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GATORBYTES



BUILDING A

BETTER TOMATO

**THE QUEST TO PERFECT
"THE SCANDALOUS FRUIT"**

UNIVERSITY *of* FLORIDA




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The Quest to Perfect
“The Scandalous Fruit”

Jeff Klinkenberg

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I eat fresh-picked tomatoes like apples—except I sprinkle them with salt and pepper and let the juices run down my chin. It was how I was raised. I learned from my adopted grandparents, Peggy and Walter Turnham, who lived behind us in Miami when I was a little boy back when Ike was president.

Mister Walter's thumbs were as green as the broccoli in his garden, but his forte was tomatoes. He'd grown up on an Alabama farm and the need to grow his own food remained in his DNA. Twice a year the retired mailman worked fish guts into the soil, planted seeds, prayed for rain, plucked off dead leaves, vanquished hungry hornworms, then babied his tender tomatoes like they were his kin, which in a way they were. "Here, honey," Miss Peggy would say as she handed over the bulging paper bag. "Take these 'maters home to your Mama." Scampering over the fence, I bolted through our own kitchen door and gobbled a tomato over the sink like I'd seen Mister Walter do.

I don't know if they were the best tomatoes ever grown, but in my memory—and memory plays a part in taste—they had to have been. Nearly six decades have passed and I still compare any tomato I eat to Mister Walter's.

I'm almost always disappointed. Because I live in a big city now and lack the space to grow my own, I rely on the supermarket for a tomato fix. Once in a while I luck into something tasty, an expensive heirloom perhaps, or one of those greenhouse

bambinos from Mexico or Canada, but like most Americans I'll often grab what looks great. Modern American tomatoes, grown at factory American farms, usually look uniformly excellent. But they're often baseball hard and as savory as tomato-flavored cardboard.

Not long ago, I read about a scientist named Harry Klee, who is trying to make the world a better place for tomato eaters. He knows he'll never make a supermarket tomato as delicious as one grown with love in a garden, but he is sure he can improve the flavor of mass market hardballs through better cross-breeding and chemistry. One of his colleagues, I also read, happened to be one of the world's foremost experts on taste. She was recruiting an army of diverse tasters to test whatever the crazed Klee might come up with.

As a fanatic who loves his marinara and dreams of BLTs, I had no choice but to drive to Gainesville and find out what was going on.

The Tomato Guy

Harry Klee, PhD, works in a one-story building on a rural part of the University of Florida campus. If this were science fiction, he'd wear a white coat and have an assistant named Ygor. But Mary Shelley probably would find his calm, patient personality somewhat disappointing. The only monster that interests him is a better tomato.

Born in 1952, he is old enough to remember when tomatoes tasted like they were supposed to. "I sometimes wonder if there's a whole generation of people who have never eaten a decent commercial tomato," he says. Sometimes, on an airplane, he'll strike up a conversation with a gray-haired stranger about his favorite topic. If he explains he's a molecular biologist he might receive a grunt in reply. If he talks about creating a tastier

tomato his seatmate might start drooling. Those of us of a certain age, serious about our tomatoes, understand completely.

Klee grew up near Boston and enjoyed growing things, but at the University of Massachusetts he studied psychology. Interning at a psychiatric hospital, he wondered if mental illness had as much to do with chemistry as emotional trauma. So he changed focus. In graduate school, he got his doctorate in biochemistry, did postdoctoral work at the University of Washington, toiled in horticulture for Monsanto, and moved to Gainesville in 1995. He served a stint as the director of the university's plant molecular and cellular biology program, but he'll answer to "Tomato Guy" or "Harry." He's considered a world expert on tomato chemistry.

For the record he holds the Dickman Chair for Tomato Improvement. The late Paul Dickman founded Ruskin, Florida's first tomato packing house in 1950; his son Glenn, a Realtor, still grows tomatoes at his "U-Pick" farm. Dickman told me recently he cares passionately about taste, which is why he helps fund Klee's \$2 million program. "The industry can do better," he said.

So how did tomatoes, especially mass-market tomatoes, lose their mojo? Once upon a time—let's say before 1960—tomatoes were a local seasonal crop wherever they were grown. In Harry Klee's boyhood Massachusetts tomatoes were a summer treat, ripened the old-fashioned way, on the vine. Floridians ate them in late fall or early spring. After tomato season we ate watermelon or strawberries.

Tomatoes were temperamental fellows, prone to splitting and bruising, susceptible to cold and drought, heat and humidity, easy pickings for insects. But if eaten straight off the vine they tended to be out-of-this-world delicious. Companies that supplied national markets, though, wanted what Klee calls an "industrial tomato," one hardy enough to survive shipping,

viruses, and insects. An industrial tomato would grow uniformly large and round. It would ripen, not a little at a time, but relatively quickly and evenly. An industrial tomato plant would produce big, profitable boxfuls of indestructible reddish cannonballs.

Scientists, cross-breeding different varieties, developed a kind of Frankenmato. The new boy was big, hard, and round. Picked green, it could be reddened by exposure to ethylene gas and not rot for weeks. A Frankenmato could survive rough handling and bumpy shipping on roads and rails from Atlantic to Pacific. Thanks to the Frankenmato, Florida even became the winter tomato capital of North America.

Taste?

Who cared about taste?

The Fruits of Retronasal Olfaction

Oh, Harry Klee.

About 7,000 varieties of tomatoes are grown on farms, gardens, and greenhouses around the world. Each variety is a compromise of strengths and weaknesses. Some are tasty but delicate. Some are insect resistant but don't tolerate heat. Some require less water than average, some more. Some are large and bumpy, others the size of peas. For Klee, the idea is to find a tasty tomato that is also hardy, large, bug resistant, and will survive a long time on the shelf. The problem: No such tomato apparently exists.

He's been trying to create his own by cross-breeding different varieties, not once but hundreds of times, year after year after year, in the lab, in the greenhouse, in farm fields. And then he analyzes those tomatoes again and again, with a special focus on flavor, specifically the perception of flavor. His challenging work involves taste buds, aromatic volatiles, and

how something called—take a deep breath—retronasal olfaction helps you taste a tomato.

And it's not just him. A veritable crop of scientists has been trying to make a tastier industrial tomato now for years, and for years industrial tomato growers have looked at the new tomato, tasted the new tomato, dribbled the new tomato, and said: "Nope. This doesn't work for us."

Klee's friend and colleague, Jay Scott, actually got close. About a decade ago he developed, through cross-breeding, a tomato he called the Tasti-Lee. It ripened on the vine to a satisfying red, thwarted insects, and tasted better than any mass-market tomato. Alas, industrial growers turned it down—they said it was too small and soft. In 2011, however, Scott's Tasti-Lee was picked up by retailers that include Publix and Costco. It's Klee's ambition to improve on the Tasti-Lee by creating something not only yummiier but acceptable—"acceptable" is the key word—to industrial growers who want big and hard.

Tomato breeding is a competitive enterprise with a cash jackpot as the possible prize. An acceptable mass-market tomato might be worth millions to the winning university and something substantial to the scientist who develops it. Even better, as far as Klee is concerned, a delicious industrial tomato likely will be eaten more frequently than a bland industrial tomato. In a nation populated by couch potatoes, anything that might make us healthier is a welcome bonus.

In Harry Klee's office I sat beneath a poster of tomatoes small and large, round and oval, from all over the Americas. On Harry's desk I counted three jars of tomato sauce and several tomatoes he said tasted good but were too small and misshapen to be acceptable to industrial farmers. Behind him, hundreds of books about tomatoes and cellular biology threatened to tumble from the groaning shelves onto his head.

"I just came back from Japan," he told me. "I was totally

surprised by consumers there. They don't care about cost—they want a tasty tomato. And of course, that's how it is in Italy, France, Spain. You can buy a delicious tomato in any market because they're grown locally and ripened on the vine. In America, it's different. But I do think consumers are becoming more demanding."

Tomatoes are a \$2 billion industry in the United States. In Florida, tomatoes are a \$600 million business. But growers in Mexico and Canada and small farmers who specialize in heirlooms are providing stiff competition for industrial enterprises.

"The tomato industry hates for me to say this but consumers are beginning to walk away from Florida-produced tomatoes," Klee told me. "Really, Florida's tomato industry at this point is surviving basically because the fast-food industry just wants something firm and reddish that slices easily for a salad or a burger."

Ancient Roots, Modern Complexities

Tomatoes, thy name is disappointment.

Decades ago, when it seemed almost impossible to find a good supermarket tomato, I tried growing my own in a backyard garden. My organics, like a colicky infant, kept me hopping. Just when I thought they were going to be okay they'd awaken to the fact that it was hot and humid in Florida, or too cold and dry, and display their displeasure with leaf curl, mildew, dark spots, and alarming white streaks. I'd beg, cajole, sing opera to them, and for a day or so they'd be kind. Then, in the middle of the night, ninja caterpillars somehow would parachute into the garden and eat tomato leaves down to the nubs. Still, a few brave plants lived long enough to gift me with something edible. In the kitchen I devoured them over the sink,

juice dripping, and remembered Mister Walter, mostly with kindness.

Today I live in Pinellas, a densely populated county in west central Florida where commercial agriculture long ago vanished but backyard gardeners flourish. My friend Nicolas Weathersbee brags he last bought a store tomato five years ago and recently started a business, Urban Microfarms, to help rookie gardeners. Another friend, Lyn Van Voorst, a retired elementary school guidance counselor, planted a garden on her St. Petersburg property out of tomato desperation. Soon, envious neighbors were stopping by to admire the bounty. Now some of those same neighbors lease garden plots in her spacious yard. "Everybody wants a delicious tomato," she told me.

Harry Klee grows tomatoes in a greenhouse where plants used in his study sag with all manner of heirlooms and commercial tomatoes. An hour from campus, he maintains a small farm for growing the cross breeds employed in experiments and occasionally for his kitchen. "To tell the truth," he told me, "I'm sick of eating raw tomatoes because I've eaten so many in my work. But I do like to make a fresh marinara sauce."

Tomatoes originated not in Italy but in South America. Wild plants with tiny fruits, they grew in a desert near the Andes. Over the centuries the Inca and Maya domesticated them; by the time Hernando Cortés conquered Mexico City in 1521 the Aztecs were eating tomatoes. Nobody knows who carried the first tomato across the Atlantic, but an Italian herbalist, Pietro Andrea, mentioned them in a paper in 1544. "Golden apples," he called them. He considered tomatoes decorative rather than something to eat.

A marinara recipe showed up in a Neapolitan cookbook in 1692. In North America, Thomas Jefferson grew them because the fruits were pretty; like many English-speakers, he apparently

thought tomatoes, members of the deadly nightshade family, were poisonous. It wasn't until the 1840s that an Ohio farmer, Alexander Livingston, began growing tomatoes on a commercial basis. Florida's first known tomato farm was born in Manatee County in 1870.

Everything about tomatoes seems needlessly complicated. For example, a tomato botanically is a fruit but is usually treated as a vegetable. In 1893, the U.S. Supreme Court made it official—tomatoes were a vegetable and, unlike fruits, eligible to be taxed.

In America, the tomato even has its Mecca. The holy temple is found in Davis, California, at the Charles M. Rick Tomato Genetics Resource Center. It's the repository for tomato seeds and tomato lore from all over the world. Rick, who died in 2002, traveled to South America a dozen times to collect wild seed from what he thought were relatives of prehistoric tomato plants.

Rick comes up in conversation whenever tomato scientists gather. Born in 1915, passionate and generous, he was a true eccentric. He hated the aroma of cigarettes but liked traveling in the smoking section of 1950s-era airplanes because he thought that suave, sophisticated smokers told more interesting stories than milquetoast nonsmokers. He rode a bicycle on campus and seldom wore a shirt. The grizzled scientist once was seen on his knees pawing through a pile of tortoise feces in hopes of collecting an undiscovered tomato seed.

Rick provided rare seeds and tomato DNA to scientists all over the world. Harry Klee, who has visited the Rick Resource Center, planted some in his UF greenhouse. Stone-age tomatoes are about the size of blueberries. "They're pretty good," Klee said.

His day begins early with espresso. A self-professed coffee snob, he grinds the beans, would never think about drinking

from a paper cup. Sometimes he walks outside after breakfast and chases the deer away from his plants. Sometimes he drinks his espresso while reading a snatch of history, perhaps Doris Kearns Goodwin's book about Lincoln or something from *The Science of Cooking*. "To me, cooking is like science. You may have a formula but you still have to adapt because things don't go according to the plan." Perhaps tonight he will cook something French for him and Sharon. Or something that requires tomato sauce.

Cooking up a better-tasting tomato doesn't sound like it should be rocket science. But consider this: We put a man on the moon in 1969 but haven't yet made an industrial tomato taste better.

"What are the most important chemicals that go into what we define as a good tomato?" Klee asked recently in his office. "For that matter, what constitutes a good-tasting tomato? What is its chemistry? Sweet, sour, bitter, salty? You taste those with your tongue. Then there are what we call volatiles or aromatic units. They are what create that explosive taste when you bite into a tomato. You might smell the volatiles through your nose. As you chew your food the aromatic volatiles enter your nasal cavity behind your palate. Perceiving the flavors that way is called retronasal olfaction."

About 400 volatiles, or aroma chemicals, lurk in a typical tomato. Klee's accomplishment was to sort through them all to find the important ones. What was their chemistry? Over about a decade Klee and helpers narrowed the number of volatiles from 400 to 30. By 2014 he believed about a dozen, probably fewer, were key to flavor.

At noon, he eats a sandwich at his desk, or goes out for Thai. Afterward, back in the office, the gourmand pours himself a satisfying glass of high-caffeine Mountain Dew, which will fuel his work the rest of the day.

Over two decades he has grown 200 different kinds of tomatoes, some going back to the nineteenth century. He peruses old seed catalogs for tomatoes that sound interesting and goes hunting. He acquires seed from seed banks, farmers, and home gardeners.

In the spring and fall he grows tomatoes. He tastes them, analyzes them—tries to build a molecular profile. If it's tasty, he may breed it with something that has the advantage of being larger or hardier. He may breed the result with something else. Victor Frankenstein had it easier.

"It's hard work," Klee told me. "And it's slow."

The Queen of Taste

One morning I arrived at the lab early. Test tubes stood at attention and machines hummed. On the wall Elvis Presley—Klee collects kitschy velvet paintings—remained forever The King. Klee was traveling. Denise Tieman, a research assistant professor, was running the tomato show. She looked exhausted. She and Klee's other assistants had spent the previous afternoon kneeling in the rain while picking the latest tomato crop at the UF Farm near Live Oak. The four of them, their bones protesting, had collected 5,000 tomatoes from 245 plants. Because the harvest was for scientific purposes, tomatoes picked from each plant got their own plastic bag, and each plastic bag received an identification number for records that would later be analyzed by computer.

An assistant marched to a table flashing a knife. Her task—the task of every lab assistant—was to start chopping tomatoes, 5,000 of them, into tiny pieces. "I chop so many tomatoes I dream about them when I sleep," research assistant Dawn Bies said.

She carried a container of chopped tomatoes to senior biologist Mark Taylor. His task—cramming tomato chunks into Luke Skywalker’s *Star Wars* Light Saber. At least that’s what it looked like to me. Taylor called the long glass tube a “volatile collection apparatus.”

When the apparatus was stuffed with tomato chunks, Taylor carried it to Tiemen. Her task: screwing the tube into a machine which sucked the volatiles out of the tomato and turned them from liquid to gas. Another machine analyzed the data. A printer sputtered life and spewed out a long graph.

Tieman held a vial under my nose.

One important tomato volatile smelled to me like dirty socks. One, eugenol, had a minty aroma. Guaiacol had a cough medicine odor. Cis-3-hexenal reminded me of fresh-cut grass. Put them together and they said, “You’re eating a tomato.”

“It’s complicated,” Tieman told me. “You should speak to Linda.”

So I did. Linda Bartoshuk is a psychologist, according to her resumé. But those who know her best consider her the queen of taste. She grew up a science-crazy kid in a small South Dakota town. Among her early memories is stargazing in the backyard. In high school during the 1950s, determined to take classes in physics and trigonometry, she was advised to take typing and bookkeeping because of her gender. At Carleton College in Minnesota she majored in astronomy. Two years into her studies she discovered that the hefty telescopes were off limits to women. She changed majors and came to love the study of taste, graduating with a psychology degree. At Brown, she went on to obtain a master’s and doctorate.

She had long hair and wore granny glasses. She was a nerd. She couldn’t dance, wasn’t interested in dancing, liked to talk about science, and married a physicist. In 1971 she began her

career at Yale. She remembers the lab director who noticed her pregnancy and dropped by to say farewell. She explained she had no intention of quitting, that she'd return to work after giving birth. A half century later she can still quote him: "Women like you are going to destroy western civilization."

Civilization failed to crumble. She remained at Yale for 36 years. Among her achievements was proving that post-menopausal women suffering from a burning sensation on the tongue were not imagining their pain, as insensitive physicians sometimes had suggested, but dealing with something physical.

Her "supertaster" work, in 1991, brought her to the scientific world's attention again. Supertasters, she believed, were people "who live in a neon taste world." They might be Paris chefs, a grumpy homemaker next door, or even a pimply-faced college student who subsisted on French fries at McDonald's. But how to prove her theory?

She tested them. She asked participants to touch their tongue to a paper containing propylthiouracil, a bitter chemical. Some, including Bartoshuk, could chew the paper and taste nothing extraordinary. They were "nontasters." Others noticed the bitter taste but found it tolerable. A minority of tasters found the acidic paper sickening. Something physical was at play.

One afternoon, in her office, the queen of taste handed me a small square of paper and asked me to touch it with my tongue. Instantly my eyes watered. The taste was so bitter I thought I might throw up. Bartoshuk looked pleased.

"You might be a supertaster," she said with delight.

She led me into another room, where I sat nervously in a dental chair. Her assistant swabbed my tongue with blue dye. I held a glass slide against my blue tongue. As I lay still, a microscope swooped down and began snapping photographs.

"Look at all those fungiform papillae!" Bartoshuk declared. Fungiform papillae contain neurons sensitive to touch and to

taste. A nontaster might have fewer than 10, a supertaster closer to 50. My tongue was high on the scale. Like most supertasters, I had a lot of taste buds.

In the United States, only about 15 percent of us are so blessed, or cursed, Bartoshuk explained. Women are most likely to be supertasters, an evolutionary advantage. Thousands of years ago a supertaster pregnant woman, or a breastfeeding supertaster mother, would detect poison while eating a plant much faster than an ordinary person and survive. On the other hand, not all bitter plants are poisonous, which meant supertasters ate from a smaller, less healthy menu. Someone who avoids eating nutritious vegetables, in fact, might be more likely to develop cancer.

Soon after Bartoshuk joined the University of Florida faculty in 2007, she began looking for a range of tasters all across campus. She needed supertasters as well as others to sample Harry Klee's tomatoes.

In many ways, she and Klee are peas in the same pod. They are passionate and articulate. When the *New York Times* needs a quote from a certain kind of expert it's their phones that ring. Their achievements have been recognized with membership in the National Academy of Sciences, among the profession's highest honors.

They also are as different as heirloom tomatoes and sweet potatoes. Klee reads history, Bartoshuk prefers science fiction. Klee whips around campus in a BMW sports car, Bartoshuk drives so timidly traffic backs up behind her Honda Fit. Klee eats adventurously, Bartoshuk's food allergies limit her diet. She regards leftover mashed potatoes with Spam a perfect dinner. For breakfast, give her a gluten-free bagel smeared with low-sodium liverwurst.

"YOU THINK I'M GOING TO GIVE UP LIVERWURST?" she asked in a loud voice. "That would suck."

Over the years Bartoshuk assembled an army of 200 volunteers to sample Harry Klee's tomatoes. This one is good, said a supertaster. Nope, not that one. They'd sniff volatiles too. Six volatiles, found in various tomatoes, enhance sweetness, it turned out. Because supertasters prefer sweetness, Bartoshuk points out, Klee theoretically could breed a tomato just for them. Two volatiles depress a tomato's sweetness. Klee could also breed a tomato for folks who like their tomatoes more sour.

Toward a Better Industrial Tomato

Whenever I visit the Everglades, I have to drive past an industrial tomato packing plant that stretches for blocks in Homestead. In fields that stretch to the horizon, pickers by the hundreds march down neat rows with sacks. DiMare Fresh is among North America's largest tomato companies, with 18 offices, farms, or packing facilities found coast to coast. If you have ever bought a large, sturdy, and somewhat reddish tomato from the supermarket, or asked for a tomato on your patty at Burger King, you probably have tasted a DiMare Fresh.

The company began in 1928 in Boston, where teenage brothers Anthony, Dominic, and Joseph sold tomatoes from a pushcart. They worked so hard and saved so much that a banker made them a loan. They bought farm land. In 1950, they bought their first farm and packing house in Homestead, Florida. Paul DiMare, who inherited the business from his father, Anthony, is 73. A member of Florida's Agriculture Hall of Fame, he's known as "Mr. Tomato."

Over the telephone he told me about the challenges facing his industry. They include government regulations, immigration reform, climate change, bad soil, voracious insects, viruses, hurricanes, freezes, droughts, floods, unreliable labor, and unfair

competition from foreign countries. He didn't mention tomato taste until I did. If somebody comes up with a big, commercial tomato that ships well and tastes good, he said he'd be interested. "But it's going to be hard to do that," he said. "Tomatoes are complicated." Anyway, he said, he didn't think the taste of industrial tomatoes was a big problem. If consumers learn to resist cooling their tomatoes in the refrigerator—cold destroys the tomato volatiles—they'll enjoy a better product, he said.

Before we hung up he suggested I talk to his son, Anthony, who manages DiMare Fresh's other huge operation. It's in Ruskin, close to where I live. One afternoon I parked in a huge lot where rumbling trucks laden with green tomatoes were lined up outside of what seemed like a factory. Inside, as we talked, Anthony glanced over my head at a television tuned to the Weather Channel. "Nature never sleeps," he said.

The Ruskin facility boasts 300,000 square feet of warehouse that can accommodate 235 truckloads of tomatoes—400,000 pounds per load—at a time. In late fall and early spring sometimes the plant is processing 9.4 million pounds of tomatoes on any given day.

Anthony showed me around. In the airport terminal-sized warehouse, he had to shout to be heard over the roar of trucks dumping tomatoes into vats that washed away chemicals and debris. From the vats tomatoes tumbled along belts lined by workers in gowns and hairnets who separated tomatoes according to size. Once in a while I noticed workers tossing tomatoes into bins.

"Rejects," DiMare yelled.

The conveyer belts deposited acceptable tomatoes into 25-pound boxes; other belts conveyed the boxes to forklift operators who carried boxes into ripening rooms that smelled of ethylene gas.

The tomatoes were green, but “they’re actually ripe,” DiMare told me. The gas would turn the tomatoes a pale red. Then they would be reloaded onto trucks and shipped to supermarkets and fast-food chains across the country.

I’m a bold guy. I wondered if I might have a few tomatoes to take home for supper.

Anthony pointed me to a box of rejects. They’d been rejected because they had ripened on the vine. In other words, they were ready to eat now.

I carried my small box of tomato rejects into the parking lot and set it on the tailgate of my truck. In the dark I found my shaker, dribbled salt onto the ripe tomato, and took an immodest bite. My refined supertaster tongue analyzed the texture—hmm, a little hard—and perceived the salt and a little sweet. Heading for my gullet, the crushed tomato flesh sent an explosion of volatiles into my nasal cavity. Thanks to my new friend—retronasal olfaction—I tasted the tomato, a trifle sweet, musky, earthy.

It wasn’t a tomato I’d have offered my adopted grandpa, Mister Walter, who might have found it bland, and it wouldn’t have impressed Harry Klee and his exacting standards. But I thought it was okay. At least it was juicy and would make a decent marinara.

On the drive home I remembered my last conversation with Klee.

“How long before you develop a better industrial tomato?” I asked.

“Soon,” he said.

“I’m 65,” I said.

“It’s going to happen during your lifetime.”

I plan to live long enough to taste it.

Further Reading

Tomatoland: How Modern Industrial Agriculture Destroyed Our Most Alluring Fruit by Barry Estabrook.

Ripe: The Search For the Perfect Tomato by Arthur Allen.

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