# Team finds an economical way to boost the vitamin A content of maize

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Maize has considerable natural variation in levels of provitamin A, the precursors that are converted to vitamin A upon consumption. These ears of maize are part of a collection of lines derived from an analysis that identifies different forms of a gene that influences concentrations of provitamin A. Credit: Photo by Catherine Bermudez Kandianis

A team of plant geneticists and crop scientists has pioneered an economical approach to the selective breeding of maize that can boost levels of provitamin A, the precursors that are converted to vitamin A upon consumption. This innovation could help to enhance the nutritional status of millions of people in the developing world.

The new method is described this week in the journal *Science*.

The team includes scientists from Cornell University, the University of Illinois, Boyce Thompson Institute, DuPont Crop Genetics Research, the University of North Carolina, the City University of New York, the International Maize and Wheat Improvement Center and the U.S. Department of Agriculture.

The innovation involves a new approach for selecting the parent stock for breeding maize, and significantly reduces the ambiguity and expense of finding varieties that yield the highest provitamin A content available. As part of this investigation, the researchers have identified a naturally mutated enzyme that enhances the provitamin A content of maize.

Vitamin A deficiency is a leading cause of eye disease and other health disorders in the developing world. Some 40 million children are afflicted with eye disease, and another 250 million suffer with health problems resulting from a lack of dietary vitamin A.

“Maize is the dominant subsistence crop in much of Sub-Saharan Africa and the Americas,” the researchers write, “where between 17 and 30 percent of children under the age of 5 are vitamin A deficient.”

Maize also is one of the most genetically diverse food crops on the planet, said Torbert Rocheford, a professor of plant genetics in the department of crop sciences at Illinois and a corresponding author on the paper.

This diversity is tantalizing to those hoping to make use of desirable traits, but it also provides a formidable challenge in trying to understand the genetic basis of those attributes.

One hurdle to increasing the provitamin A content of maize has been the expense of screening the parent stock and progeny of breeding experiments, Rocheford said.

A common technique, called high performance liquid chromatography (HPLC), can assess the provitamin A content of individual plant lines. But screening a single sample costs $50 to $75, he said.

“That’s really expensive, especially since plant breeders like to screen hundreds or more plants per cycle, twice a year,” he said. “The cost was just prohibitive.”

The new approach uses much more affordable methods and gives a more detailed picture of the genetic endowment of individual lines. One technique the researchers employed, called quantitative trait loci (QTL) mapping, allowed them to identify regions of the maize chromosomes that influence production of the precursors of vitamin A. They also used association mapping, which involves studying variation in selected genes and tracking inheritance patterns to see which form of a gene coincides with the highest provitamin A content. Polymerase chain reaction (PCR) allowed them to amplify and sequence the different versions (alleles) of the genes of interest, to find the alleles that boosted levels of vitamin A precursors in the plant.

This approach led to an important discovery. The team found a mutant form of an enzyme vital to the cascade of chemical reactions that produce the precursors of vitamin A in the plant. This mutant is transcribed in lower quantities than the normal allele and steers the biochemistry toward producing higher levels of vitamin A precursors.

The study analyzed 300 genetic lines selected to represent the global diversity of maize, and identified some varieties that came close to the target amount of 15 micrograms of beta-carotene (a form of provitamin A) per gram. Current maize varieties consumed in Africa can have provitamin A content as low as 0.1 micrograms per gram.

The researchers can now inexpensively screen different maize varieties for this allele and breed those that contain it to boost the nutritional quality of the maize, said Rocheford, who also is affiliated with the Institute for Genomic Biology.

Source: University of Illinois at Urbana-Champaign