Fortified cassava could provide a day's nutrition in a single meal

June 30 2008

Scientists have determined how to fortify the cassava plant, a staple root crop in many developing countries, with enough vitamins, minerals and protein to provide the poor and malnourished with a day's worth of nutrition in a single meal.

The researchers have further engineered the cassava plant so it can resist the crop's most damaging viral threats and are refining methods to reduce cyanogens, substances that yield poisonous cyanide if they are not properly removed from the food before consumption. The reduction of cyanogens also can shorten the time it takes to process the plant into food, which typically requires three to six days to complete.

Studies also are under way to extend the plant's shelf life so it can be stored or shipped.

The international team of scientists hopes to translate the greenhouse research into a product that can be field tested in at least two African nations by 2010. Funded by more than $12.1 million in grants from the Bill & Melinda Gates Foundation, the group of researchers is led by Richard Sayre, a professor of plant cellular and molecular biology at Ohio State University.

Sayre presented an update on the BioCassava Plus project June 30 at the American Society of Plant Biologists meeting in Mérida, Mexico.

"This is the most ambitious plant genetic engineering project ever attempted," Sayre said. "Some biofortification strategies have the objective of providing only a third of the daily adult nutrition requirements since consumers typically get the rest of their nutritional requirements from other foods in their diet. But global food prices have recently gone sky high, meaning that many of the poorest people are now eating just one meal a day, primarily their staple food.

"So what we're working on has become even more important in the last year than it was when we started, not just in regions where people are malnourished, but across developing countries where food has gotten so expensive that people can't afford the diverse diet that they're used to."

Cassava (Manihot esculenta) is the primary source of calories for an estimated 800 million people worldwide, including 250 million people in sub-Saharan Africa, the current focus of the Gates-funded project. But the plentiful crop has several drawbacks. It is composed almost entirely of carbohydrates so it does not provide complete nutrition.

"So what we're working on has become even more important in the last year than it was when we started, not just in regions where people are malnourished, but across developing countries where food has gotten so expensive that people can't afford the diverse diet that they're used to."

The roots can be banked in the ground for up to three years, providing food security, but the plant must undergo time-consuming processing immediately after harvest to remove compounds that generate cyanide. Unprocessed roots also deteriorate within 48 hours after harvest, limiting the food's shelf life. And a plant disease caused by the geminivirus reduces yields by 30 percent to 50 percent in many areas in sub-Saharan Africa, a major blow to farm productivity.

Sayre and colleagues from multiple institutions set out to tackle virtually all of cassava's problems to make the plant more nutritious and to increase the crop's revenue-producing potential for farmers.

Sayre reported that the research team has been able to address each of the plant's deficiencies in individual transgenic plants. The next step will be to combine some or all of the bioengineered traits into a single, farmer-preferred cultivar, with the goal of eventually developing cassava varieties that carry all of the improvements developed by the researchers.

"We've begun field trials in Puerto Rico to make sure the plants perform as well outside as they do in greenhouses, and we hope to start field trials in the target countries of Nigeria and Kenya by 2009," Sayre said.

The labs in the project have used a variety of techniques to improve on the model cassava plant used for the research. They used genes that facilitate mineral transport to produce a cassava root that accumulates more iron and zinc from the soil. To fortify the plants with a form of vitamin E and beta-carotene (also called pro-vitamin A because it converts to vitamin A in the body), the scientists introduced genes into the plant that increase terpenoid and carotenoid production, the precursors for pro-vitamin A and vitamin E. They achieved a 30-fold increase in pro-vitamin A, which is critical for human vision, bone and skin health, metabolism and immune function.

Adding protein to the cassava plant has posed a challenge, Sayre said. The scientists discovered that most of the nitrogen required to make the amino acids used for protein synthesis in roots is derived from the cyanogens that also cause cyanide toxicity. So their strategy for increasing protein levels in roots focuses on accelerating the conversion of cyanide-containing compounds into protein rather than completely eliminating cyanogen production, which would hinder the efforts to increase protein production, Sayre explained. To further address the cyanide problem, the scientists have also developed a way to accelerate the processing methods required to remove cyanide – a days-long combination of peeling, soaking and drying the roots before they are eaten.

To strengthen the cassava plant's resistance to viruses, the scientists introduced a protein and small interfering RNA molecules that interfere with the viruses' ability to reproduce.

Prolonging cassava's shelf life has involved the development of a hybrid species that crosses two related plants native to Texas and Brazil. The strategy, still in development, will combine the properties of these plants and additional genes that function as antioxidants, slowing the rotting process that has been traced to the production of free radicals that damage and kill cells in newly harvested cassava roots.

The first cassava product the team plans to develop for investigations in the field will likely include the virus resistance, elevated protein, elevated beta-carotene (pro-vitamin A) and elevated minerals (iron and zinc), Sayre said.

"These traits have been working the best in the greenhouse, and the virus resistance is critical to success in the field," he said. "The thinking behind starting with these four traits is driven by science and by the impact they can have."

The BioCassava Plus project was launched with a $7.5 million grant from the Gates Foundation and recently received an additional $4.6 million in supplemental funding from the foundation to accelerate the application of this research in Africa by African scientists. The supplemental funding will support the training of African scientists so they can produce the transgenic plants in African institutions for use on African farms.

"It will not only be an improved staple crop eaten as a main source of nutrition, but we're also looking at the transformation of cassava from a staple crop to an income-generating crop," Sayre said. "That lifts people out of poverty, allows families to send kids to school and build infrastructure in their villages, so this is an important way to cross cultural barriers. There are many different cultures and languages in Africa, but higher crop yield, productivity, longer shelf life and making money are things that everyone understands."

Source: Ohio State University

Citation: Fortified cassava could provide a day's nutrition in a single meal (2008, June 30) retrieved 4 May 2024 from
https://phys.org/news/2008-06-fortified-cassava-day-nutrition-meal.html