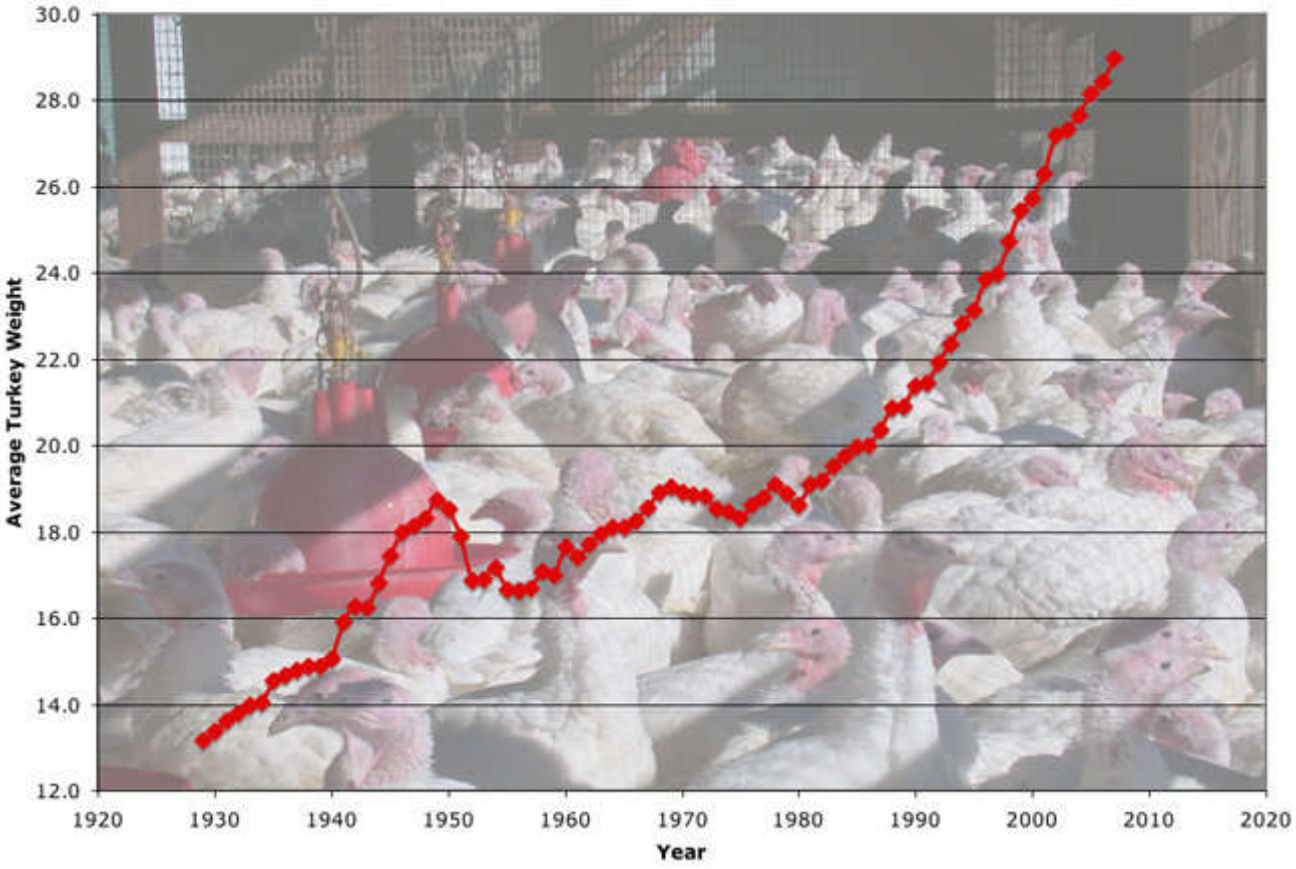
ALEXIS MADRIGAL SCIENCE 11.25.08 5:33 PM

Give Thanks? Science Supersized Your Turkey Dinner



Your corn is sweeter, your potatoes are starchier and your turkey is much, much bigger than the foods that sat on your grandparents' Thanksgiving dinner table.

Most everything on your plate has undergone tremendous genetic change under the intense selective pressures of industrial farming. Pilgrims and American Indians ate foods called corn and turkey, but the actual organisms they consumed didn't look or taste much at all like our modern variants do.

In fact, just about every crop and animal that humans eat has experienced some consequential change in its DNA, but human expectations have changed right along with them. Thus, even though corn might be sweeter now, modern people don't necessarily savor it any more than their ancestors did.

“Americans eat a pound of sugar every two-and-a-half days. The average amount of sugar consumed by an Englishman in the 1700s was about a pound a year,” said food historian Kathleen Curtin of Plimoth Plantation, a historical site that recreates the 17th-century colony. “If you haven’t had a candy bar, your taste buds aren’t jaded, and your apple tastes sweet.”

The traditional Thanksgiving dinner reflects the enormous amount of change that foods and the food systems that produce them have undergone, particularly over the last 50 years. Nearly all varieties of crops have experienced large genetic changes as big agriculture companies hacked their DNA to provide greater hardiness and greater yields. The average pig, turkey, cow and chicken have gotten larger at an astounding rate, and they grow with unprecedented speed. A modern turkey can mature to a given weight at twice the pace of its predecessors.

In comparison with old-school agriculture or single-gene genetic modification, these changes border on breathtaking. Imagine your children reaching full maturity at 10 years old.

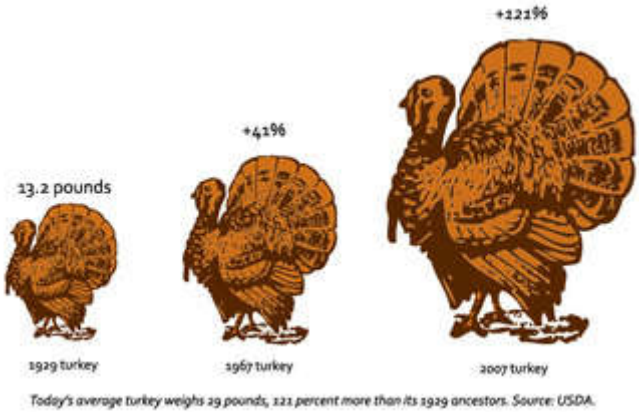
This human-directed evolution has generated animals and plants that share little more than a name with their wild or pre-industrial farm-domesticated relatives. The accumulation of agricultural breeding knowledge and consumer testing has resulted in plants and animals that are physically shaped by consumer tastes. Americans like a medium-size corn kernel, so kernels aren’t too big or small. American consumers like white meat, so turkeys are grown with larger breasts.

The breeding programs of the last half-century are, in some ways, a tremendous scientific accomplishment. For example, the United States pumped out 33 times more pounds of turkey at a lower cost to consumers in 2007 than our farmers did in 1929.

Turkeys more than doubled in size in that time from an average of 13 pounds to an average of 29 pounds, and as seen in the chart above, show no signs of stopping. If the trend continues, we could see an average turkey size of 40 pounds by 2020. According to the National Wild Turkey Federation, the largest wild turkey on record is 38 pounds.

In fact, in commercial and academic turkey-breeding programs, adult male turkeys, called toms, can reach 50 pounds at the tender age of five months, said John Anderson, a longtime turkey breeder at Ohio State University.

“We get 50 pounders at 20 weeks, but that’s at the top edge of our normal distribution,” Anderson said. “We’ve got some adult male-line birds that went over 80 pounds.”



Today's average turkey weighs 29 pounds, 121 percent more than its 1929 ancestors. Source: USDA.

Anderson, who has bred the birds for 26 years, said the key technical advance was artificial insemination, which came into widespread use in the 1960s, right around the time that turkey size starts to skyrocket. The reason is that turkeys over 30 pounds are "inefficient" breeders: It's difficult for them to actually perform the natural mating act. With artificial insemination, the largest birds can still be used as sires, even if they have a hard time walking, let alone engaging in sexual reproduction.

"You can spread the one tom around better. It adds a whole new level of efficiency. You can spread him over more hens," Anderson said. "It takes the lid off how big the bird can be. If the size of the bird keeps them from mating, then you're stuck."

This process, compounded over dozens of generations, has yielded turkeys with genes that make them very big. In one study in the journal Poultry Science, turkeys genetically representative of old birds from 1966 and modern turkeys were each fed the exact same old-school diet. The 2003 birds grew to 39 pounds while the legacy birds only made it to 21 pounds. Other researchers have estimated that 90 percent of the changes in turkey size are genetic.

Perhaps the most obvious change in turkey genetics is that, unlike the colorful pictures we all drew in elementary school, modern, factory-farmed birds are all white. The Broad Breasted White turkey became the dominant commercial breed in the middle of the 20th century.

These fast-growing, big birds are more energy efficient than their forebears. They can convert 2.5 pounds of feed into a pound of body weight. Legacy breeds take a longer time to add weight and can need over 4 pounds of feed to add a pound of weight.

But all that bulk comes with consequences. Commercial turkeys can't fly and researchers have even invented a way of quantifying how impaired the birds' walking has become. The 1-to-5 scale ranges from "birds whose legs did not have any defect" to bowlegged birds who have "great difficulty walking." After 30 years of breeding, Ohio State's big birds average a 3.

The birds also have a hard time regulating their own food intake. In essence, they eat too much and get fat.

“Commercial broiler breeder strains, selected for rapid growth and high meat yields, do not adequately regulate voluntary feed intake commensurate with their energy needs,” wrote two USDA scientists last year. “Consequently, these birds must be given a limited amount of feed to avoid overconsumption that can lead to excessive accumulation of energy stores [fat tissue].”

And some food lovers argue that fast growth and genetic change have robbed turkey meat of its distinctive taste. Some are turning to heritage-breed turkeys like the Blue Slate variety that pack pre-industrial genomes.

“One thing I would say about a modern turkey is that they have a lot less flavor,” said food historian Curtin. “If you’ve ever had a chance to taste a heritage breed, there’s subtleties in turkey.”

Turkey isn’t the only element of the iconic Thanksgiving dinner that science has given an overhaul. Corn breeding has made corn six times sweeter than the variations that the Pilgrims probably encountered back in 1620.

We eat a type of corn called, appropriately enough, sweet corn. The maize that American Indians grew in the 17th century would have been more like the type we feed to animals now, said Bill Tracy, a corn agronomist at the University of Wisconsin-Madison.

The maize would have looked like the ear pictured on the left. Eventually, this type of corn was crossed with the Virginia Southern dent on the right to create the field corn that we feed to animals. You wouldn’t want to eat any of these.

“It wouldn’t have been particularly sweet,” Tracy said.

Sweet corn is the result of a mutation that replaces some of the corn’s starchiness with sugar. It spread from the Iroquois to European settlers in the late 1770s. While it’s considerably sweeter than the nasty stuff the Pilgrims ate — due to a mutation in a gene called Sugary1 — it wouldn’t taste much like the corn we know.

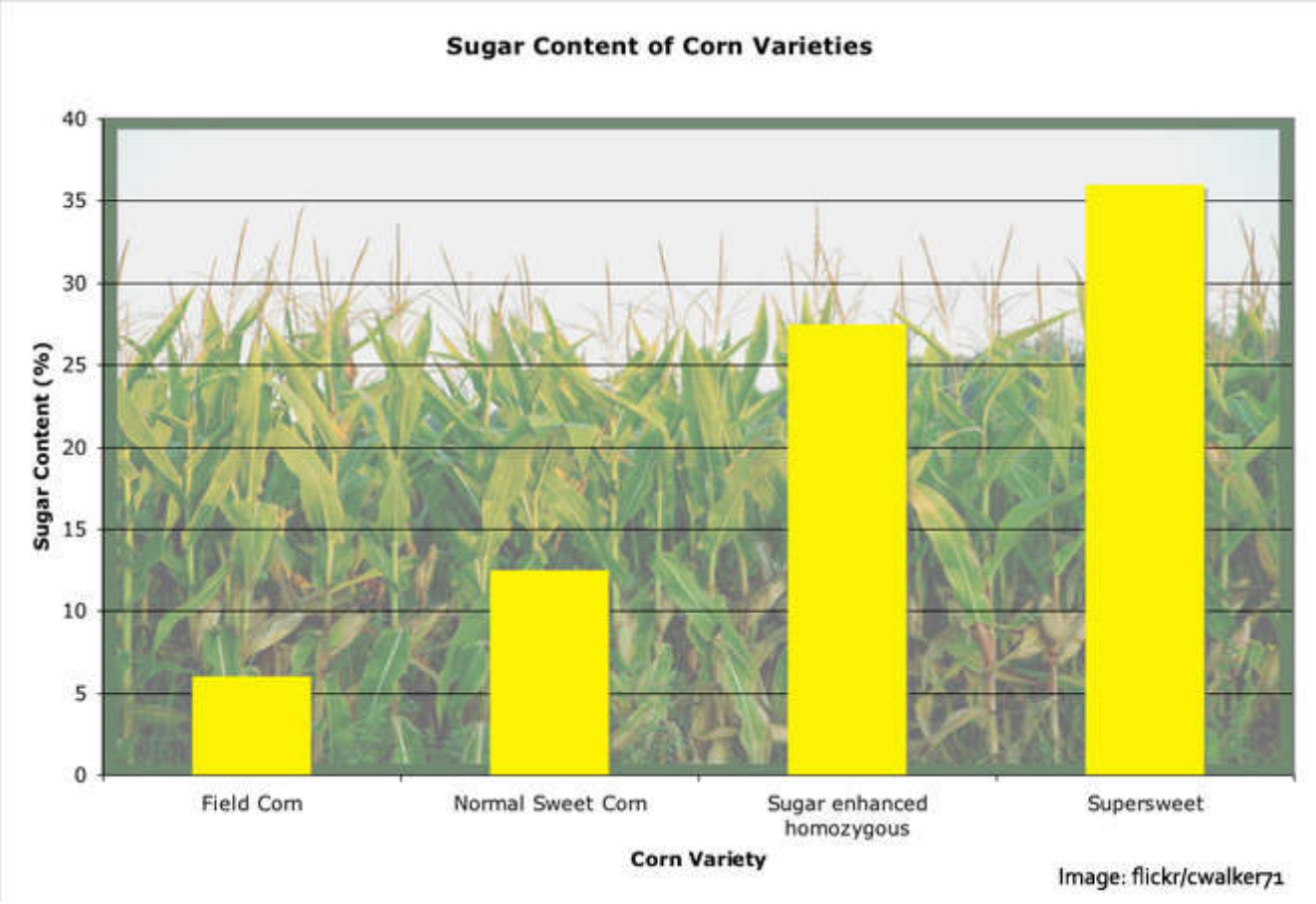
“From that time, it has gone through quite a few changes. Today, through conventional breeding, we have genes in it that make it sweeter, maintain its quality longer, and make it much more tender,” Tracy said. “If people had the opportunity to taste Jeffersonian sweet corn and modern sweet corn, there’d be no question what they’d prefer.”

That original sweet corn was only about 10 percent sugar, but it also was about 25 percent phytoglycogen, lending it a nice, creamy texture. In the next major corn transition — to supersweet corn in the 1970s through a variation in the Shrunken2 gene — that creamy texture was lost, even as the sweetness of the corn skyrocketed.

Among the thirteen genes known to affect corn sweetness, however, industrious agronomists have found an even better gene to work with, called SE, and they made “sugar enhanced corn.”

“That’s the most popular for fresh market today,” Tracy said. “It gives a sugar level of 20 to 25 percent and it turns out to be very tender.”

But even as modern consumers prefer the SE corn — and often find the supersweet corn too sweet — the Shrunken2 corn is making a comeback as retailers prefer its longer shelf life.



Retailer and food processor demands, rather than your fresh-vegetable interests, play a major role in the evolutionary history of potatoes as well. Though they were not present at that original feast, they have been a major part of the holiday since Lincoln created it in 1863.

Potatoes are now driven by a decidedly nonfestive activity: the making of french fries and potato chips. Almost a mirror of corn genetics, agronomists have ratcheted up the starch in potatoes and turned down the sugar, said Gregory Porter, a potato specialist at the University of Maine.

“High-starch french fries, when they fry, don’t get soggy,” Porter said. “Low sugars are important because high sugars in potatoes would result in a dark brown discoloration. High-starch potatoes result in a nice golden-colored fry.”

So the modern potatoes of today, even the round ones that look more like their colonial predecessors, have undergone major biological changes.

“When you look at potatoes that would have initially come in the 1700s, those potatoes weren’t being selected for processing ability,” Porter explained. “Those potatoes probably would have been round and had lower starch content and high sugars. They would not have made good french fries or potato chips.”

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