived name describes a plant family that could be considered royalty. It embodies not just one, but two of our most valued vegetables: the tomato and the potato—not to mention other culinary notables such as the eggplant and chili pepper.

This group of premier plants was the focus last July at the 6th International Solanaceae Conference in Madison, Wisconsin. ARS played a key role in organizing the special event, which united more than 550 researchers from 30 countries. Researchers from at least six ARS laboratories attended.

The group's common goal is to use ever-evolving genetic tools to evaluate and organize the diverse Solanaceae family. For the layperson, this research promises new-and-improved fruits and veggies, with a greater zing, zest, and connection to their roots.

According to David Spooner and Shelley Jansky—the ARS researchers who helped organize the conference—the event was especially timely, since the genomes of both the tomato and the potato are currently being sequenced.

To learn more about the conference, go to: www.horticulture.wisc.edu/PAA-Solanaceae.—By **Erin Peabody,** ARS.