

How early humans evolved to be able to eat starch



Two new studies found that ancient human ancestors carried a surprising diversity of genes for amylase, an enzyme that breaks down starch like wheat. ADAM RIDING — THE NEW YORK TIMES

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As soon as you put starch in your mouth — whether in the form of a dumpling, a forkful of mashed potatoes or a saltine — you start breaking it down with an enzyme in your saliva.

That enzyme, known as amylase, was critically important for the evolution of our species as we adapted to a changing food supply. Two new studies revealed that our ancestors began carrying more amylase genes in two major waves: the first one several hundred thousand years ago, possibly as a result of humans starting to cook with fire, and the second after the agricultural revolution 12,000 years ago.

"This combination of adapting to diverse environments and modifying our diets is a core tenet of what makes us human," said Omer Gokcumen, a geneticist at the University at Buffalo who led one of the studies, which published Thursday in Science.

As ancient societies developed different diets, the new research suggests, they evolved to have different numbers of amylase genes. Gokcumen speculated that people today who have fewer amylase genes may be more vulnerable to diseases such as diabetes that are fueled by a starch-heavy modern diet. Down the line, the findings could point to potential amylase-based treatments for these diseases. *

"This is obviously in the future, but I think our studies are really setting the stage for doing this," Gokcumen said.

The first clues to the extraordinary history lurking in our mouths emerged in the 1960s, when scientists discovered that some people made extra amylase in their saliva. But only in the past few years has DNA-sequencing technology become accurate enough to decipher the amylase genes people carry in their cells.

"We've been looking at a shadow, and now we're looking at the real thing," said Peter Sudmant, a geneticist at the University of California, Berkeley, who led the second new study, which was published last month in Nature.

Sudmant and Gokcumen's teams cataloged a wide range of amylase copies in people's DNA. Some had a single amylase gene on each copy of chromosome 1, whereas most people had many more — in some cases, as many as 11 copies.

These larger numbers put humans in stark contrast to other species. Chimpanzees and other apes also make amylase in their saliva, but they carry only a single gene for the enzyme.

Gokcumen's team found fossil evidence for how our early ancestors gained more amylase genes. The researchers looked at pieces of DNA retrieved from the bones of hunter-gatherers who lived 45,000 years ago. They estimated these early humans had around five copies of amylase genes. When they looked at Neanderthal fossils, they also found evidence for several copies.

Since the common ancestor of modern humans and Neanderthals lived more than 600,000 years ago, it's possible that extra amylase genes had already evolved by then, perhaps after those hominids had learned to control fire, Gokcumen said.

Before the advent of cooking, our ancestors could get little nutrition from raw tubers and other starch-rich plants. But the heat from fires could break down the tough fibers in the plants, making them more digestible.

"It's night and day with cooking," Gokcumen said.

As people depended more on starch in their diet, he hypothesized, natural selection might have favored those who made more amylase in their mouths. The extra enzymes may have also helped them absorb more nutrition.

In the Nature study, Sudmant also found evidence suggesting that amylase genes started duplicating in our ancestors hundreds of thousands of years ago. While it's possible that fire spurred the evolution of extra amylase genes, Sudmant cautioned that the evidence for the hypothesis remains thin. "That's purely speculation," he said.

Early hunter-gatherers experienced mutations that added even more amylase genes to their DNA. Some experienced mutations that chopped genes out, leaving them with fewer copies than their parents had. But the new studies found no evidence that hunter-gatherers gained any evolutionary advantage from having extra amylase genes.

That changed drastically about 12,000 years ago, the new studies found. It was then, at the end of the last ice age, that a number of societies began domesticating crops, including starch-rich foods like wheat, barley and potatoes.

Across Europe and western Asia, archaeologists have uncovered a vast number of skeletons from this period, from which geneticists have retrieved DNA. The new studies revealed that DNA containing extra amylase genes became more common over the past 12,000 years.

The best explanation for that trend, the scientists concluded, was a pulse of natural selection: People with more amylase genes were much more likely to survive and have children than those with fewer.

Both teams have uncovered additional evidence suggesting that amylase was strongly favored by natural selection not just in Europe and western Asia, but in other places where people shifted to starch-rich diets.

In a study that has not yet been published, Gokcumen's group found that extra copies of amylase rose rapidly in the past few thousand years in Peru, where potatoes were domesticated over 5,000 years ago.

The idea that amylase has experienced intense natural selection in certain regions of the world may sound like "a remarkable and kind of crazy claim," Sudmant said. "But maybe it's not so crazy, because this is a region of the genome that's both plastic and powerful."

Amylase still poses profound mysteries. Today, the amount of enzyme any given individual makes seems to have no major effects on health or reproductive success. If there's no advantage to extra amylase genes today, what ? sort of advantage could they have provided our ancestors?

To answer that question, we may have to rethink the role of amylase in our mouths, Gokcumen said. Researchers have traditionally thought of the enzyme as the first step in our digestion of starch. But perhaps its real job is to provide our bodies with a signal that food is on its way.

