Researchers discover secrets of nutritious corn breed that withstands rigors of handling

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Until the arrival of QPM a decade ago, corn did not provide a balanced protein mix when used as a sole food source. A hybrid developed in 1960 increased protein levels with essential amino acids but was commercially unsuccessful, because its soft kernels subjected the harvest to spoilage.

In a paper posted this week to the online early edition of the Proceedings of the National Academy of Sciences (*PNAS*), Rutgers geneticists reported their findings about genetic coding responsible for making QPM kernels sturdy. The sturdiness results from threshold levels of a specific gene product encoded by two gene copies. Their investigation explains the role of this gene product in generating a protein matrix around starch particles that imparts seed strength.

"While QPM was developed in the late 1990s, scientists have not had a thorough knowledge of how kernel strength could be achieved in a rational way," said Joachim Messing, professor of molecular genetics at Rutgers. "Our work contributes knowledge that will help other scientists develop better hybrids going forward, either through traditional breeding techniques or genetic engineering."

At the same time, the Rutgers findings will help scientists understand more about the evolution of seeds and their components.

Corn is naturally low in lysine and tryptophan, amino acids that are essential to make corn an adequate source of protein. Some societies supplement corn with soybeans or other sources of protein in human food and livestock feed. Yet there are societies, generally in South

America and Africa, where people rely on corn as their sole source of nutrition.

"QPM has made strides in overcoming malnutrition in these populations, but to make it more available to people who need it, modern approaches to breeding called 'marker-assisted breeding' will be superior in adapting local corn varieties for these people," said Messing, who is also director of the Waksman Institute of Microbiology.

As part of the investigation, Rutgers postdoctoral researcher Yongrui Wu used a technique to eliminate, or "knock out," the expression of the genes that geneticists suspected were involved in QPM kernel hardness. After knocking out these two genes, responsible for producing proteins known as gamma zeins, Wu observed softer kernels in the offspring.

Detailed investigation of original and knockout kernels using electron microscopy revealed that soft kernels lacked a proteinaceous matrix interconnecting starchy components while providing structural integrity. Such structures were not present in the knockout offspring. The researchers therefore pegged the gamma zeins regulated by these two genes, labeled 16- and 27-kDa gamma zein, as key components of this molecular structure and, as a result, QPM's hardness.

The softer, commercially unsuccessful hybrid from 1960 had higher levels of lysine and tryptophan because it had reduced levels of several categories of zein proteins, which conferred kernel hardness but crowded out other proteins that carried lysine and tryptophan. QPM has the gamma zeins responsible for the hardness-preserving structure while still lacking other zeins that crowded out nutritional proteins.

Provided by Rutgers University